The Balta Alba Kurgan loess-paleosol sequence - Chronology and paleoclimate in the northern Lower Danube Basin, Romania

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Introduction

Loess-paleosol sequences (LPS) are widely spread across central and southeastern Europe and are studied intensively, as they are important terrestrial archives that preserve paleoenvironmental and paleoclimatic information. In the Lower Danube Basin large areas are covered by loess, loess derivates, sandy loess, and sand dunes (Lehmkuhl et al., 2021, Fig. 7). The investigated Balta Alba Kurgan (BAK) sequence is located close to the forelands of the Eastern Carpathians, an area that is largely underrepresented in loess research. High-resolution geochemical analyses identified the Eastern Carpathians as a main source region of the loess at this site (Pötter et al., 2021). The BAK sequence consists of loess with several intercalated paleosols and weaker pedogenetic horizons (Figs. 1, 15), reflecting Late Pleistocene environmental conditions. Furthermore, the Campanian Ignimbrite/Y-5 tephra is preserved that serves as a chronological marker horizon (Fig. 4) and which had severe ecological impact in southeastern Europe. A robust age model (Fig. 6) was established for the upper 10 m using a multi-method approach (luminescence dating, radiocarbon dating, magnetic stratigraphy, and tephrochronology) which shows that this part of the sequence covers the MIS 3/2 transition up to present (published in Scheidt et al., 2021). Here, we present additional geochronological data obtained from luminescence dating (Figs. 8-14) as basis for further paleoenvironmental investigations.

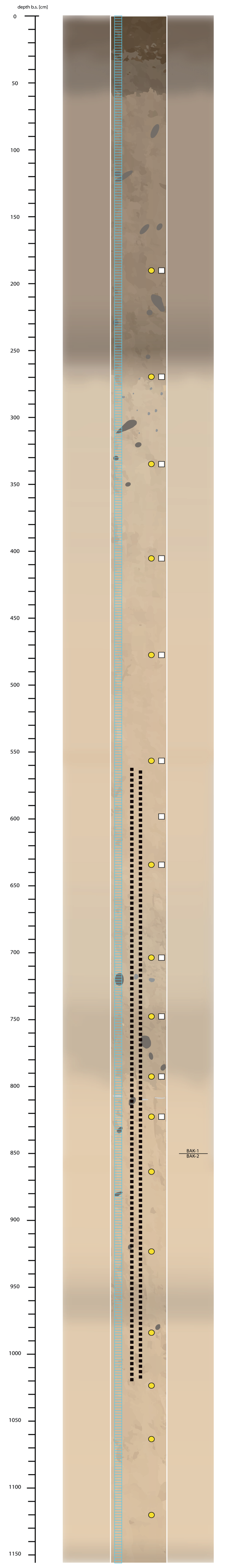


Fig. 1: Profile sketch showing the location of the magnetic (black squares), radiocarbon (white squares) and luminescence (yellow cirlcles) dating samples.

