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Published in:
Quaternary

DOI:
10.3390/quat9010010

2026

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):
Perić, Z., G. Bosnić, M., Marković, R. S., & Marković, S. B. (2026). Comment on Makó et al. Examination of Age-Depth Models Through Loess-Paleosol Sections in the Carpathian Basin. Quaternary 2025, 8, 55. *Quaternary*, *9*(1), Article 10. https://doi.org/10.3390/quat9010010

Total number of authors:
4

quaternary

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Comment

Comment on Makó et al. Examination of Age-Depth Models Through Loess-Paleosol Sections in the Carpathian Basin. *Quaternary* 2025, *8*, 55

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Abstract

This commentary re-evaluates the study by Makó et al. which reconstructs dust accumulation rates from loess–paleosol sequences in the Carpathian Basin. Several methodological and factual issues substantially limit the reliability of their interpretations. The study reports linear sedimentation rates (mm a^{-1}) as mass accumulation rates (MARs) without accounting for bulk density, rendering their values non-comparable with established MAR datasets. It also overlooks a documented systematic bias between ^{14}C and luminescence-derived MARs which are shown to differ by a factor of nearly three in Perić et al., a directly relevant synthesis that is not cited. Furthermore, the conflation of distinct sites (Surduk and Veliki Surduk) and the incorrect attribution of the Surduk section's location indicate errors in basic site metadata. Together, these issues suggest that the reported "high accumulation axis" may reflect methodological artefacts rather than genuine environmental gradients. Improved methodological transparency and consistency are essential for robust regional reconstructions.

Keywords: loess; mass accumulation rates; Carpathian Basin; radiocarbon; luminescence dating; chronological bias; sedimentation rate; Quaternary

Check for updates

Academic Editor: James B. Innes

Received: 10 November 2025
Revised: 20 January 2026
Accepted: 26 January 2026
Published: 30 January 2026

1. Introduction

The paper by Makó et al. [1] aims to reconstruct dust accumulation rates from loess–paleosol sequences (LPS) in the Carpathian Basin, a key region for understanding European Quaternary environments. The study utilizes age–depth modelling to calculate sedimentation rates for twelve profiles. However, the study's conclusions are framed without reference to a critical prior synthesis by Perić et al. [2] that directly addresses the methodological challenges inherent in such an endeavor in the very same region. Our study, "A synthesis of luminescence and ^{14}C dated dust mass accumulation rates for LPSs from the Middle Danube Basin" [2], which analyzed 34 LPS using a standardized Bayesian approach, established that MAR estimates are highly sensitive to the chosen dating method.

We demonstrated a systematic ~2.9× offset between ^{14}C- and luminescence-derived MARs for the same time interval (MIS 2), a bias that arises from methodological differences and material-specific limitations. Makó et al. [1] do not acknowledge this bias, nor do they address key related issues such as the conflation of sedimentation rates with mass accumulation rates (due to omitted bulk density data), insufficient transparency in age–depth model settings, and factual inaccuracies in site metadata, all of which fundamentally undermine their interpretation of regional dust accumulation patterns. Therefore, this discussion aims not only to rectify these omissions but also to re-contextualize Makó et al.'s findings within a more robust methodological framework, one that accounts for systematic dating biases, corrects factual errors, and adheres to standard MAR reporting practices.

2. A Fundamental Methodological Error: Sedimentation Rate vs. Mass Accumulation Rate

A primary issue undermining the quantitative findings of Makó et al. [1] is the conflation of linear sedimentation rates with mass accumulation rates. Throughout their manuscript, the authors report "accumulation rates" in millimeters per year (mm/year) ([1], Abstract, Sections 3 and 4). These values are derived from their age–depth models and represent linear sedimentation rates (SRs). However, in the context of quantifying past atmospheric dust flux and enabling regional comparisons, the critical metric is the mass accumulation rate (MAR), which quantifies the mass of sediment deposited per unit area per unit time (typically in g m^{-2} a^{-1}). The standard method for calculating MAR from an SR is expressed by the following formula:

$$MAR = SR \times BD$$

where BD is the dry bulk density of the sediment (in g cm^{-3}) [3,4]. Alternatively, they could have used the method newly suggested by Cosentino et al. [5] for calculating DMAR (dust MAR). Makó et al. [1] provide no data on dry bulk density for any of their twelve investigated profiles. They do not mention this parameter, perform the conversion, or justify its omission. Consequently, the values they report and use for spatial and temporal interpretation are not true MARs.

