New geochronology of the Stalać section at the southern limit of European loess occurrence through $pIR_{50}IR_{290}$ dating

J. Bösken[1], I. Obreht[1], N. Klasen[2], C. Zeeden[1], S.B. Marković[3], U. Hambach[3,4], F. Lehmkuhl[1]

Introduction & Regional Setting

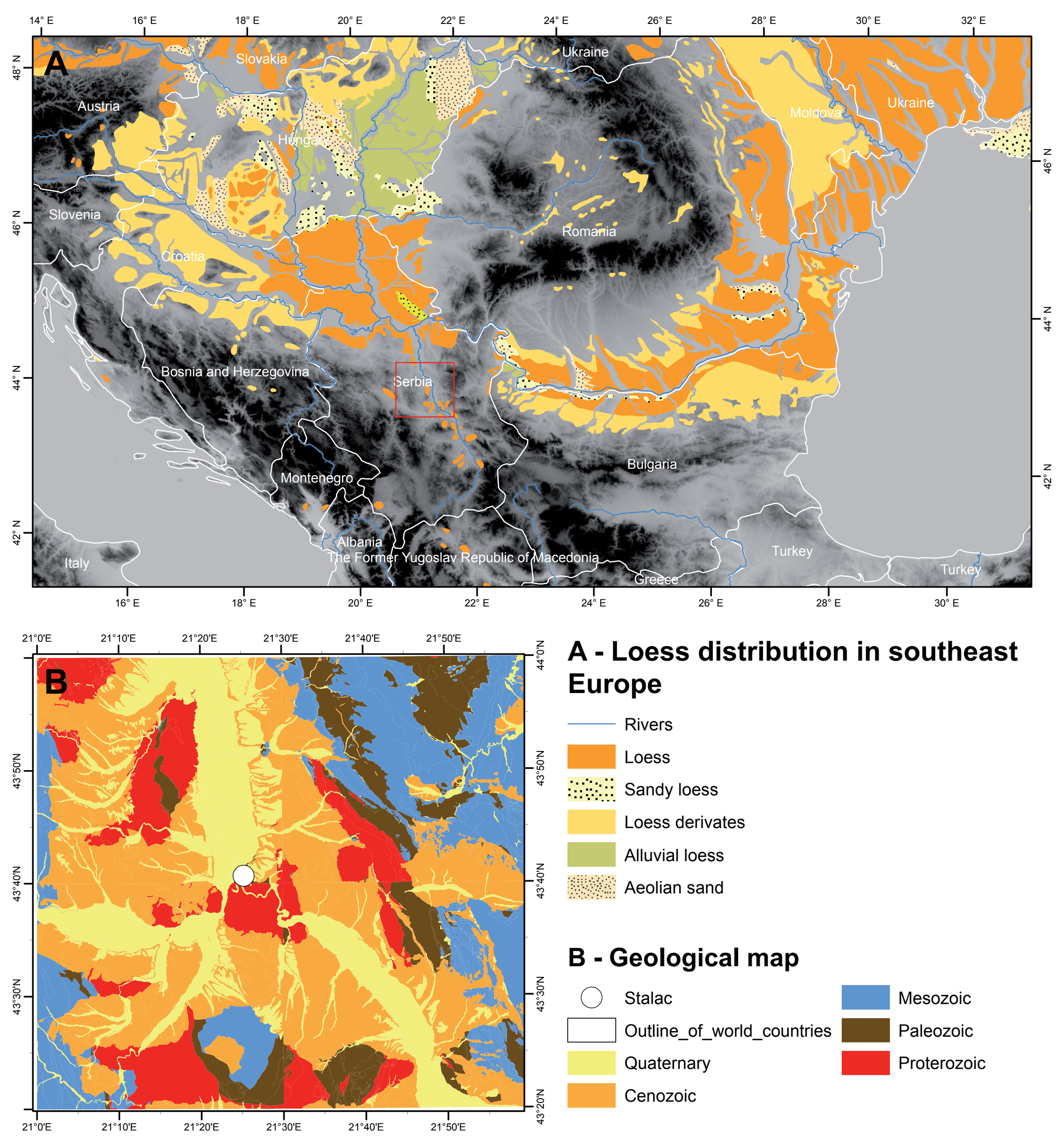

Fig. 1: A - loess distribution in southeast Europe (after Haase et al., 2007). B - basic geological map of the area. Location is indicated with red square in map A.

