

LOESSFEST 2026



Loessfest 2026, Krapets 7 – 11 of September 2026, Bulgaria

Loess Fest 2026

Echoes of the past: Loess, climate and
human interactions during the
Pleistocene

September 7 – 11, Krapets, Bulgaria

ABSTRACT BOOK

Organizer: National Institute of Geophysics, Geodesy and Geography (NIGGG) – Bulgarian Academy of Sciences; Acad. G. Bonchev str., block 3, 1113 Sofia

Organizing committee:

Diana Jordanova	NIGGG - Bulgarian Academy of Sciences
Neli Jordanova	NIGGG - Bulgarian Academy of Sciences
Daniel Ishlyamski	NIGGG - Bulgarian Academy of Sciences
Bozhurka Georgieva	NIGGG - Bulgarian Academy of Sciences
Petya Trifonova	NIGGG - Bulgarian Academy of Sciences

WITH THE SUPPORT BY:

Zdzisław Jary - Loess and Pedostratigraphy Working Group INQUA

Slobodan Markovic - Loess and Pedostratigraphy Working Group INQUA



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Scientific Committee members:

Ian Smalley	UK
Kaja Fenn	UK
Shilling Yang	China
Ashok Singhvi	India
Pierre Antoine	France
France Lagroix	France
Olivier Moine	France
Gyorgy Varga	Hungary
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Tin Lukić	Serbia
Yunus Baykal	Denmark
Diana Jordanova	Bulgaria
Neli Jordanova	Bulgaria

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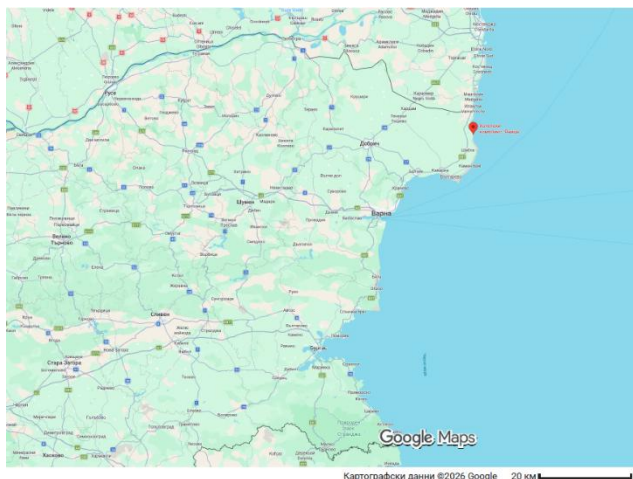
Abstracts – posters

List of participants

Loessfest 2026, Krapets 7 – 11 of September 2026, Bulgaria

Venue: Krapets village, Black sea coast

Hotel complex “Yanitsa”



Preliminary program

date	hour	event	topic
07.09.2026	<i>arrival, registration, ice breaker, dinner</i>		
08.09.2026	9⁰⁰ – 09³⁰	welcome	
	09³⁰ – 11⁰⁰	session 1:	Palaeoenvironmental and palaeoclimatic reconstructions. Chronostratigraphy
	<i>11⁰⁰ – 11³⁰</i>	<i>coffee break</i>	
	11³⁰ – 13⁰⁰	session 2:	Loess landscapes as records of Pleistocene dust cycles
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	14³⁰ – 16⁰⁰	session 3:	Loess malacology and other biotic proxies
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	16³⁰ – 18⁰⁰	session 4:	Magnetic properties of loess paleosol sequences
	18⁰⁰ – 19³⁰	poster session 1	
	<i>20⁰⁰ – 22⁰⁰</i>	<i>dinner</i>	
09.09.2026	09⁰⁰ – 11⁰⁰	session 5:	Loess geochemistry and paleopedology
	<i>11⁰⁰ – 11³⁰</i>	<i>coffee break</i>	
	11³⁰ – 12³⁰	session 6:	Paleolithic archaeology in loess regions and paleoclimate
	<i>12³⁰ – 14⁰⁰</i>	<i>lunch break</i>	
	14⁰⁰ – 15⁰⁰	session 7:	Paleolithic archaeology in loess regions and paleoclimate
	15⁰⁰ – 15³⁰	coffee break	
	15³⁰ – 16³⁰	session 8:	Social and geotechnical aspects of loess research
	<i>16³⁰ – 18⁰⁰</i>	poster session 2	
	18⁰⁰ – 19³⁰	visit to Krapets loess outcrop	
	<i>20⁰⁰ – 23⁰⁰</i>	conference dinner	
10.09.2026	<i>08³⁰ – 10³⁰</i>	<i>travel to Kolobar outcrop</i>	
	10³⁰ – 13⁰⁰	field workshop	presentation of the site Discussion
	<i>13⁰⁰ – 14⁰⁰</i>	<i>lunch break</i>	
	14⁰⁰ – 16⁰⁰	field workshop – results from high resolution studies on Kolobar site	LOEs CLIMBE project team members Discussion
	16⁰⁰ – 18⁰⁰	<i>social event – visit to Sveshtary tracian tomb</i>	
	<i>18⁰⁰ – 20⁰⁰</i>	<i>travel back to Krapets</i>	
	<i>20⁰⁰ – 22⁰⁰</i>	<i>dinner</i>	
11.09.2026	<i>departure</i>		

Sessions and speakers:

Loessfest 2026, Krapets 7 – 11 of September 2026, Bulgaria

ORAL PRESENTATIONS			
Presenting Author	Affiliation	Country	Title
1 Antoine, Pierre /INVITED/	CNRS	France	Permafrost dynamics and Dansgaard-Oeschger (D-O) cycles in Last Glacial loess sequences from Western Europe
2 Jary, Zdzisław	Univ. Wrocław	Poland	Periglacial phenomena in loess as paleoenvironmental indicators
3 Tomeniuk, Olena	Ivan Franko National University of Lviv	Ukraine	The Krasyliv Palaeocryogenic Stage as a Marker of Final Pleistocene Cooling in Ukrainian Loess–Palaeosol Sequences
4 Veres, Daniel	Romanian Academy Cluj	Romania	On the high-resolution investigation of Danube loess-paleosol records since the mid-Brunhes event – a view from the LOEs-CUMBE project
5 Skurzynski, Jacek		Poland	Introduction to the DUSTCODE project: Unifying European loess archives to decode MIS 2 climate and dust transport systems
6 Lehmkuhl, Frank /INVITED/	Department of Geography, RWTH Aachen University, Germany	Germany	Eurasian Loess Landscapes in a Three-Eco-zone Framework: Conceptual Model and Regional Illustrations
7 Sisi Liu /CANCELLED/	College of Geography and Environmental Sciences, Zhejiang	China	Spatial Heterogeneity of the Westerlies Evolution over Mid-latitude Asia Since the Middle Pleistocene: Evidence from Loess Records
8 Zeeden, Christian	LIAG-Institute for Applied Geophysics, Hannover	Germany	Magnetic enhancement in Eurasian soils, paleosols and loess: insights over formation processes
9 Jiang, Wenying	Institute of Geology and Geophysics, Chinese Academy of Sciences	China	Holocene hydroclimate and dust activity, as reconstructed from the sediments of Lake Bayanchagan, on the northern margin of the East Asian summer monsoon
10 Krawczyk, Marcin	Univ. Wrocław	Poland	Paleoenvironmental changes during the Late Pleistocene recorded in the grain-size of loess-paleosol sequences in southwest Poland.
11 Baykal, Yunus	Romanian Academy Cluj	Romania	Detailed luminescence dating of late Quaternary loess at Kolobar, Bulgaria
12 Yang, Shiling /INVITED/	Inst. of Geology and Geophysics, Chinese Acad. Sci.	China	Pliocene CO ₂ rise driven by sea-level fall as a mechanism for the delayed ice age: Evidence from carbonate clumped-isotope analysis of aeolian deposits
13 Moine, Olivier	CNRS	France	The Gravettian site of Amiens-Renancourt 2: a new reference loess sequence for the late Weichselian Middle Pleniglacial in northern France
14 Wiesenberg, Guido	Univ. Zurich	Switzerland	Bioturbation in loess-paleosol sequences: To which extent does it disturb sedimentary, paleoenvironmental and paleoclimatic records?
15 Rowley, Mike	Univ. Zurich	Switzerland	Investigating Bioturbation-Driven Element Redistribution and Calcium Speciation in the Kolobar Loess–Palaeosol Sequence Using Synchrotron-based Spectromicroscopy
16 Ghafarpour, Amin	Terrestrische Paläoklimatologie/Paläontologie Universität Tübingen	Germany	Magnetic signature of loess in the northern Tien Shan piedmont, eastern Kazakhstan
17 Lagroix, France /INVITED/	CNRS, IPGP	France	Paleowind directions, paleosecular variations and relative paleointensity from MIS 6 loess at Harlezt, NW Bulgaria
18 Dragomirov, Dragomir	IPGP	France	Rock magnetic study of the Dejvice loess/paleosol sequence (Prague, Czech Republic)
19 Chadima, Martin	Institute of Geology of the Czech Academy of Sciences	Czech Republic	Filling the gap between loess regions of the European Loess Belt - the loess-palaeosol profile of Dejvice (Czech Republic)
20 Kolarikova, Kristyna	Charles University	Czech Republic	Sanzhiyka—a new key loess-palaeosol sequence in the western Black Sea region
21 Hlavatskyi, Dmytro	Institute of Geophysics, Ukrainian Acad. Sci.	Ukraine	Holocene soil evolution on loess in south Poland – old concepts and new models
22 Kabala, Cezary /INVITED/	Wrocław University of Environmental and Life Sciences	Poland	Holocene Transformation of Agriculturally Used Loess Areas: A Chronological Perspective Based on Examples from Southern Poland
23 Poreba, Gregorz	Silesian University of Technology, Gliwice	Poland	Can stacks of paleosols in a Pleistocene loess-paleosol sequence be regarded as temporal soil catenas and do spatial pedofacies changes in paleosols exist?
24 Hambach, Ulrich	Universität Bayreuth	Germany	High-resolution MIS 3-2 loess-palaeosol record at the Novostav site (NW Ukraine): evidence from palaeopedology, malacology, and microtheriology
25 Bonchkovskiy, Olesandr	Institute of Geography-National Academy of Sciences of Ukraine	Ukraine	Pedogenic developmental variation through a novel Loess-Palaeosol Sequence in Kolobar, Bulgaria, since the Mid-Brunhes Event (430 kyr) assessed by geochemical proxies.
26 Trott, Andrew	Univ. Zurich	Switzerland	Analyzing temporal changes in loess provenance using XRF geochemistry: insights from the Velika Vrbica loess section
27 Petar Krsmanović	Physical Geography, Department of Geography Faculty of Novi Sad,	Serbia	Frequency and age spectrum of Carpathian zircons deposited in the Boyanchik loess section (W Ukraine) and in the modern alluvial sediments of the Vistula River.
28 Nawrocki, Jerzy	Polish Geological Institute	Poland	Loess and Palaeolithic sites in Poland: An Overview of the Recent Research
29 Wisniewski, Andrzej	LIAG- Institute for Applied Geophysics, Hannover	Germany	Does the Dupljaja loess sequence (southeastern Carpathian Basin) record evidence for the Danube Paleolithic corridor "opening"?
30 Markovic, Slobodan	Univ. Novi Sad	Serbia	Late Quaternary atmospheric dynamics recorded in the Shankerpora loess-paleosol sequence, Kashmir Valley, Northwestern India
31 Amiri, Zaniar	Taras Shevchenko National University of Kyiv	Ukraine	The palaeoenvironmental record of the loess-palaeosol succession of Eastern Ukraine
32 Gerasimenko, Natalia	Geography Department, Federal Institute of Minas Gerais, Ouro Preto, Brazil	Brazil	Coarse fragments and soil classification: conceptual and taxonomic challenges from a Brazilian perspective
33 Delpupo, Caroline	CENTRE FOR ENVIRONMENT STUDIES, Anna University	India	Contemporaneous loess deposition and soil pedogenesis from the Kashmir Valley, western Himalaya: Multiproxy records since 300 ka
34 Auchyuthan, Hema	Ivan Franko National University of Lviv	Ukraine	Palaeolithic Cultural Horizons within the Loess–Palaeosol Sequence of Western Ukraine
35 Tomeniuk, Olena	University of Architecture, Civil Engineering and Geodesy, dept. of Geotechnics	Bulgaria	Analysis of the Condition of Lipnik Dam (Ruse Region, Bulgaria) Following the Extreme Rainfall Event of 2025
36 Mihova, Lena	Geological Institute, Bulgarian Academy of Sciences	Bulgaria	Deformations of a high-rise building caused by inappropriate foundation design in collapsible loess soil (block "Russia", Ruse, Bulgaria)
37 Petrova, Vanushka		Bulgaria	Collapse-induced settlement of a loss terrain within urban infrastructure due to technogenic wetting
38 Nedelcheva, Mariana	Geological Institute, BAS	Bulgaria	Loess Geoheritage and Accessible Geotourism in Kłodzko for Seniors and Persons with Disabilities
39 Widawski, Krzysztof	Dept. Regional Geography and tourism, Univ. Wrocław	Poland	