This omission is significant for the following reasons:

- It invalidates comparative analysis. Their "accumulation rates" (in mm/year) cannot be directly compared to the vast majority of published loess MAR studies, e.g., [4,6–12], including our synthesis for the same basin [2], which report values in g m^{-2} a^{-1}.
- It oversimplifies depositional processes. Linear sedimentation rates do not account for changes in sediment compaction and porosity. Although Makó et al. [1] introduce stratigraphic boundaries in their Bacon age–depth models, such boundary flags do not automatically correct for compaction or porosity differences. They only indicate where the statistical model is allowed to change its accumulation rate behavior (priors or segmentation); they do not adjust the depth–mass relationship affected by compaction. Therefore, without incorporating bulk density or mass–depth corrections, the reported linear sedimentation rates cannot reflect the true variability in dust deposition because changes in sediment compaction, porosity, and composition, common in alternating loess and paleosol layers, alter the mass–depth relationship. A unit thickness of compacted paleosol represents more mass than the same thickness of uncompacted loess, yet linear rates treat them equally. Only mass accumulation rates (MARs), calculated as SR × BD, capture these mass-related changes and enable meaningful comparisons of dust flux across different lithologies and sites.

https://doi.org/10.3390/quat9010010

- By presenting sedimentation rates as a proxy for dust accumulation without this fundamental conversion, the study's quantitative conclusions about the magnitude of dust deposition are methodologically unsound and potentially misleading.

3. Additional Methodological Concerns

While both studies employ the Bacon age–depth modeling software [13], the level of methodological transparency differs significantly between them. Perić et al. [2] justified their choice of method and applied a standardized set of priors and settings (e.g., 5 cm resolution, 20 cm thickness, sample size = 12,000) across all 34 sites, providing a consistent and reproducible framework. In contrast, Makó et al. [1], while reporting the number of iterations and some stratigraphic boundaries, provide no justification for their chosen priors (e.g., acc.mean, mem.strength) and give no information on key Bacon settings such as thickness (thick), resolution (d.by), and sample size (ssize).

This lack of an explicitly justified modeling approach makes it effectively impossible to independently assess the robustness, reproducibility, and comparability of their individual age–depth models. Without these settings, the models cannot be replicated, and their results remain unverifiable.

Moreover, the internal robustness of their models is questionable even when assessed on their own terms. For instance, their high-resolution radiocarbon model for the Dunaszekcső profile, comprising 133 dates [14] and presented as a chronological benchmark, shows only ~61% of dates within the 95% confidence interval of the model ([1], Section 3.1.5), indicating poor model fit. Without knowing the priors and settings used, it is unclear whether this poor fit stems from inappropriate model assumptions, unresolved chronological noise (e.g., age reversals, reservoir effects in snail shells), or subjective tuning of parameters.

The low fit statistic suggests that the model may struggle to reconcile a dataset with significant internal inconsistencies, possibly reflecting complex depositional or post-depositional processes. A reanalysis of the very data used by Makó et al. [1] reveals at least seven significant age reversals outside 2σ error limits and fourteen depths with double or multiple ages, often based on different shell species. This high frequency of reversals and overlaps points to a complex depositional history. Age reversals and overlaps are most consistent with post-depositional reworking of snail shells (e.g., bioturbation, slope processes) and/or significant reservoir effects in carbonate shells, both of which are well documented in loess sequences. Hiatuses are less likely to produce repeated age reversals, but these cannot be ruled out, especially at paleosol boundaries. The Bacon model, without explicit priors for hiatuses or reservoir offsets, cannot automatically correct for these issues, especially because calibration of land snail ^{14}C ages in this region requires correction for the dead carbon effect [15,16], an offset not accounted for in Makó et al.'s chronology. The low 61% fit statistic directly reflects this data quality, indicating that the model's smooth accumulation curve poorly represents a noisy depositional record. Consequently, the reliability of the derived accumulation rates for this key site is fundamentally undermined.