The Stalac loess paleosol sequence (LPS) is located in the Western Balkans, south of the typical loess distribution area of the Carpathian Basin. Presently a continental climate is present, but climatic shifts have been proposed, making the section senstive to past climatic changes and interesting as a paleorecord. Fig.1 above shows maps of the regional area (A) and the basic geology (B). The area is not yet intensively studied, and is therefore of special interest, in particular for paleoenvironmental reconstructions during the time frame in which anatomically modern humans migrated to Europe.

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Acknowledgments

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Results

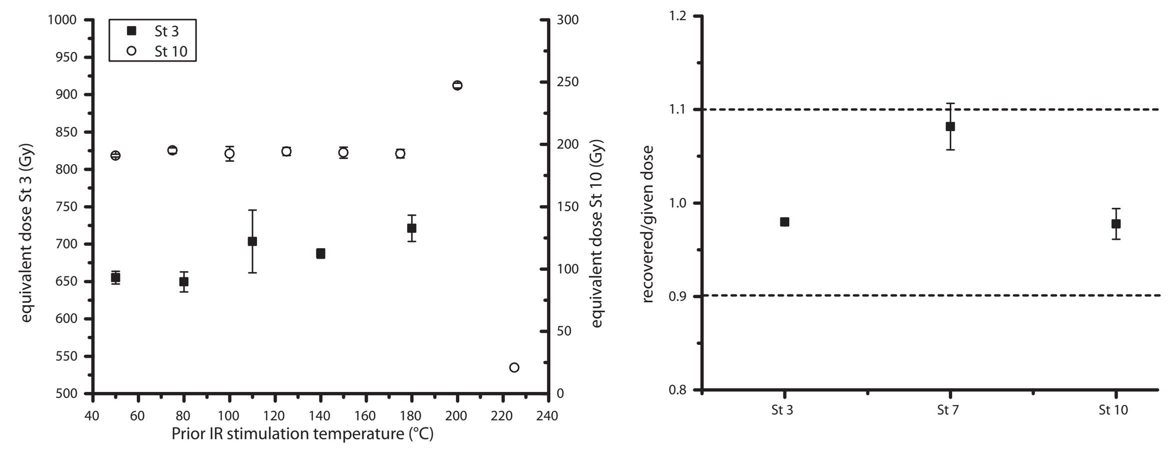


Fig. 2: The polymineral fraction offers ideal luminescence characteristics. A plateau over several prior IR stimulation temperatures is present indicating that any of these temperatures will give the same equivalent dose (left). Also the dose recovery test behaves well within 10% of unity, showing that measurement results are reproducible (right). Moreover, the samples showed low resiudal doses (< 2.5% of De). Resulting ages are indicated in the profile sketch below.