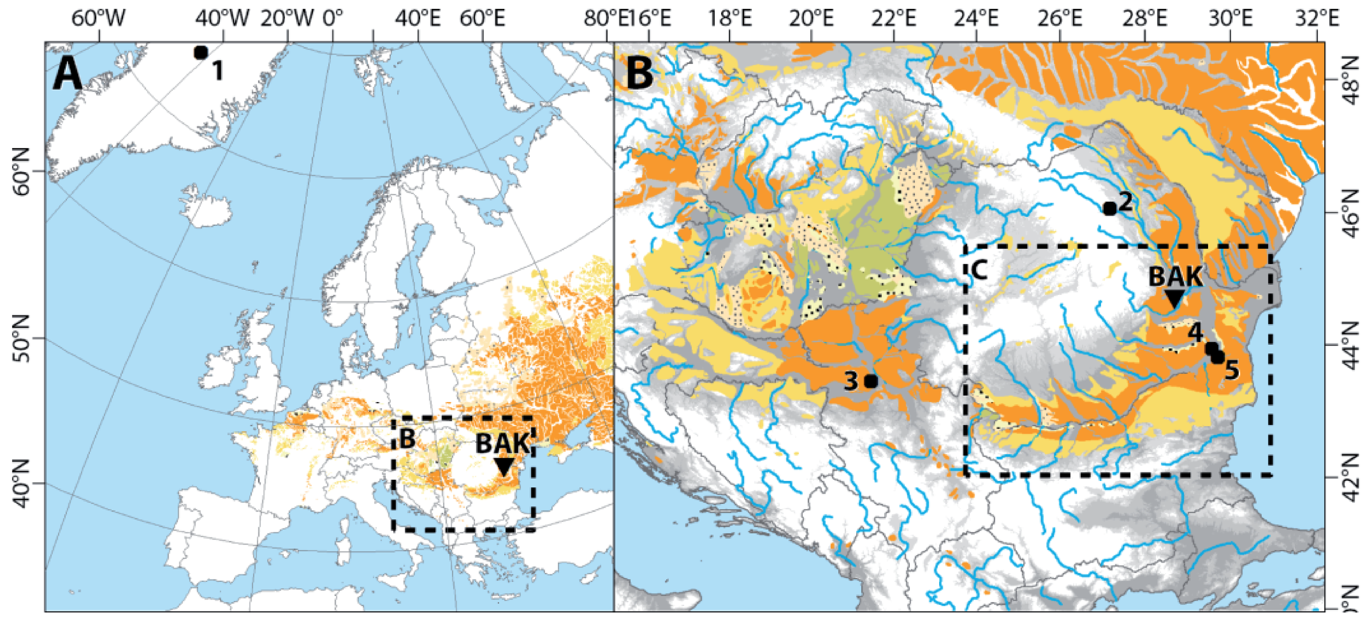
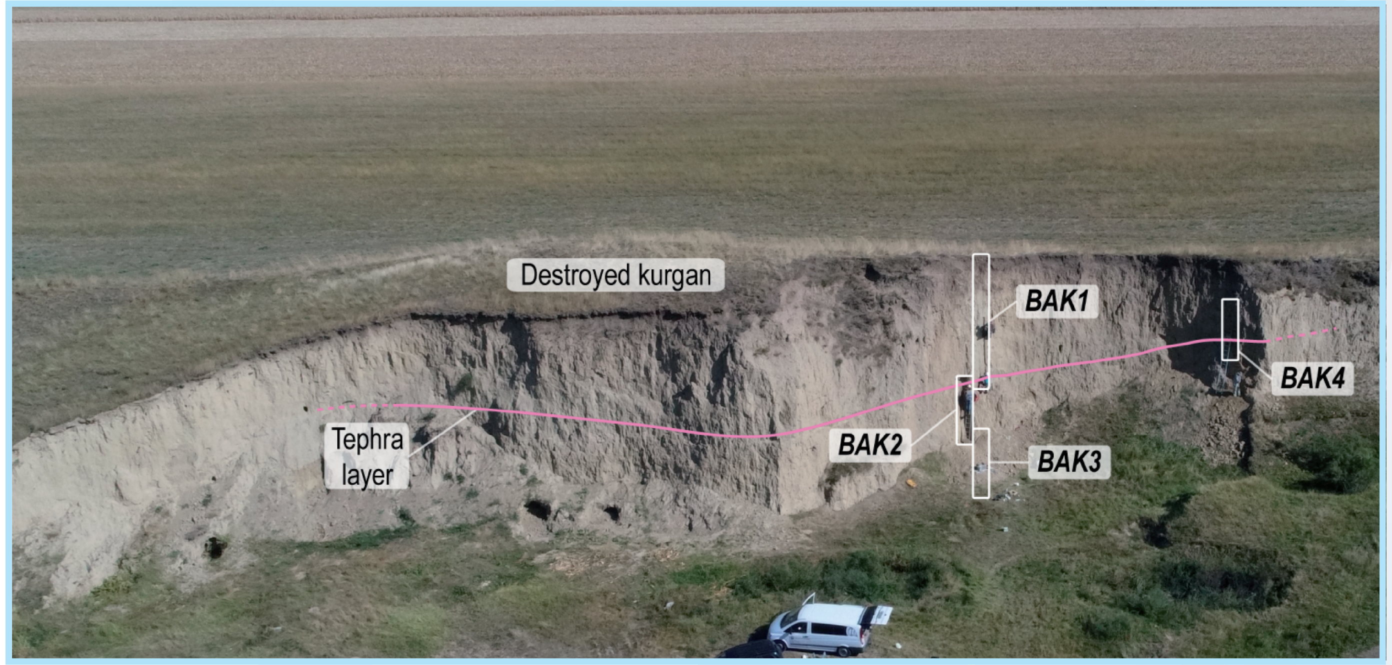