Poster presentations:

	POSTERS		
1	Evlogiev, Yordan Geological Institute, BAS Albert Ludwigs-Universität Freiburg	Bulgaria	The Loess-soil Complex in Northeastern Bulgaria – Geomorphology, Lithology and Stratigraphy Loess-Palaeosol-Sequences at the Kaiserstuhl – Towards a million years record at the interface of the Atlantic and Mediterranean climate systems
2	Vinnepand, Mathias Isotope Climatology and Environmental Research Centre, Institute for Nuclear Research	Germany	Earthworm biospheroids as radiocarbon chronological markers in the Süttő loess-paleosol sequence, Hungary
3	Kertész, Titanilla LIAG Institute for Applied Geophysics Hannover	Hungary	Quantitative Climate Signals in European Loess-Palaeosol Systems: Insights from Modern Soil Calibration
4	Ryzner, Kamila NIGGG - BAS	Germany	Local and Regional Controls on Magnetic Susceptibility Records in the Lower Danube Loess Region
5	Ishlyamski, Daniel Georgieva – Ishlyamska, Bozhurka	Bulgaria	High-resolution magnetic and geochemical study of magnetic depletion in the S4 paleosol of the Kolobar loess-paleosol sequence (NE Bulgaria)
6	Trott, Andrew Univ. Zurich	Switzerland	Initial insights from alkane- and organic geochemical proxies of a novel loess-paleosol sequence from Kolobar, Bulgaria
7	Steuck, Eva Chair Physical Geography and Geocology	Germany	New insights into Pleistocene environmental dynamics recorded on the Titel Loess Plateau, Serbia
8	Ning, Wenxiao Chinese Academy of Sciences	China	Magnetic Proxy of Eurasian Loess Revealing Enhanced Physical Erosion Since the Mid-Pleistocene Transition
9	Zhang, Yanguang LIAG- Institute for Applied Geophysics, Hannover	Germany	A 13,000-year record of glacier fluctuations at YuzhuFeng glacier (Kunlun Mountains)
10	Raczyk, Jerzy Univ. Wroclaw	Poland	Inferred from periglacial loess grain size Coarse silt from the Sahara: long-range dust transport to Central Europe in April 2026
11	Lopuch, Michał Univ. Wroclaw	Poland	The relation between loess and dunes in south-west Poland: evidence of a shift in atmospheric circulation at the end of the last glaciation?
12	Ohler, Svenja Physical Geography and Geocology, RWTH Aachen University	Germany	Exploring the landscape setting: First results of geomorphological and sedimentological investigations of the mammoth bone site Dolní Věstonice I (Czech Republic)
13	Makaroglu, Ozlem Istanbul University- Cerrahpasa	Turkey	Preliminary Environmental Magnetic Evidence from a Possible Dust-Dominated Sequence in Central Anatolia, Türkiye
14	Sowińska, Zuzanna Univ. Wroclaw	Poland	Ice wedge pseudomorphs mark the degradation of permafrost in southwestern Poland
15	Korabiewski, Bartosz Univ. Wroclaw	Poland	A Geomorphological Perspective on Contemporary Fluvial-Aeolian Sediment Transfer in the Yarlung Tsangpo Valley (Southern Tibetan Plateau)
16	Doroshkevych, Serhii CANCELLED Institute of Geography- National Academy of Sciences of Ukraine	Ukraine	THE POTENTIAL OF MICROMORPHOLOGICAL ANALYSIS FOR DETERMINING THE GENESIS OF FOSSIL SOILS IN UKRAINE
17	Poreba, Grzegorz Silesian University of Technology, Gliwice	Poland	An Anthropogenic Water System in Mačva: OSL and Radioisotope Evidence from Bitva, Jerez, and Obrovčine Channels
18	Vajsov, Ivan NAIM - BAS	Bulgaria	Stratigraphic relationships between Neolithic and Chalcolithic sites and their host loess-soil sediments near the village of Koprivets, Ruse region
19	Lesygiarski, Deyan NIGGG - BAS	Bulgaria	Provenance and technological study of Iron Age ceramic amphorae from the northern Black sea coast of Bulgaria
20	Nikolova, Anelia Sofia University "St. Kliment Ohridski"	Bulgaria	A study of ceramic residues with FT-IR and Raman spectroscopy – preliminary report
21	Zlatarov, Atanas University of Architecture, Civil Engineering and Geodesy	Bulgaria	Determination of the Properties of copolymer-stabilized loess under laboratory conditions

Abstracts – oral presentations

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Permafrost dynamics and Dansgaard - Oeschger (D-O) cycles in Last Glacial loess sequences from Western Europe /INVITED/

¹Antoine, P. ^{1*}, Moine, O. ¹, Hatté, C. ² and Prud'homme, C. ³

1) UMR 8591 CNRS-Universités Paris 1 & UPEC. Laboratoire de Géographie Physique, Environnements quaternaires et actuels, 2 Rue Henri Dunant, 94320 Thiais, France.

2) Laboratoire des Sciences du Climat et de l'Environnement (LSCE) ; UMR CEA CNRS UVSQ 8212 CEA, Université Paris-Saclay, 91 191 Gif-sur-Yvette, France & Silesian University of Technology, 44-100 Gliwice, Poland.

3) Centre de Recherches Pétrographiques et Géochimiques de Nancy, UMR 7358 CNRS-Université de Lorraine 15, rue Notre-Dame des Pauvres 54 500 Vandœuvre-lès-Nancy, France
: * pierre.antoine@lgp.cnrs.fr

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Loess are the most extensive continental archive of the last glacial period in NW Europe. The large periglacial plains of this area (≤ 200 m. a.s.l.), influenced by westerly winds and bounded to the north by the British and Fennoscandian ice sheets and to the south by the Alpine ice cap, were ideally situated to record the impact of millennial climate variations (Dansgaard-Oeschger cycles) and changes in ocean circulation during the Weichselian Pleniglacial (≈ 70 to 15 ka). Numerous evidences of periglacial processes associated with ice-rich permafrost, such as extensive networks of large ice-wedges, cryoturbation horizons and thermokarst erosion gullies, appear in the loess sequences and can be traced at least from northern France to Poland via western Germany (Antoine et al., 2016; Vercelot et al., 2025). In these sequences a succession of more or less cryoturbated 20 to 50 cm thick tundra gley horizons (Gelic Gleysols) and of boreo-arctic brown soils (Cambisols) attests to short events of development and deepening of the permafrost active layer. The high-resolution sedimentological and malacological studies, combined with ^{14}C dating of earthworm calcite granules, which are particularly abundant in these horizons, show that the response of loess environments to the

Dansgaard-Oeschger cycles is recorded as a succession of loess-paleosol cycles between approximately 50 and 20 ka (Moine et al., 2017). Dating these pedogenic horizons and correlating them with reference climate records also demonstrates that several generations of large (> 10 m) polygonal ice wedge networks associated with tundra gleys developed and degraded during these short-term events (≤ 1 ka). These structures are typical of specific palaeoclimatic conditions, which remain to be defined within the framework of a modelling approach involving the extent of the ice sheet, sea ice, atmospheric circulation and temperature reconstructions. This research also enables us to describe how continental glacial environments responded to past millennial climate variations over long distances, providing a solid database for studying the relationships between the dynamics of hunter-gatherer populations and the environmental variability during the last glacial period. Finally, it is also proposed that the deep incisions resulting from thermokarst erosion gullies (approximately 20 by 5 m) have favoured major landscape rejuvenation.