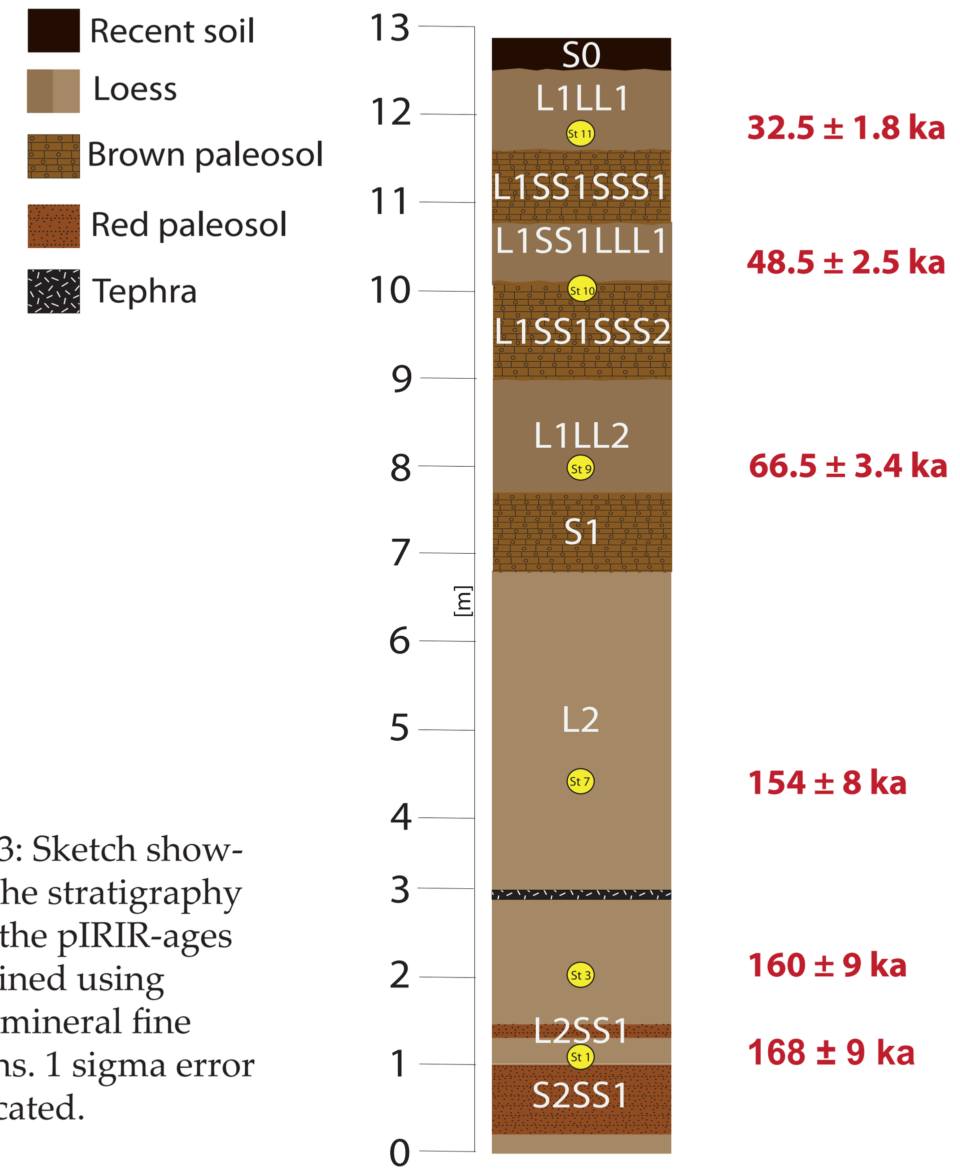


Fig. 3: Sketch showing the stratigraphy and the pIRIR-ages obtained using polymineral fine grains. 1 sigma error indicated.

Discussion & Summary

- good luminescence behavior
- reliable chronology framing the last two glacial cycles was established
- L1SS1 soils (likely MIS3) and S1 (likely MIS5e) show the same characteristics, indicating a similar climatic evolution. These paleosols are more weakly expressed in the Carpathian Basin to the north, indicating an asynchronous paleoenvironmental evolution of the Carpathian Basin and the Central Balkan region (Stalać)
- L2 tephra dated with bracketing samples between 160±9 ka and 154±8 ka
- weak soil formation dated to 168±9 - 160±9 ka, which fits nicely to published data of magnetic susceptibility (e.g. Sun et al., 2006; Heslop et al., 2006), especially within the Chinese loess plateau; see also Fig.4.
- end of S2 soil formation older than 168±9 ka also fits nicely with published MS data (see Fig.4)