Fig. 7: Distribution of loess (orange) and sand (yellow) in Europe (left); Location of the BAK site and other LPS (triangles) on the right.



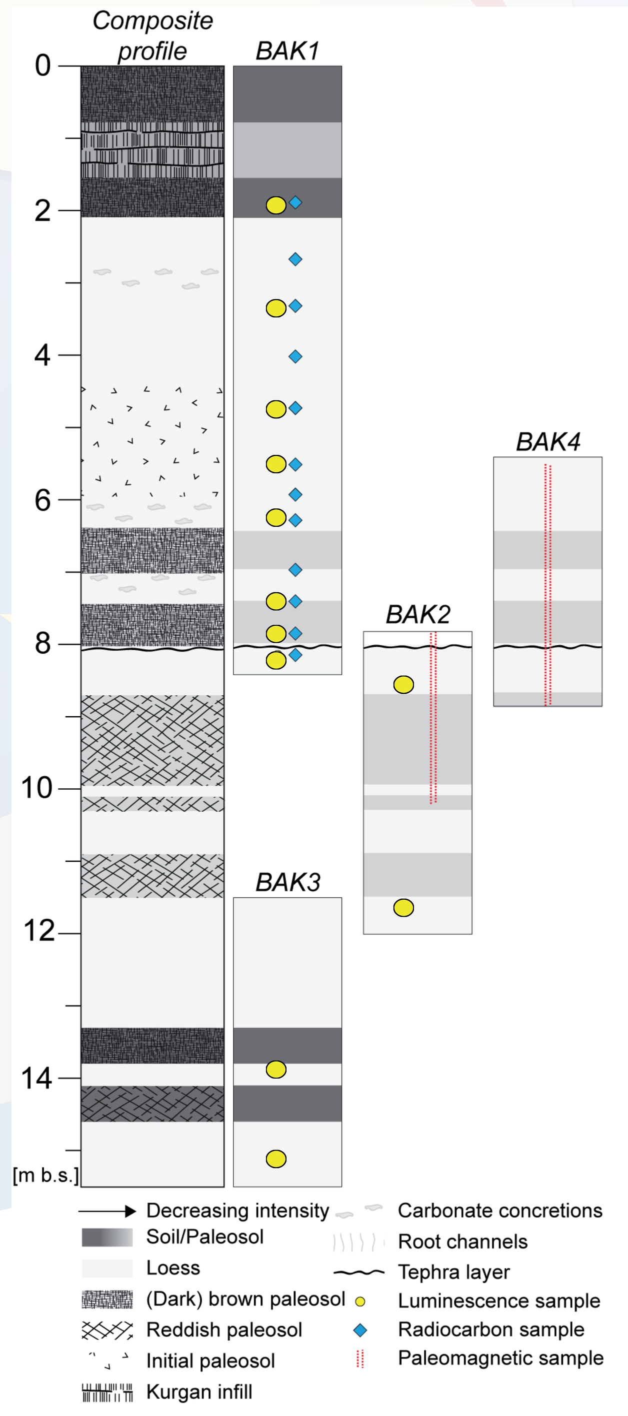


Fig. 15: Stratigraphy of the BAK section. Four smaller profiles build composite on the left.