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Periglacial phenomena in loess as paleoenvironmental indicators

^{1*}Jary, Z., ¹Krawczyk, M., ²Tomeniuk, O., ³Moska, P., ²Bogucki, A.,
¹Skurzyński, J., ¹Raczyk, J., ⁴Mroczek, P., ¹Lopuch, M., ¹Sowińska, Z.

¹*Department of Physical Geography, University of Wrocław, Poland*

²*Ivan Franko National University, Lviv, Ukraine*

³*Silesian University of Technology, Gliwice, Poland*

⁴*Maria Curie-Skłodowska University, Lublin, Poland*

*zdzislaw.jary@uwr.edu.pl

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The best record of periglacial environments of the Late Pleistocene is preserved in loess deposited in the extraglacial zone of the ice sheet – in the North European loess belt (NELB). In the NELB loess sequences, three groups of periglacial structures are most common: cryogenic wedges with primary mineral filling, cryoturbation and gelifluction structures, and ice wedge pseudomorphs.

Cryogenic wedges with primary mineral filling are common in S1 palaeosols, where they form polygons with a diameter of 2-5 m and a wedge height of 1-2 m. Their occurrence indicates a cold and dry environment in which deflation and aeolian transport occurred during snowless winters. Accurate environmental reconstruction is limited due to the wide range of environments in which they occur today. They most likely indicate deep, seasonal frost penetration (not necessarily permafrost), usually facilitated by sparse vegetation and little snow cover. They record a period of marked increase in climate continentality enabling the development of cryodesiccation processes.

Cryoturbations and gelifluction structures are among the most common periglacial structures in loess. They occur in several horizons but are most common at the tops of the S1 and L1SS1 palaeosols. In modern periglacial environments, these structures

develop in both permafrost and non-permafrost areas. The irregular deformations that sometimes occur in highly gleyed loess or tundra-gley soils are probably caused by the pressure of freezing water trapped between freezing fronts.

Among the numerous periglacial phenomena, the most important are the pseudomorphs of ice wedges, which are direct evidence of the former presence of permafrost. For ice wedges to form, the average annual temperature must fall below a certain value, which depends mainly on the lithology and moisture content of the ground. Due to the high coefficient of thermal expansion of loess, it is higher than that of sandy sediments and is likely around -4 - -6 °C. Melting of ice and the formation of pseudomorphs require much higher average annual temperatures. In loess deposits, the voids left by the melted ice wedge are filled with liquefied loess material, which gets there mainly from the surface.

It is assumed that ice wedges in loess are of epigenetic origin, but their syngenetic and anti-syngenetic origin cannot be excluded. This may be indicated by the large vertical dimensions and the external outlines of some pseudomorphs. OSL age of the loess filling the ice wedge pseudomorphs, recently studied in the Podolia, also indicates their syngenetic origin. The varied age of their filling most likely indicates multiple reactivations and melting of these structures.

The Krasyliv Palaeocryogenic Stage as a Marker of Final Pleistocene Cooling in Ukrainian Loess–Palaeosol sequences

^{1,2*}Tomeniuk, O., ¹Bogucki, A.

¹*Ivan Franko National University of Lviv, Lviv, Ukraine*

²*I. Krypiakevych Institute of Ukrainian Studies of NAS of Ukraine*

*olena.tomeniuk@lnu.edu.ua

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The Krasyliv (Final Pleistocene) palaeocryogenic stage was distinguished in 1990 and corresponds to one of the most distinct cooling events of the Late Pleistocene (MIS 2). Its characteristic feature is the development of large polygonal ice-wedge systems, evidenced by the widespread occurrence of large-polygonal post-cryogenic relief on the Volhynian Upland, in the northern part of the Podillian Upland, and in other regions of Ukraine, as well as by numerous ice wedge pseudomorphs. These structures represent some of the largest Pleistocene cryogenic features identified in Ukraine and constitute an important component of the palaeoclimatic archive documenting the cyclicity of environmental development during the Quaternary (Bogucki et al., 2021).

The age of the Krasyliv subhorizon sediments has been established on the basis of TL and OSL dating results. In the Korshiv section, ages of 14.0 ± 6.2 ka (OSL, Gliwice laboratory), 14.2 ± 2.0 ka and 16.6 ± 2.5 ka (TL, Gdańsk laboratory), and 19.7 ± 2.4 ka and 19.9 ± 2.4 ka (TL, Lublin laboratory) were obtained (Fedorowicz et al., 2013), as well as 15.3 ± 1.3 ka, 15.6 ± 1.1 ka, and 15.7 ± 1.3 ka (OSL, Lublin laboratory) (Nawrocki et al., 2019). For the Boyanychi section, an age of 15.8 ± 1.5 ka (TL, Lublin laboratory) was determined (Kusiak et al., 2012). In the Rivne section, ages of 13.5 ± 0.9 ka and 14.6 ± 1.0 ka (OSL, Lublin laboratory) were obtained (Nawrocki et al., 2018), whereas in the Volochysk section, ages of 18.6 ± 2.6 ka (TL, Gdańsk laboratory) and 15.9 ± 1.0 ka (OSL, Lublin laboratory) were established (Fedorowicz et al., 2018).

Ice wedge pseudomorphs exhibit a distinct wedge-shaped morphology. Their vertical extent reaches 6–7 m on the Volhynian Upland and 3–4 m in the northern part of the Podillian Upland. The width of the upper part of these structures beneath the buried

active layer is typically 2.0–2.5 m, although larger dimensions occasionally occur. South of the latitude of Ternopil, such features are encountered only rarely. The morphometric parameters of the polygonal networks have been investigated at numerous key sections across the Volhynian and Podillian uplands, with polygon diameters most commonly ranging from 20 to 30 m.