4. Omission of Relevant Prior Research in the Region

Beyond the core methodological issue, Makó et al. [1] investigate eight sites (Dunaszekcső, Tokaj, Madaras, Katymár, Szeged-Othalom, Crvenka, Surduk, Zmajevac) that were included in the broader comprehensive synthesis by Perić et al. [2]. Our work provided a pan-basin perspective on MAR variability over the last ~130 ka, highlighting significant spatial and temporal patterns. More importantly, it included a substantial analysis of the reliability of the underlying chronologies. The failure to cite this directly relevant and prior published work is a significant oversight, as it deprives the reader of essential context for interpreting MAR values and their inherent uncertainties in the Carpathian Basin.

5. The Central Issue: Systematic Bias from Dating Methodologies

The most critical shortcoming of Makó et al. [1] is that they treated MARs derived from different dating methods as being directly comparable. Our synthesis [2] quantitatively demonstrated that this is not the case.

5.1. Quantifying the Bias

In Perić et al. [2] (Section "^{14}C or luminescence chronologies-which are more suitable for MAR estimates?"), the authors performed a direct comparison of mass accumulation rates (MARs) derived from ^{14}C and luminescence chronologies for the Last Glacial Maximum (Marine Isotope Stage 2—MIS 2). The results were clear and consistent: MARs based on ^{14}C dates ranged from 207 to 1922 g m^{-2} a^{-1}, with a mean of 755 ± 140 g m^{-2} a^{-1}, whereas those derived from luminescence dates (OSL, IRSL, pIRIR) for the same interval ranged from 50 to 426 g m^{-2} a^{-1}, with a mean of 260 ± 43 g m^{-2} a^{-1}. This represents a difference of a factor of 2.9 between the two methods. We addressed this in detail in [2], where we identified that the bias could stem from (1) fundamental differences in the materials dated (organic vs. mineral), (2) systematic errors such as the dead carbon effect in ^{14}C-dated snail shells, (3) the direct dating of sediment deposition by luminescence versus indirect dating of included organics, (4) interaction of these biases with accumulation rate calculations, and (5) commonly known complications in luminescence dating such as incomplete bleaching and anomalous fading, e.g., [17]. This results in consistently higher MARs from ^{14}C chronologies, compared with luminescence chronologies. Despite these well-documented issues and their potential implications for MAR estimates, none of these aspects were considered or discussed by Makó et al. [1].

5.2. Implications for the Makó et al. Findings and the "High Accumulation Axis"

This systematic bias directly challenges the core conclusion of Makó et al. [1]: the identification of a primary north–south axis of high accumulation. This claim is fundamentally unsupported for three primary reasons: insufficient data density, methodological confounding, and a lack of statistical robustness.

First, the claim is an over-interpolation of a spatially sparse and uneven dataset. Making a robust claim about a coherent regional pattern across the entire, geomorphologically complex Carpathian Basin (covering ~300,000 km^2) based on only 12 irregularly distributed sites is not statistically sound. The sites are clustered in certain sub-regions (e.g., several in central Hungary/northern Serbia) while vast areas, particularly in the eastern and western fringes of the basin, are unsampled. With such sparse and uneven coverage, any interpolated pattern (like an "axis") is highly sensitive to the specific location of the few high-value points and may not reflect a genuine, basin-wide process. Robust spatial analysis of regional gradients (e.g., using geostatistical methods like kriging or trend surface analysis) requires a denser, more systematically distributed network of sites to distinguish signal from spatial sampling artefact. While there is no universal minimum number, a dataset an order of magnitude larger (~100+ sites) with strategic spatial coverage would typically be necessary to confidently identify and contour a regional feature like an "accumulation axis" against the background of local site-specific variability. The pattern they observe could easily be an artifact of their specific site selection rather than a genuine basin-wide paleoenvironmental signal.

Second, and most critically, the purported "axis" is perfectly aligned with a methodological dichotomy. The core sites defining this axis (Pécel, Dunaszekcső, Madaras) are exclusively dated using ^{14}C. In contrast, the sites used to define the "lower accumulation" regions (e.g., Zmajevac, Šarengrad, Crvenka) are predominantly dated by luminescence. Given that ^{14}C-derived MARs are systemically ~2.9 times higher than luminescence-derived MARs for the same period [2], the presented spatial pattern could be conflated with a methodological artefact. This methodological split is likely coincidental, arising from historical and practical research choices rather than a deliberate comparative design. In loess studies, the choice between ^{14}C and luminescence dating is often dictated by material availability, target age range, and regional research traditions. However, Makó et al. did not design their study to test for or correct this known methodological bias. They combined datasets from the literature that used different methods, without applying any correction factor or discussing the implications. Therefore, the apparent north–south 'high accumulation axis' aligns perfectly with a north–south '^{14}C vs. luminescence method axis,' making it impossible to disentangle a genuine paleoenvironmental signal from a methodological artefact.