Magnetic Statigraphy

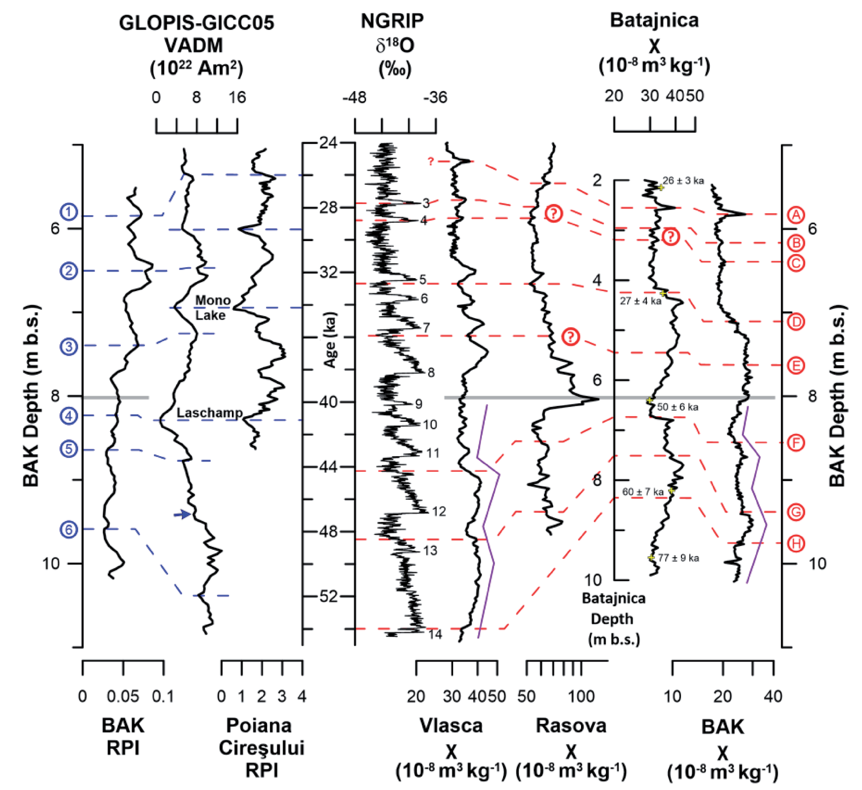


Fig. 2: Correlation of the BAK pmag composite (Scheidt et al., 2021). CI/Y-5 tephra shown in grey. Relative Paleointensity (RPI) is correlated with GLOPIS-GICC05 and compared to the RPI of the Poiana Ciresului site (left, blue lines). The magentic susceptibility (χ) is correlated (red lines) with the sites Rasova, Vlasca, Batajnica, and NGRIP δ18O (right, red).

Radiocarbon dating

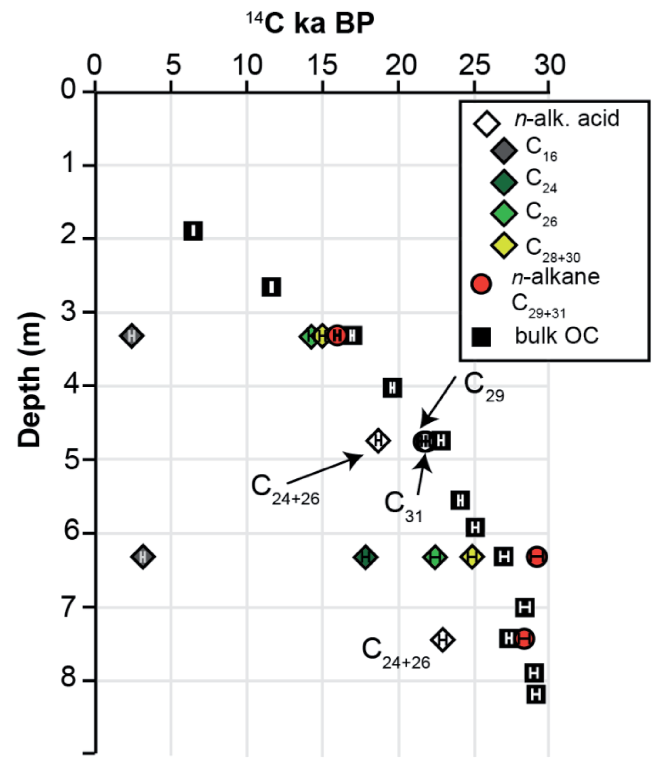


Fig. 3: Conventional 14C ages of bulk organic carbon (OC) and of n-alkanes and n-alkanoic acids versus depth. Symbols include error bars (from Scheidt et al., 2021).