It has been established that the Krasyliv palaeocryogenic stage exerted a significant influence on the engineering-geological properties of the loess–palaeosol sequence. The infill of polygonal structures is characterised by increased looseness and macroporosity and frequently exhibits collapsible behaviour even under natural loading conditions. At the same time, zones of compaction can be observed along the margins of the pseudomorphs. These findings are of considerable importance for reconstructing the palaeogeographical conditions of the Final Pleistocene and for assessing the engineering-geological properties of the loess deposits of Ukraine.

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On the high-resolution investigation of Danube loess-paleosol records since the mid-Brunhes event – a view from the LOEs-CLIMBE project

¹Veres, D., *²Jordanova, D., ^{1,3}Hambach, U., ^{4,1}Baykal, Y., ^{1,5,6} Robu, M., ⁷Trott, A., ²Georgieva – Ishlyamska, B., ²Ishlyamski, D., ¹Faragau, A., ⁷Buchmann, L.S., ²Jordanova, N., ²Dimov, D., ⁷Rowley, M. and ⁷WiesenberG, G.

¹ Romanian Academy Cluj-Napoca Branch, Republicii 9, 400015 Cluj-Napoca, Romania

² National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Acad. G. Bonchev, block 3, 1113 Sofia, Bulgaria

³ BayCEER, University of Bayreuth, 95440 Bayreuth, Germany

⁴Department of Physics, Technical University of Denmark, Frederiksborgvej 399, 4000 Roskilde, Denmark

⁵ “Emil Racoviță” Speleology Institute, Romanian Academy, Bucharest, Romania

⁶ Research Institute of the University of Bucharest, Bucharest, Romania

⁷ Department of Geography, University of Zurich, Winterthurerstrasse 190, 8057 Zürich, Switzerland

*dan.veres@acad-cj.ro

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The Mid-Brunhes Event (MBE) refers to a distinct turning point in Earth's climate history, about 430,000 years ago. Specifically, it marks the shift towards greater amplitude in temperature and hydroclimate variability within orbital cycles, resulting in harsher glacial conditions and more intense and abrupt warming periods compared to early/middle Pleistocene. Since the MBE, periodic global climate shifts have caused profound variations in ocean circulation, ice and vegetation cover, and carbon cycling

across the globe. The environmental extremes and related ecological shifts on land may have also acted as key drivers in human evolution since the middle Pleistocene.

Within the LOEs-CLIMBE project – ‘Shedding Light on *Lower Danube* Black Sea region paleo*CL*imate since the Mid-Brunhes Event (*MBE*) by novel loess-paleosol records’ we aim to significantly improve our understanding of past climate and environment in southeastern Europe throughout the last 4-6 glacial-interglacial cycles. We focus on investigating at high-resolution loess-paleosol sequences (LPS) located between the Danube and the Black Sea in Romania and Bulgaria, an ecologically region of interest marked by strong local differences in bio-edaphic conditions. Long-term variability in such conditions is expressed also in the appearance, thickness and geochemical characteristics of both paleosol and loess units, likely reflecting strong hydroclimate forcing via paleovegetation and paleoenvironment.

In this project we employ a multiproxy approach that relies on novel methods in loess research including various biomarkers, compound-specific $\delta^2\text{H}$ analyses, stable isotopes ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) of organic matter and carbonates as well as detailed environmental magnetic analyses to reconstruct past vegetation, temperature and hydroclimate dynamics. We couple these proxy data to synchrotron-based spectromicroscopy analyses for assessment of calcium speciation and its relation to bioturbation features. Finally, we use cosmogenic dating in combination with tephrochronology, chronostratigraphy and detailed luminescence dating to yield robust depositional chronologies.

In this contribution we present preliminary but high-resolution geochemical and rock magnetic datasets over S6 to S0 paleosols from the Lower Danube Basin and highlight how systematic and quantitative evaluation of similarities and dissimilarities between records may lead to a better understanding of past climate conditions and their reflectance in loess – paleosol records.

Introduction to the DUSTCODE project: Unifying European loess archives to decode MIS 2 climate and dust transport systems

Skurzyński, J.^{1*}

¹*Department of Physical Geography, University of Wrocław, Poland*

*jacek.skurzynski@uwr.edu.pl

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The DUSTCODE project aims to generate the first fully standardized, continent-wide, multi-proxy dataset for MIS 2 loess across Europe. This dataset will enable robust reconstruction of dust provenance, weathering intensity and paleoclimate gradients. The project covers all six major European loess domains and sixteen subdomains, with particular focus on the silt-sized fraction that forms the primary loess mantle and mainly records local to regional dust sources active during MIS 2.

Existing continental-scale studies of European loess are often limited by inconsistent sampling strategies and non-comparable analytical protocols, which can obscure genuine environmental gradients. DUSTCODE addresses these limitations through a unified field, laboratory and interpretative workflow. Field campaigns across Europe will provide harmonized lithological and geomorphological documentation, together with high-resolution sampling at 5 cm intervals. All collected samples will undergo screening analyses, including grain-size distribution, color, carbonate content, TOC/TIC and handheld XRF measurements. These data will guide the selection of representative samples for detailed geochemical and mineralogical analyses. Bulk geochemical analyses will be performed using ICP-based methods after lithium–borate fusion, ensuring complete dissolution of refractory minerals and minimizing biases commonly associated with four-acid digestion. This approach will produce directly comparable major-, trace- and rare-earth-element datasets suitable for evaluating weathering intensity, sediment recycling and source-related contrasts. Mineralogical composition will be quantified using automated SEM–EDS analysis with QEMSCAN[®],

supported where necessary by EBSD and Raman verification. This workflow will allow the identification of provenance-sensitive phases and the assessment of pre- and post-depositional weathering trajectories within and between loess subdomains. An independent climatic reference framework will be developed from isotopic analyses of land-snail shells. Carbonate clumped isotopes ($\Delta 47$) will provide growing-season palaeotemperature estimates, whereas stable isotopes ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) will serve as indicators of aridity and moisture balance. The use of carefully selected taxa will ensure reliable interpretation based on established methodological foundations. Existing site chronologies will be verified and refined through new OSL dating.

The integrated mineralogical, geochemical, isotopic and granulometric datasets will be used to evaluate the validity of established European loess domains, quantify the relative roles of local and regional dust sources, and reconstruct spatial patterns of MIS 2 climate across Europe. The project will produce a coherent, fully comparable continental-scale reference dataset for European loess, archived in the open-access ELAMOR database (European Loess Archive: Mineralogical and geoChemical Repository). Its results will provide a methodological benchmark for future studies of dust–climate interactions and significantly refine our understanding of environmental gradients during MIS 2.