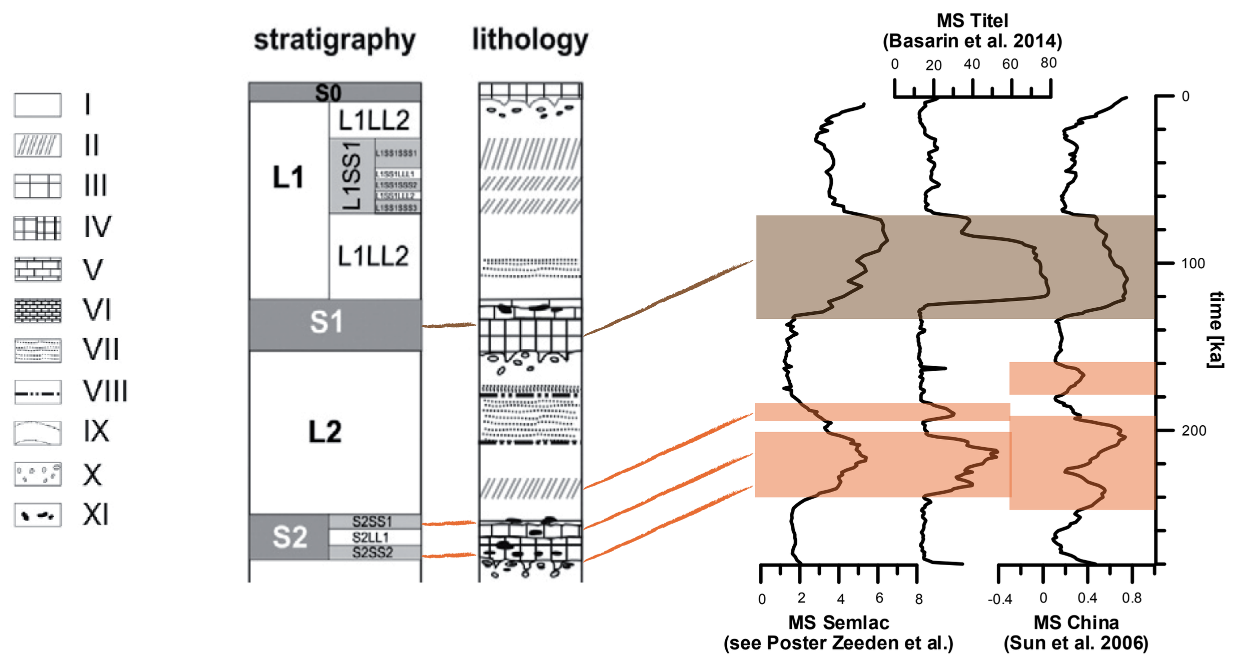


Fig. 4: Lithology and stratigraphy of the Mošorin LPS (Marković et al., 2015) on the left (I. Loess; II. embryonic pedogenic layer; III. A horizon; IV. Ah horizon; V. B horizon; VI. Bwt rubified horizon; VII. sand beds; VIII. possible tephra layers; IX. hydromorphic features; X. carbonate concreations; XI. Krotovinas; Marković et al., 2015, 2012). Magnetic susceptibility plotted on a timescale of the Chinese Loess Plateau, Titel Loess Plateau and Semlac LPS on the right. The ages at Stalać are in good agreement with the correlative ages of the Chinese Loess Plateau. Location of corresponding soils are indicated with the colored boxes.