Tephrochronology

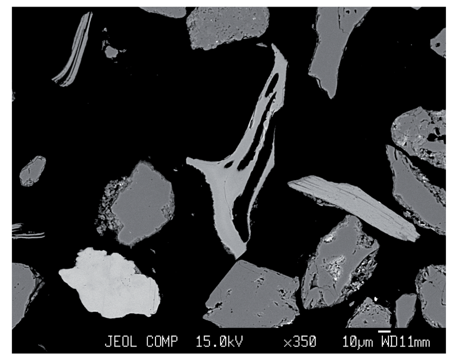


Fig. 4: Scanning electron microscope (SEM) images of the glass shards in bulk samples from the Campanian Ignimbrite/Y-5 ash bed identified at BAK (Scheidt et al., 2021).

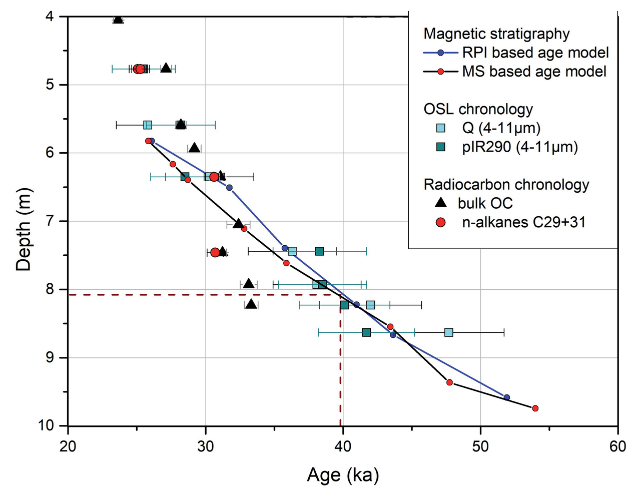


Fig. 5: Comparison of radiocarbon, luminescence and magnetic statigraphy chronology (Scheidt et al., 2021).

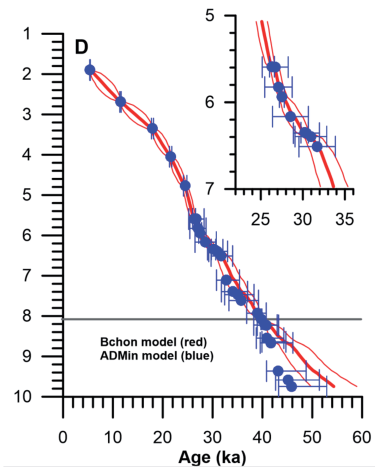


Fig. 6: Comparison of ADMin (blue) and Bchron (red) age models. Note deviation from 5.5m downwards.