Third, the "axis" is presented as a subjective interpretation rather than a statistically robust feature. It is visualized as a subjective ellipse drawn on a map to connect a few high-value points. Without geostatistical analysis (e.g., kriging, contouring) that accounts for uncertainty and spatial autocorrelation—which would be highly questionable with only 12 points—the "axis" remains a visual assertion, not a quantitatively demonstrated phenomenon [1], p. 11.

Consequently, the assertion that certain areas were "consistently exposed to dust deposition" on the basis of these high ^{14}C-derived rates is problematic. Our synthesis suggests these absolute values are likely overestimates of the true regional atmospheric dust flux. A more scientifically cautious and accurate conclusion from their data would have been "Our data from 12 sites show a cluster of higher calculated sedimentation rates in the central part of our study area, while lower rates were calculated for sites in the east and west. However, this apparent spatial pattern is strongly correlated with the dating methodology employed, with ^{14}C-dated sites yielding systematically higher rates. Therefore, it cannot be determined from the present dataset whether this cluster represents a genuine paleoenvironmental feature or a methodological artefact" [1], p. 11–12.

5.3. Unacknowledged Limitations of Radiocarbon Dating

A further shortcoming of Makó et al. [1] is their implicit assumption that radiocarbon chronologies are inherently more accurate than luminescence chronologies [1], p. 12. While ^{14}C dating often provides higher precision, its accuracy can be significantly compromised by a range of well-documented issues. These include contamination with modern or 'dead' carbon reservoirs and hard-water effects in carbonate materials such as snail shells, issues that cannot be fully avoided even with meticulous sampling and identification, as well as post-depositional carbon exchange and uncertainties arising from calibration curve plateaus, particularly between 20–40 ka [18–22]. Moreover, the effective upper limit of reliable ^{14}C dating (~50 ka) restricts its applicability to younger sediments. Beyond this limit, luminescence methods remain indispensable [23]. None of these inherent constraints are acknowledged in the paper, despite the authors' extensive reliance on mollusk-shell ^{14}C ages. By omitting discussion of these proven limitations, their portrayal of radiocarbon dating as universally "more reliable" introduces an unbalanced methodological bias and obscures important sources of potential chronological error in their dataset. A further and more fundamental limitation concerns the interpretative value of ^{14}C ages derived from mollusk shells in loess. The radiocarbon age of a snail shell reflects the time of shell formation, not the time of loess deposition [15]. Because terrestrial snails live on the ground surface, their shells are incorporated into the sediment slightly after or even long after the primary dust deposition. Consequently, such ages can only approximate, and often postdate, the time of loess accumulation. Moreover, ^{14}C ages of snail shells are, in some cases, affected by the so-called "dead carbon effect," where snails ingest carbon from old, radiocarbon-dead carbonate sources (e.g., limestone dust or pedogenic carbonates). This leads to apparent ages that are systematically older than the true age of shell formation and, therefore, of the enclosing sediment. This leads to apparent ages that are systematically older than the true age of shell formation and, therefore, of the enclosing sediment. Calibrating such ages requires applying a site-specific 'dead carbon fraction' (DCF) or reservoir correction (ΔR), which quantifies the local offset from atmospheric ^{14}C levels, e.g., [15,16]. These corrections are rarely applied in loess chronology, and were not considered by Makó et al., introducing an unquantified systematic bias into their age models. The magnitude of this offset can vary considerably, depending on local geology and environmental conditions [15,16]. These complications make snail-shell ^{14}C ages inherently uncertain, meaning that they provide, at best, minimum age estimates for the timing of loess deposition. Given these well-evidenced issues, ^{14}C dating of snail shells should not be treated as a precise proxy for the depositional age of loess, and any results obtained should always be interpreted in conjunction with independent chronological controls (such as luminescence dating).