Basics of Optically Stimulated Luminescence (OSL) dating

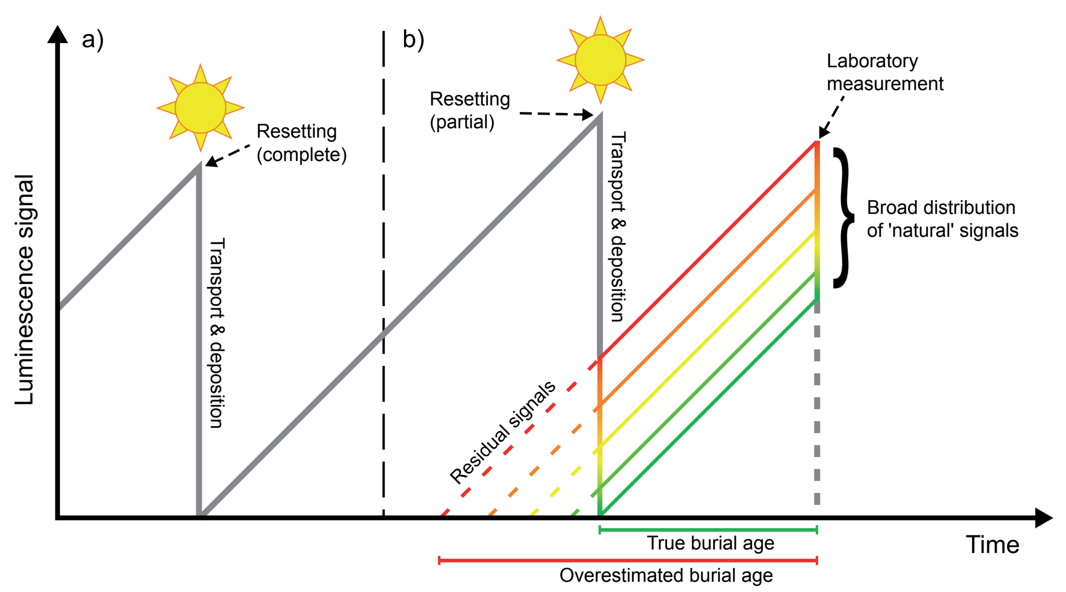
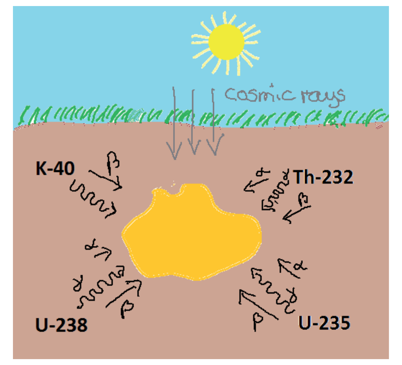


Fig.5: Basic principle of luminescence signal accumulation (after Burow, 2013). During transport the luminescence signal is bleached by sunlight (or heat for some burned archeological deposits). Once deposited and buried, the signal starts to accumulate through naturally occuring radioactivity by K, U, and Th. Measurements of the luminescence signal in the laboratory give an equivalent dose (De), which corresponds to the time since last bleaching.

Fig. 6: Radionuclide concentrations are measured with a high-purity germanium gamma-ray spectrometer and tranfered into dose rates. These indicate the amount of radioactive energy deposited on the sediment grains per year. With these two values the age can be easily calculated:

$$\text{Age} = \frac{\text{total energy accumulated during burial (De [Gy])}}{\text{energy delivered each year from radioactive decay}}$$



Fine grains of quartz

- quartz signal bleaches easily
- SAR-protocol (Murray & Wintle, 2000) can be used (reliable, well known)
- signal saturates faster, i.e. De>200Gy problematic
- problems between different grains sizes and differences between laboratory and natural doses still not understood
- typical tests to be performed before De measurements are preheat plateau test (to check a dependendy of preheat temperature on De) and dose recovery test (to check if a known laboratory dose can be measured adequately and hence results are reproducible)

Polymineral fine grains

- by means of certain stimulation and detection windows, only the feldspars within the polymineral fraction are investigated
- feldspar signal does not bleach as fast as quartz (problematic for fluvial environments)
- signal saturates later (we can date older sediments)
- IRSL protocols have problems with anomalous fading
- post-IR-IRSL protocols circumvent fading (e.g. Thiel et al., 2011)
- typical tests to be performed before De measurements are the prior IR stimulation temperature test (to decide on the best first IR stimulation) and dose recovery test (to check if a known laboratory dose can be measured adequately and hence results are reproducible)

Janina J. Bösken
[1]Physical Geography and Geoecology, Department of Geography, RWTH Aachen University
+49 241 80 96476, janina.boesken@geo.rwth-aachen.de
[2]Institute of Geography, University of Cologne
[3]Laboratory for Paleoenvironmental Reconstruction, University of Novi Sad
[4]BayCEER & Chair of Geomorphology, University of Bayreuth