Luminescence dating

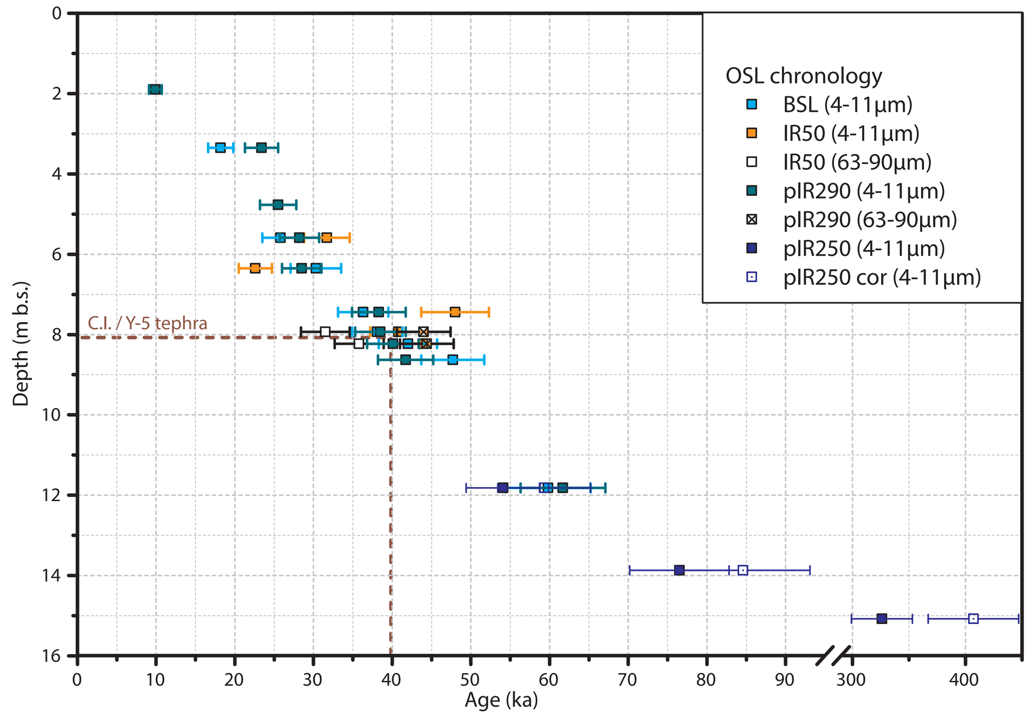


Fig. 8: Age-depth plot showing all luminescence ages determined. pIRIR250 ages are plotted without (filled purple squares) and with fading correction (open purple squares; Huntley and Lamothe, 2001).

Results

- Quartz (4-11μm): preheat plateau tests (PHT, Fig. 9) and dose recovery tests (DRT, Fig. 10) confirm the reliability of the used measurement protocol. De's and ages range from ~55-184 Gy and ~18-60 ka.
- Polymineral (4-11 μm): Uppermost samples use the pIRIR290 protocol. While the DRT results were acceptable for samples BAK1-11, BAK1-9 & BAK 1-7 (Fig. 10), the recovered/given dose ratio of sample BAK2-1 was overestimated. To avoid further complications which possibly enhance down-profile, we additionally measured this and the lower two samples using a pIRIR250 protocol.
- BSL and pIRIR ages agree well. Slight deviation at 1σ is only observed for sample BAK1-9, were a minor overestimation of the pIRIR290 age might be assumed.
- lowermost sample exhibits a very high De of 1005±53 Gy. To make sure that the sample is not in saturation, an extended dose response curve was built placing it at 79% (Fig. 11).
- Portable OSL: follows similar trend as conventional samples (Fig. 13). Fig. 14 shows an attempt to relate the portable OSL measurements to the measured OSL ages giving reliable age estimates.

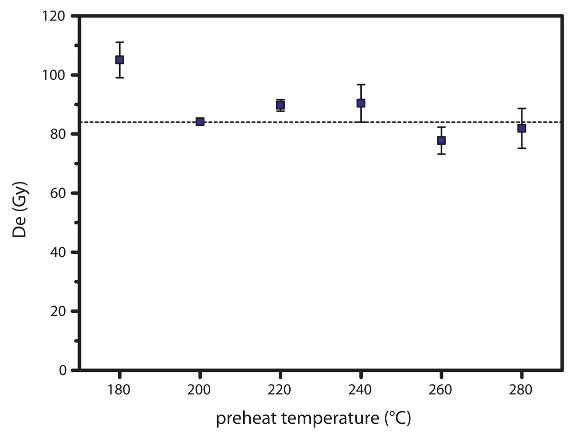


Fig. 9: Preheat plateau test of the quartz sample BAK2-1 (4-11 μm) showing that the preheat-cutheat combination of 200°C and 180°C (dashed line) determined in Scheidt et al. (2021) can be used for the remaining quartz samples. Cutheat temperatures were always 20°C lower than preheat temperatures.