To illustrate the potential of the proposed methodological framework, this presentation will also show preliminary results from the pilot stage of the project. These results focus on grain-size-resolved mineralogical analysis using QEMSCAN[®] and bulk geochemical analysis using ICP-based methods for Late Pleistocene loess from two subdomains of the Northern European loess belt in Poland. The analyzed sites are represented by the Biały Kościół loess–palaeosol sequence, located in subdomain IIb, and the Tyszowce loess–palaeosol sequence, located in subdomain IIc. Together, these pilot data demonstrate how standardized mineralogical and geochemical workflows can reveal subdomain-scale differences in loess composition, sediment provenance and post-depositional transformation.

Eurasian Loess Landscapes in a Three-Eco-zone Framework: Conceptual Model and Regional Illustrations /INVITED/

¹Lehmkuhl, F., ²Zeeden, C., ³Jary, Z., ⁴Veres, D., ⁵Shiling Yang, ¹Schulte, P.,
^{4,6}Hambach, U.

¹*Department of Geography, RWTH Aachen University, Germany*

²*LIAG Institute for Applied Geophysics, Hanover, Germany*

³*University of Wroclaw, Institute of Geography and Regional Development,
Wroclaw, Poland*

⁴*Romanian Academy, Institute of Speleology, Cluj-Napoca, Romania*

⁵*Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing,
China*

⁶*BayCEER & Chair of Geomorphology, University of Bayreuth, Bayreuth,
Germany*

*flehmkuhl@geo.rwth-aachen.de

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At least 10% of the continental surface in the Northern-Hemisphere —particularly in western and central Eurasia—is covered by eolian mineral dust and sandy deposits, many of which are mapped as loess. The origin and spatial pattern of these sediments reflects past (paleo-)environmental conditions and are an important edaphic factor for eco-zone evolution.

Here, we present an updated conceptual model based on the European loess facies classification (Lehmkuhl et al., 2021), which distinguishes three climate-controlled modes of loess formation: **Mode 1:** periglacial/tundra loess (cold, moist climate; tundra/alpine vegetation; silt-dominated deposits). **Mode 2:** temperate-subtropical loess (moderate temperature and precipitation; forest/steppe vegetation; mixed silt-/fine-sand fractions). **Mode 3:** desert-margin loess (warm, arid climate; xeric

shrubland/desert vegetation; sand-rich deposits sourced from dry riverbeds and exposed lacustrine surfaces).

Continuous silt-dominated, typical loess primarily forms in the transitional zones between these modes.

Applying the model to the Chinese Loess Plateau reveals a gradient in grain-size from clay-rich to silty loess in the humid southern areas to increasingly sandy loess toward the semi-arid and arid north-west regions. Similar patterns occur in Eastern Europe and Central Asia (e.g., the surroundings of the Sea of Azov, the Caspian Lowlands and the deserts towards the east). Periglacial loess (Mode 1) dominates in high mountain regions and in northern Mongolia and Siberia, whereas desert-margin loess (Mode 3) is found in the arid regions of Central Asia. Humid highlands, such as the eastern margin of the Tibetan Plateau, lack loess almost entirely.

The model provides a unified framework for interpreting loess distribution across climatic, vegetational, and topographic gradients in Eurasia.

Lehmkuhl, F., Nett, J.J., Pötter, S., Schulte, P., Sprafke, T., Jary, Z., Antoine, P., Wacha, L., Wolf, D., Zerboni, A., Hošek, J., Marković, S.B., Obreht, I., Sümegi, P., Veres, D., Zeeden, C., Boemke, B., Schaubert, V., Viehweger, J., Hambach, U. (2021): Loess landscapes of Europe – mapping, geomorphology, and zonal differentiation. *Earth Science Reviews* 103496, <https://doi.org/10.1016/j.earscirev.2020.103496>

Spatial Heterogeneity of the Westerlies Evolution over Mid-latitude Asia Since the Middle Pleistocene: Evidence from Loess Records

^{1,2} Liu, S., ^{1,2*} Jia, J., ^{1,2} Chen, N., ^{1,2} Chen, P., ^{1,2} Zhao, D., ^{1,2} Zhang, J., ^{1,2} Zhu, Z., and ^{1,2} Wang, B.

¹ *College of Geography and Environmental Sciences, Zhejiang Normal University, Jinhua 321004, China*

² *Zhejiang Key Laboratory of Digital Intelligence Monitoring and Restoration of Watershed Environment, Zhejiang Normal University, Jinhua, Zhejiang, 321004, China*

*jiaj@zjnu.edu.cn

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The westerlies over mid-latitude Asia play a crucial role in the global climate system by regulating the transport of energy, water vapor, and dust. However, the long-term evolution and driving mechanisms of the upper-level westerlies since the Mid-Pleistocene remain poorly understood due to the lack of reliable proxies. Here, we investigate three representative loess sections under different circulation regimes, including the DK section in Tajikistan within the westerly-dominated region, the XF section on the Chinese Loess Plateau within the monsoon-dominated region, and the NYZ19 section in northeastern China within the westerly-monsoon transitional zone. Using high-resolution grain-size records combined with single-sample unmixing (SSU) and Ensemble Empirical Mode Decomposition (EEMD) analyses, we extracted fine-grained components transported by the upper-level westerlies and reconstructed the spatiotemporal evolution of the upper-level westerlies over mid-latitude Asia since 800ka and explored their forcing mechanisms. The results show that pronounced glacial-interglacial cyclicity, with stronger westerlies during glacials and weaker westerlies during interglacials, although their amplitude and stability vary spatially. EEMD analyses show that all studied sections record precession, obliquity, and eccentricity cycles, although the dominant periodicities differ among sections.

Specifically, the fine-grained component transported by the upper-level westerlies in the DK section is dominated by 100 ka glacial periodicity, primarily reflecting the control of global ice volume on the background intensity of the westerlies. In contrast, the corresponding fine-grained components in the XF and NYZ19 sections exhibit a more pronounced 19-23 ka precessional cycle, suggesting that their variations were primarily controlled by the response of glacial activity over the upwind Tibetan Plateau to changes in summer insolation. Mechanistically, precession regulates glacier and periglacial activity across the Tibetan Plateau and its surrounding regions, thereby influencing the production and supply of fine-grained materials. Obliquity affects the meridional temperature gradient and the meridional position of the westerlies, thereby influencing the transport and depositional expression of fine-grained materials in downwind areas. The climate formed by different combinations of orbital parameters leads to spatially heterogeneous responses of the westerlies, which reflects shifts in the westerlies under precession and obliquity forcing. Meanwhile, the Tibetan Plateau profoundly affected the fine-grained material transport processes of the westerlies since the Middle Pleistocene through three pathways: enhancing sediment supply, facilitating vertical uplift of materials, and improving the transport efficiency of the westerlies. Overall, orbital forcing, global ice-volume changes, and regional topography jointly shaped the evolution of the upper-level westerlies since the Mid-Pleistocene.