6. Factual Errors in the Geographical Locations of Key Sites

Beyond the omission of relevant literature, the paper by Makó et al. [1] contains factual errors concerning the locations of two key study sites. It appears the authors have conflated the Surduk LPS near Belgrade with the Veliki Surduk LPS, which is located on the Titel loess plateau. They cite Radaković et al. [24], a study which explicitly investigates the Veliki Surduk section, yet they apply this reference to the incorrectly located "Surduk" site. These are two distinct and separate sites. The Surduk LPS is a classic and widely documented site in the Serbian loess region, situated on the right bank of the Danube river (45°04′ N; 20°20′ E), approximately 30 km northwest of Belgrade Balkans [25–27] while the Veliki Surduk LPS is located on the northwestern margin of the Titel loess plateau (45°17′40″ N, 20°11′17″ E) near the Mošorin village in Vojvodina, northern Serbia [10]. Both are important and representative reference sites for reconstructing Late Pleistocene paleoenvironmental and paleoclimatic conditions in the Middle Danube Basin, e.g., [10,27]. Their stratigraphy and chronology have been extensively published in numerous high-profile studies over the past two decades, establishing them as key reference sections for the central Balkans. Furthermore, in Section 2.1 from [1], the authors incorrectly state that the Surduk loess–paleosol sequence is located in Croatia. This is factually incorrect. These misattributions are serious oversights that undermine the geographical and contextual accuracy of their dataset and raise concerns about the overall rigor of their data compilation.

7. An Unsubstantiated Claim on Luminescence Dating Reliability

We respectfully disagree with the authors' concluding statement that luminescence (OSL/IRSL) dating is 'generally less reliable for constructing detailed age–depth models'. This broad and dismissive claim is not substantiated by any rigorous analysis within their own study, and reflects a fundamental misunderstanding of chronological reliability. While Makó et al. acknowledge that luminescence dating is essential for older sediments, their conclusion that it is 'generally less reliable for constructing detailed age–depth models' is not supported by a balanced methodological comparison. In fact, numerous studies have successfully constructed detailed and robust age–depth models using high-resolution luminescence chronologies, e.g., [7,11,28–33]. The assessment of Makó et al. is based on comparing high-resolution radiocarbon chronologies with low-resolution luminescence datasets, a method which inherently affects model detail. Moreover, the reliability of a chronology depends on data quality and resolution, not solely on the dating method. Therefore, their broad dismissal overlooks the indispensable role and robustness of luminescence dating in Quaternary research. In particular, their assessment is based on an invalid comparison between high-resolution radiocarbon (^{14}C) chronologies (e.g., Dunaszekcső, with 133 dates) and low-resolution luminescence chronologies (e.g., Šarengrad II, with only 3 dates). It is a foregone conclusion that a model with orders-of-magnitude-more data points will appear more "detailed". Crucially, their own data contradicts this generalization: their OSL-dated Crvenka section, with 12 ages, demonstrated "good internal consistency" (with ~75% of dates within the 95% confidence interval of the model), outperforming their own high-resolution ^{14}C model for Dunaszekcső (~61% within CI). The model's inability to satisfactorily accommodate these dates strongly implies the presence of numerous unresolved outliers [14,34], many of which may be attributable to the very reservoir effects, reworking, and post-depositional processes that the authors fail to acknowledge. This demonstrates that a high quantity of radiocarbon dates does not automatically equate to a high-quality chronology, especially when the dated material possesses inherent vulnerabilities. It also underscores that model reliability is a function of dating resolution and data quality, not the dating method per se. Furthermore, the claim conflates the higher precision (smaller uncertainties) of ^{14}C dates with overall reliability, while ignoring potential issues of accuracy in ^{14}C dating. This unsupported conclusion unfairly discredits a method that is indispensable for dating beyond the range of ^{14}C and which directly dates the sediment deposition event itself.

8. Conclusions and Way Forward

The interpretation of past environmental conditions from loess accumulation records relies fundamentally on methodological rigor and contextual awareness. The study by Makó et al. [1] is hampered by the following:

- A fundamental error in reporting sedimentation rates instead of mass accumulation rates, e.g., [3,4].
- A failure to engage with a demonstrated, major source of systematic error stemming from dating method biases [2].
- Factual inaccuracies with regard to site locations [10,24,25].
- An unsubstantiated and misleading generalization about the reliability of luminescence dating, e.g., [30,35–37].