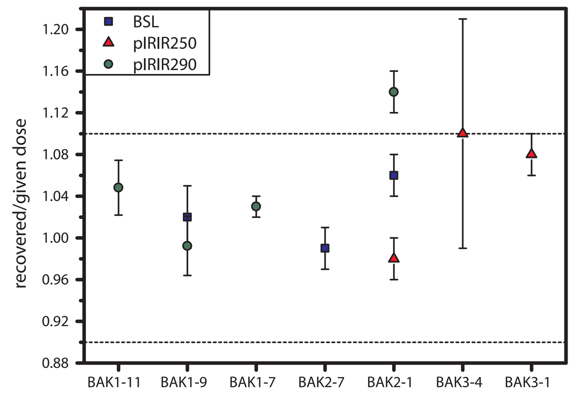


Fig. 10: Results of dose recovery tests done on the fine-grain (4-11μm) fraction using blue stimulation (BSL) on quartz, pIRIR250 and pIRIR290 on polyminerals. Uncertainty shows standard deviation. Large uncertainty of BAK3-4 is related to one possible outlier with a very high recovered/given dose ratio of 1.32. Excluding it leads to an average ratio of 1.04±0.01. Dashed lines indicate acceptable 10% deviation from 1.0.

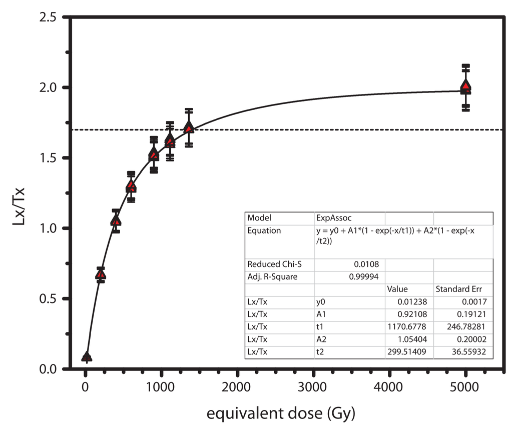


Fig. 11: Extended dose-response curve: 7 aliquots of BAK3-1 were irradiated up to a dose of 5000 Gy to inform about the saturation characteristics. Assuming full saturation is reached at 5000 Gy, places a limit of 85% saturation at Lx/Tx = 1.7 or 1292 Gy, respectively. This limit was used to assess whether the BAK3-1 (De = 1005 Gy) is in saturation.

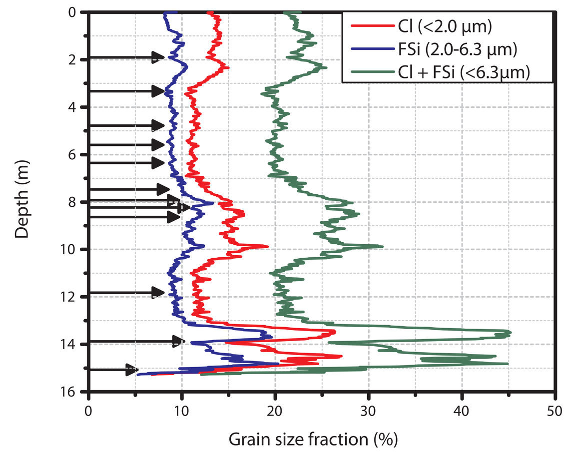


Fig. 12: : Distribution of clay (Cl, red line) and fine silt (FSi, blue line) in the BAK LPS. Additionally, a cumulative curve of both grain size fractions is shown (green line). The depths of the luminescence samples are indicated with black arrows. For samples with a clay and fine silt fraction of ~20%, ~22%, and >25% moisture contents of 15±10%, 20±10%, and 25±10% were used, respectively.