Magnetic enhancement in Eurasian soils, paleosols and loess: insights over formation processes

¹Zeeden, C.*, ¹Ryzner, K., ^{1,2}Vinnepand, M., ³Veres, D., ⁴Bosnić, M., ¹Amiri, Z., ⁵Frank Lehmkuhl, ⁶Reyaz Dar, ⁷Dmytro Hlavatskyi, ¹Paknia, M., ⁸Mathieu Martinez, ^{3,9}Ulrich Hambach

¹*LIAG-Institute for Applied Geophysics, Hannover, Germany*

² *Universität Freiburg, Freiburg, Germany*

³ *Institute of Speleology, Romanian Academy, Cluj-Napoca, Romania*

⁴ *Laboratory for paleo-environmental reconstruction, University of Novi Sad, Novi Sad, Serbia*

⁵ *Physical Geography and Geoecology, RWTH Aachen University, Aachen, Germany*

⁶ *Department of Earth Sciences, University of Kashmir, Srinagar, India*

⁷ *Institute of Geophysics of National Academy of Sciences of Ukraine, Kyiv, Ukraine*

⁸ *Geosciences Rennes, Rennes, France*

⁹ *BayCEER, University of Bayreuth, Germany*

* christian.zeeden@liag-institut.de

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Magnetic properties of loess have been used over the last decades to understand past climate regimes. Numerous climate proxies have been suggested based on magnetic susceptibility- and remanence properties, all with good theoretical background. In particular magnetic enhancement, the parallel increase in magnetic susceptibility with its frequency dependency, has been shown to be a rather straightforward and powerful tool to understand processes influencing the magnetic susceptibility.

Here, we provide an overview of magnetic susceptibility and frequency-dependent susceptibility data from loess and topsoils, fossil soils formed in loess from Eurasia to evaluate the range of processes recorded by magnetic enhancement signals. Using multiple datasets, we showcase that magnetic enhancement, depletion, wind vigour effects and tephra candidates may be derived from magnetic susceptibility properties. This first large-scale compilation provides a framework for comparing magnetic enhancement signals across Eurasian loess archives and assessing their potential and limitations as paleoenvironmental indicators.

Holocene hydroclimate and dust activity, as reconstructed from the sediments of Lake Bayanchagan, on the northern margin of the East Asian summer monsoon

Jiang, W.Y.*, Li, W.B.

Institute of Geology and Geophysics, Chinese Academy of Sciences

*wjiang@mail.iggcas.ac.cn

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The sediments of closed-basin lakes on the margin of the East Asian summer monsoon (EASM) are valuable archives of past changes in hydroclimate and dust activity, and thus potentially can help to understand future climate changes. We present high-resolution, well-dated records of the grain-size and carbonate mineralogy from Lake Bayanchagan, northern China, spanning the last 11.5 ka. Grain-size end-member (EM) analysis distinguished four EMs, each linked to different sediment transport processes. EM1 (0.4-0.6 μm) and EM3 (14-102 μm) reflect the strength of regional dust activity, whereas EM2 (1.3-31 μm) represents variations in local hydrodynamic conditions related to lake-level changes and EM4 (68-500 μm) is associated with local dust activity. Our results show that a high lake-level and weakened dust activity occurred during 10–5.8 ka, as indicated by increased EM2 and decreased EM3, respectively. After 5.8 ka, EM2 decreased as the three other EMs increased, and dolomite appeared in the sediments while calcite decreased — indicating both a decline in lake-level and strengthened dust activity. The fluctuations in lake-level and dust activity are in good agreement with precipitation variations reconstructed from other records, which are in turn correlated to movement of the EASM rainfall belt, in response to temperature changes.

Paleoenvironmental changes during the Late Pleistocene recorded in the grain-size of loess-paleosol sequences in southwest Poland.

^{1*}Krawczyk M., ¹Jary Z., ¹Łopuch M.

¹ *Institute of Geography and Regional Development, University of Wrocław,
Pl. Uniwersytecki 1, 50-137 Wrocław, Poland*

*marcin.krawczyk2@uwr.edu.pl

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Loess–paleosol sequences (LPSs) from southwestern Poland provide an important archive of Late Pleistocene environmental change at the northern margin of the European Loess Belt and in the foreland of the Fennoscandian Ice Sheet. However, the mechanisms controlling the spatial variability of loess deposition in this region, particularly their links with ice-sheet dynamics, dust supply, and local depositional conditions, remain insufficiently understood. This presentation addresses these issues by analysing grain-size variability and end-member composition in three LPSs from southwestern Poland.

Three sites were analysed: Biały Kościół (Niemcza–Strzelin Hills), Zaprzężyn, and Trzebnica (both in the Trzebnica Hills). High-resolution sampling (>2000 samples) combined with laser diffraction grain-size measurements, color spectrophotometry, carbonate and organic matter determination, and advanced statistical techniques, including end-member modeling analysis (EMMA), enabled detailed reconstruction of Late Pleistocene depositional environments.

The results reveal the dominance of a coarse silt end-member (main mode ~63 µm; EM3), particularly within the L1LL1 units, which is interpreted as primarily reflecting enhanced dust availability and high-energy depositional conditions during the Last Glacial Maximum (MIS 2). A recurrent fine silt component (main mode ~16 µm; EM2), mainly present in older loess and paleosol horizons (L1LL2, L1SS1), indicates an increased contribution of long-distance transported dust under relatively stable depositional conditions. An additional very fine fraction (~4 µm; EM1), identified at

the Biały Kościół and Trzebnica sites, is associated with phases of enhanced humidity, pedogenic processes, and post-depositional modification. Sandy fractions (125–500 μm) occur locally and reflect short-distance transport under highly dynamic, high-energy conditions.

Comparative analysis highlights pronounced lithological variability between the studied sites despite their close spatial proximity (~ 60 km). Zaprężyn and Trzebnica, both located in the Trzebnica Hills, exhibit stratigraphic discontinuities and erosional gaps, whereas the Biały Kościół sequence preserves a more continuous sedimentary record, including Middle Plenivistulian soils (MIS 3). These differences reflect local topographic conditions, sediment supply, and varying proximity to ice-sheet margins. Overall, the results indicate that loess deposition in southwestern Poland was strongly influenced by the advance and retreat phases of the Fennoscandian Ice Sheet. Enhanced meridional temperature gradients during MIS 4 and MIS 2 promoted dust production, transport, and deposition. The study demonstrates that integrating granulometric proxies with end-member modeling provides valuable insights into the complexity of aeolian processes and Late Pleistocene paleoclimatic variability in south-west Poland.