We argue that the reported "accumulation rates" and the resulting "high accumulation axis" are not robust quantitative findings. The values are not true MARs, and the spatial pattern is defined by a cluster of ^{14}C-dated sites, which our work shows systematically yield higher values. Future work must adhere to standard metrics by properly calculating and reporting mass accumulation rates, expressed in grams per square meter per year ($g\ m^{-2}\ a^{-1}$), through the incorporation of dry bulk density measurements. It is also crucial to explicitly quantify and report methodological bias by addressing potential systematic differences between dating methods within a study area. Furthermore, researchers must ensure factual accuracy by applying greater diligence in basic compilation of site metadata. Finally, assessments of chronological methods should be based on balanced comparisons of resolution and quality matched datasets, acknowledging the distinct strengths, limitations, and appropriate applications of both radiocarbon and luminescence techniques. By integrating these considerations, the scientific community can build more accurate and reliable models of atmospheric dust activity and paleoenvironmental change in the Carpathian Basin and beyond.

https://doi.org/10.3390/quat9010010

Author Contributions: Conceptualization, writing—original draft, preparation, writing—review and editing, Z.M.P.; validation, formal analysis, and investigation, Z.M.P., M.G.B., R.S.M. and S.B.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Makó, L.; Cseh, P.; Hupuczi, J. Examination of Age-Depth Models Through Loess-Paleosol Sections in the Carpathian Basin. *Quaternary* **2025**, *8*, 55. [CrossRef]
2. Perić, Z.M.; Radaković, M.G.; Marković, R.S.; Marković, S.B. A Synthesis of Luminescence and 14C Dated Dust Mass Accumulation Rates for Loess-palaeosol Sequences from the Middle Danube Basin. *Boreas* **2025**, *54*, 179–201. [CrossRef]
3. Kohfeld, K.E.; Harrison, S.P. DIRTMAP: The Geological Record of Dust. *Earth-Sci. Rev.* **2001**, *54*, 81–114. [CrossRef]
4. Újvári, G.; Kovács, J.; Varga, G.; Raucsik, B.; Marković, S.B. Dust Flux Estimates for the Last Glacial Period in East Central Europe Based on Terrestrial Records of Loess Deposits: A Review. *Quat. Sci. Rev.* **2010**, *29*, 3157–3166. [CrossRef]
5. Cosentino, N.J.; Torre, G.; Lambert, F.; Albani, S.; De Vleeschouwer, F.; Bory, A.J.-M. Paleo±Dust: Quantifying Uncertainty in Paleo-Dust Deposition across Archive Types. *Earth Syst. Sci. Data* **2024**, *16*, 941–959. [CrossRef]
6. Fenn, K.; Durcan, J.A.; Thomas, D.S.G.; Banak, A. A 180 Ka Record of Environmental Change at Erdut (Croatia): A New Chronology for the Loess–Palaeosol Sequence and Its Implications for Environmental Interpretation. *J. Quat. Sci.* **2020**, *35*, 582–593. [CrossRef]
7. Stevens, T.; Marković, S.B.; Zech, M.; Hambach, U.; Sümegi, P. Dust Deposition and Climate in the Carpathian Basin over an Independently Dated Last Glacial-Interglacial Cycle. *Quat. Sci. Rev.* **2011**, *30*, 662–681. [CrossRef]