Portable luminescence measurements

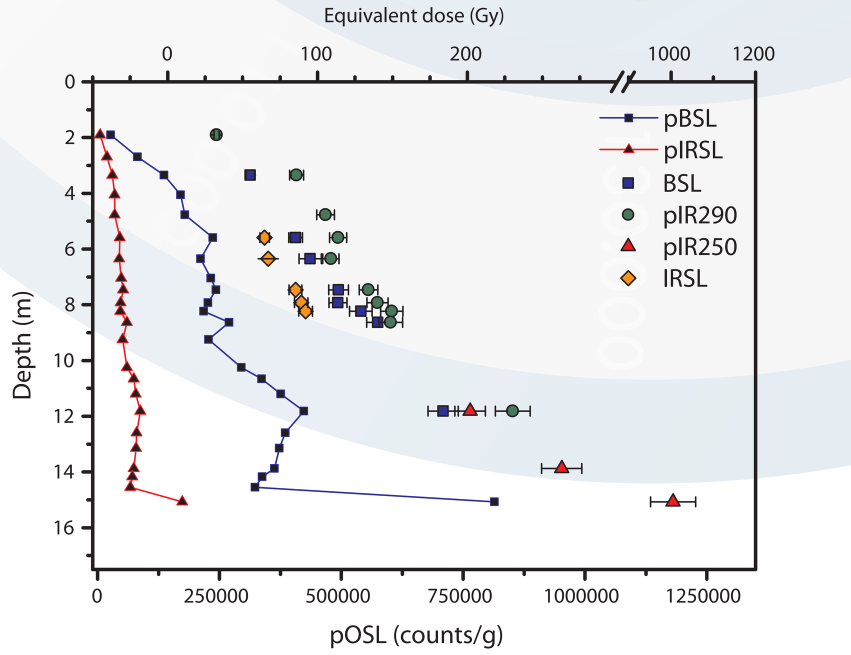


Fig. 13: Measured counts normalized to 1g of sample material (average of n=2 for each data point) of the portable OSL measurements using blue stimulation (BSL) and IR stimulation (IRSL; both plotted on lower x-axis). Protocol: 15 s BG, 100 s IRSL, 15 s BG, 60 s BSL, 15 s BG. Additionally, the equivalent doses of the conventional samples are shown.

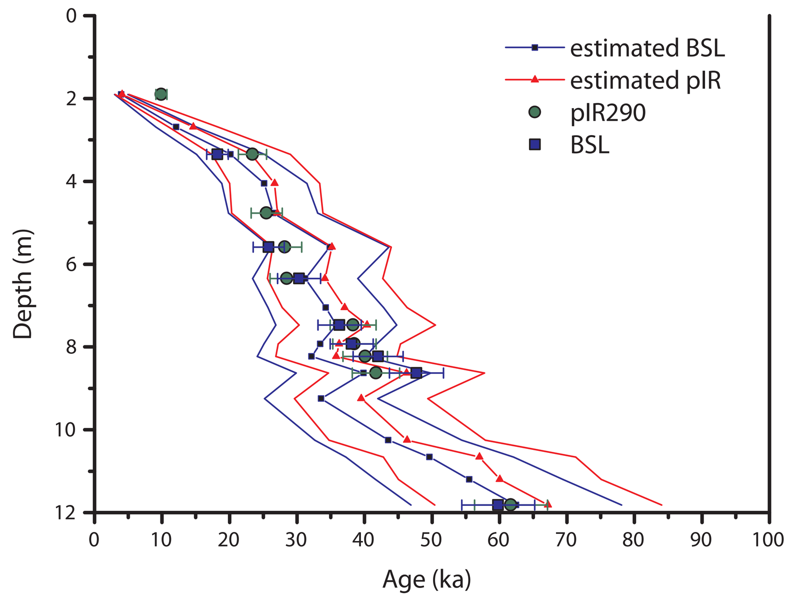


Fig. 14: Comparison of pOSL age estimates (blue and red lines) to BSL (blue rectangles) and pIR290 ages (green circles). pOSL age estimates are given with a conservative upper and lower 25% uncertainty (lines without symbols). Age estimates are calculated very simplified by relating the counts to the actual De and using an average of these as a multiplier.

What‘s next?

- Bayesian age model needs to be updated for complete profile

- further analysis of paleoproxy data (grain size, geochemistry, color) of whole profile

- paleoenvironmental reconstruction based on paleoenvironmental and geochronological data

- publish :)

Selected references

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