8. Perić, Z.M.; Marković, S.B.; Sipos, G.; Gavrilov, M.B.; Thiel, C.; Zeeden, C.; Murray, A.S. A Post-IR IRSL Chronology and Dust Mass Accumulation Rates of the Nosak Loess-Palaeosol Sequence in Northeastern Serbia. *Boreas* **2020**, *49*, 841–857. [CrossRef]
9. Perić, Z.M.; Marković, S.B.; Avram, A.; Timar-Gabor, A.; Zeeden, C.; Nett, J.J.; Fischer, P.; Fitzsimmons, K.E.; Gavrilov, M.B. Initial Quartz OSL and Dust Mass Accumulation Rate Investigation of the Kisiljevo Loess Sequence in North-Eastern Serbia. *Quat. Int.* **2022**, *620*, 13–23. [CrossRef]
10. Perić, Z.; Lagerbäck Adolphi, E.; Stevens, T.; Újvári, G.; Zeeden, C.; Buylaert, J.P.; Marković, S.B.; Hambach, U.; Fischer, P.; Schmidt, C.; et al. Quartz OSL Dating of Late Quaternary Chinese and Serbian Loess: A Cross Eurasian Comparison of Dust Mass Accumulation Rates. *Quat. Int.* **2019**, *502*, 30–44. [CrossRef]
11. Perić, Z.M.; Stevens, T.; Obreht, I.; Hambach, U.; Lehmkuhl, F.; Marković, S.B. Detailed Luminescence Dating of Dust Mass Accumulation Rates over the Last Two Glacial-Interglacial Cycles from the Irig Loess-Palaeosol Sequence, Carpathian Basin. *Glob. Planet. Change* **2022**, *215*, 103895. [CrossRef]
12. Perić, Z.M.; Ryan, C.S.; Thompson, W.; Radaković, M.G.; Krsmanović, P.; Alexanderson, H.; Marković, S.B. Palaeoenvironmental Changes Recorded at the Velika Vrbica Loess-Palaeosol Sequence, Wallachian Basin, during MIS 3–MIS 1. *Boreas* **2025**. [CrossRef]
13. Blaauw, M.; Christen, J.A. Flexible Paleoclimate Age-Depth Models Using an Autoregressive Gamma Process. *Bayesian Anal.* **2011**, *6*, 457–474. [CrossRef]
14. Újvári, G.; Molnár, M.; Novothny, Á.; Páll-Gergely, B.; Kovács, J.; Várhegyi, A. AMS 14C and OSL/IRSL Dating of the Dunaszekcső Loess Sequence (Hungary): Chronology for 20 to 150 Ka and Implications for Establishing Reliable Age–Depth Models for the Last 40 Ka. *Quat. Sci. Rev.* **2014**, *106*, 140–154. [CrossRef]
15. Goodfriend, G.A.; Hood, D.G. Carbon Isotope Analysis of Land Snail Shells: Implications for Carbon Sources and Radiocarbon Dating. *Radiocarbon* **1983**, *25*, 810–830. [CrossRef]
16. Pigati, J.S.; Rech, J.A.; Quade, J.; Bright, J. Desert Wetlands in the Geologic Record. *Earth-Sci. Rev.* **2014**, *132*, 67–81. [CrossRef]
17. Spooner, N.A. Optical Dating: Preliminary Results on the Anomalous Fading of Luminescence from Feldspars. *Quat. Sci. Rev.* **1992**, *11*, 139–145. [CrossRef]
18. Geyh, M.; Benzler, J.; Roeschmann, G. Problems of Dating Pleistocene and Holocene Soils by Radiometric Methods. In *Paleopedology*; Israel University Press: Jerusalem, Israel, 1971; pp. 63–75.
19. Geyh, M.A.; Schleicher, H. *Absolute Age Determination: Physical and Chemical Dating Methods and Their Application*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2012; ISBN 3-642-74826-0.
20. Gilet-Blein, N.; Marien, G.; Evin, J. Unreliability of 14C Dates from Organic Matter of Soils. *Radiocarbon* **1980**, *22*, 919–929. [CrossRef]
21. Hogg, A.G.; Heaton, T.J.; Hua, Q.; Palmer, J.G.; Turney, C.S.; Southon, J.; Bayliss, A.; Blackwell, P.G.; Boswijk, G.; Ramsey, C.B. SHCal20 Southern Hemisphere Calibration, 0–55,000 Years Cal BP. *Radiocarbon* **2020**, *62*, 759–778. [CrossRef]

22. Reimer, P.J.; Bard, E.; Bayliss, A.; Beck, J.W.; Blackwell, P.G.; Ramsey, C.B.; Buck, C.E.; Cheng, H.; Edwards, R.L.; Friedrich, M. IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years Cal BP. *Radiocarbon* **2013**, *55*, 1869–1887. [CrossRef]
23. Aitken, M.J. *Science-Based Dating in Archaeology*; Routledge: London, UK, 2014; ISBN 978-1-315-83664-5.
24. Radaković, M.G.; Gavrilović, B.; Gavrilov, M.B.; Marković, R.S.; Hao, Q.; Schaetzl, R.J.; Zeeden, C.; Cai, B.; Perić, Z.M.; Antić, A.; et al. A Glacial–Interglacial Malacofauna Record from the Titel Loess Plateau, Serbia, between ~350 and 250 Ka. *Quaternary* **2024**, *7*, 28. [CrossRef]
25. Antoine, P.; Rousseau, D.D.; Fuchs, M.; Hatté, C.; Gauthier, C.; Marković, S.B.; Jovanović, M.; Gaudenyi, T.; Moine, O.; Rossignol, J. High-Resolution Record of the Last Climatic Cycle in the Southern Carpathian Basin (Surduk, Vojvodina, Serbia). *Quat. Int.* **2009**, *198*, 19–36. [CrossRef]
26. Fuchs, M.; Rousseau, D.D.; Antoine, P.; Hatté, C.; Gauthier, C.; Marković, S.; Zoeller, L. Chronology of the Last Climatic Cycle (Upper Pleistocene) of the Surduk Loess Sequence, Vojvodina, Serbia. *Boreas* **2008**, *37*, 66–73. [CrossRef]
27. Marković, S.B.; Stevens, T.; Kukla, G.J.; Hambach, U.; Fitzsimmons, K.E.; Gibbard, P.; Buggle, B.; Zech, M.; Guo, Z.; Hao, Q.; et al. Danube Loess Stratigraphy—Towards a Pan-European Loess Stratigraphic Model. *Earth-Sci. Rev.* **2015**, *148*, 228–258. [CrossRef]
28. Buylaert, J.P.; Vandenberghe, D.; Murray, A.S.; Huot, S.; De Corte, F.; Van den Haute, P. Luminescence Dating of Old (>70 Ka) Chinese Loess: A Comparison of Single-Aliquot OSL and IRSL Techniques. *Quat. Geochronol.* **2007**, *2*, 9–14. [CrossRef]
29. Buylaert, J.-P.; Jain, M.; Murray, A.S.; Thomsen, K.J.; Thiel, C.; Sohbati, R. A Robust Feldspar Luminescence Dating Method for Middle and Late Pleistocene Sediments. *Boreas* **2012**, *41*, 435–451. [CrossRef]
30. Murray, A.S.; Svendsen, J.I.; Mangerud, J.; Astakhov, V.I. Testing the Accuracy of Quartz OSL Dating Using a Known-Age Eemian Site on the River Sula, Northern Russia. *Quat. Geochronol.* **2007**, *2*, 102–109. [CrossRef]
31. Murray, A.S.; Schmidt, E.D.; Stevens, T.; Buylaert, J.P.; Marković, S.B.; Tsukamoto, S.; Frechen, M. Dating Middle Pleistocene Loess from Stari Slankamen (Vojvodina, Serbia)—Limitations Imposed by the Saturation Behaviour of an Elevated Temperature IRSL Signal. *CATENA* **2014**, *117*, 34–42. [CrossRef]
32. Roberts, H.M.; Muhs, D.R.; Wintle, A.G.; Duller, G.A.T.; Bettis, E.A. Unprecedented Last-Glacial Mass Accumulation Rates Determined by Luminescence Dating of Loess from Western Nebraska. *Quat. Res.* **2003**, *59*, 411–419. [CrossRef]
33. Avram, A.; Constantin, D.; Veres, D.; Kelemen, S.; Obreht, I.; Hambach, U.; Marković, S.B.; Timar-Gabor, A. Testing Polymineral Post-IR IRSL and Quartz SAR-OSL Protocols on Middle to Late Pleistocene Loess at Batajnica, Serbia. *Boreas* **2020**, *49*, 615–633. [CrossRef]
34. Újvári, G.; Stevens, T.; Molnár, M.; Demény, A.; Lambert, F.; Varga, G.; Jull, A.J.T.; Páll-Gergely, B.; Buylaert, J.-P.; Kovács, J. Coupled European and Greenland Last Glacial Dust Activity Driven by North Atlantic Climate. *Proc. Natl. Acad. Sci. USA* **2017**, *114*, E10632–E10638. [CrossRef]
35. Aitken, M.J. *Introduction to Optical Dating: The Dating of Quaternary Sediments by the Use of Photon-Stimulated Luminescence*; Clarendon Press: Oxford, UK, 1998; ISBN 0-19-158927-6.
36. Murray, A.S. Developments in Optically Stimulated Luminescence and Photo-Transferred Thermoluminescence Dating of Young Sediments: Application to a 2000-Year Sequence of Flood Deposits. *Geochim. Cosmochim. Acta* **1996**, *60*, 565–576. [CrossRef]
37. Wintle, A.G. Luminescence Dating of Aeolian Sands: An Overview. *Geol. Soc. Lond. Spec. Publ.* **1993**, *72*, 49–58. [CrossRef]