Detailed luminescence dating of late Quaternary loess at Kolobar, Bulgaria

^{1,2}Baykal, Y., ³Jordanova, D., ¹Veres, D., ^{1,4,5}Robu, M., ³Georgieva –
Ishlyamska, B., ³Ishlyamski, D., ⁶Trott, A., ³Jordanova, N., ³Dimov, D.,
^{1,7}Hambach, U., ¹Faragau, A., ⁶Rowley, M., ⁶Wiesenberg, G., ²Buylaert, J.-P.

¹Romanian Academy, Institute of Speleology, Cluj-Napoca, Romania

²Department of Physics, Technical University of Denmark, Denmark

³National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Bulgaria; ⁴“Emil Racoviță” Speleology Institute, Romanian Academy, Romania; ⁵Research Institute of the University of Bucharest, Romania; ⁶Department of Geography, University of Zurich, Switzerland; ⁷BayCEER, University of Bayreuth, Germany

*yubay@dtu.dk

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Atmospheric mineral dust is a fundamental component of the Earth's climate system. Yet, the exact environmental controls on dust and its role in climate change are not fully understood. Extensive and thick deposits of windblown dust (loess) in the Lower Danube Basin are testament to substantial dust activity throughout the middle to late Pleistocene. However, independent high-resolution chronologies needed to reconstruct past dust deposition variability on subglacial to millennial timescales remain scarce. Here, we present a new high-resolution luminescence chronology for the Kolobar loess section located in northeastern Bulgaria, approximately 40 km south of the Danube River. Comparison of quartz OSL and feldspar IR₅₀ and pIRIR_{200,290} luminescence signals suggests that quartz doses were likely affected by post-depositional reworking processes such as bioturbation. Consequently, feldspar pIRIR_{200,290} ages, following residual dose correction, appear to provide more reliable ages of primary aeolian dust fall. The resulting preliminary chronology for the last glacial period generally agrees

well with chronostratigraphic observations. Yet, it reveals that loess accumulation at Kolobar was strongly reduced during the Last Glacial Maximum (LGM), a period that is globally associated with greatly enhanced dustiness. It remains unclear whether the apparent lack of LGM loess at the relatively source-distal Kolobar section reflects reduced dust activity or erosion, however, comparison with other loess records south of the Lower Danube River suggests this is a regional effect. These findings reinforce the complexity of loess accumulation as a function of wider dust dynamics modulated by regional to local factors and thus, the inevitable need for detailed chronological control when studying loess archives.

Pliocene CO₂ rise driven by sea-level fall as a mechanism for the delayed ice age: Evidence from carbonate clumped-isotope analysis of aeolian deposits /INVITED/

^{1,2*}Yang, S.L., ¹Wang, Y.D., ¹Huang, X.F., ¹Sun, M.M., ¹Jiang, W.Y., and ¹Ding, Z.L..

¹ *State Key Laboratory of Lithospheric and Environmental Coevolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China*

² *College of Earth and Planetary Sciences, University of Chinese Academy of Sciences, Beijing 100049, China*

*yangsl@mail.iggcas.ac.cn

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Global sea level fell progressively during the Pliocene in response to the growth of ice sheets at high northern latitudes. However, the Northern Hemisphere did not enter a major ice age until ~2.7 Ma, for which several causes have been postulated, including tropical seaway closures, permanent El Niño-like conditions, and Earth's orbital changes. Recent studies have attributed the onset of the Pleistocene ice ages in the Northern Hemisphere to the decrease in $p\text{CO}_2$. However, the link between $p\text{CO}_2$ and Pliocene glaciations, or their delay, is not well understood, mainly because the magnitude of $p\text{CO}_2$ remains uncertain beyond the maximum age of ice cores (~0.8 Ma). Here, we develop a carbonate clumped isotope (Δ_{47})–temperature calibration equation specifically for pedogenic carbonate in Chinese loess, to quantify the temperature of carbonate nodule formation and the soil-respired CO₂ concentration ($S(z)$). Then, we apply the new Δ_{47} –temperature calibration to loess-red clay sequences on the Chinese Loess Plateau to reconstruct global $p\text{CO}_2$ history since the Late Miocene.

The palaeotemperature results show an oscillatory cooling trend over time in northern China, with four prominent warm intervals (7.24–7.1 Ma, 5.8–5.2 Ma, 4.6–4.0

Ma, 3.5–2.7 Ma) occurring during the Late Miocene and Pliocene. These characteristics are consistent with those of tropical sea surface temperature records. $p\text{CO}_2$ reconstructed using the pedogenic carbonate palaeobarometer was consistently low (150–325 ppmv) during the intervals of 7.2–4.3 Ma and 2.6–0.8 Ma. In contrast, there is a three-step rise in $p\text{CO}_2$ up to 535 ppmv from 4.3 to 2.6 Ma, coincident with the oscillatory decrease in global sea level and in benthic $\delta^{13}\text{C}$ record. We suggest that the Pliocene CO_2 rise is causally related to the sea-level fall and associated organic carbon oxidation on exposed continental shelves, thereby delaying the onset of the ice age. Our results suggest a negative feedback mechanism due to the long-term cooling since the Late Miocene: i.e., once global cooling reached a critical threshold for ice sheet growth at high northern latitudes, the resulting fall in sea level and exposure of continental shelves in turn led to CO_2 release and caused distinct transient warming. This CO_2 -induced warming during the Pliocene delayed the beginning of the Northern Hemisphere ice age but did not prevent it.

The Gravettian site of Amiens-Renancourt 2: a new reference loess sequence for the late Weichselian Middle Pleniglacial in northern France

¹*Moine, O., ^{2,1}Coutard, S., ^{2,3}Paris, C., ⁴Richter, C. and ⁵Horsák, M.

¹CNRS, Laboratoire de Géographie Physique, Thiais, France

²INRAP, Glisy, France

³Technologie et Ethnologie des Mondes PréhistoriqueS, Nanterre, France

⁴Institute of Geography, Technische Universität Dresden, Germany

⁵Department of Botany and Zoology, Masaryk University, Brno, Czech Republic

*olivier.moine@lgp.cnrs.fr

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In north-western Europe, and more specifically in northern France, the chronostratigraphy and the palaeoenvironmental evolution of the late Weichselian Middle Pleniglacial remain poorly constrained. They presently rely on a few sites of plateau context, which only exceptionally combine a detailed stratigraphy, a robust chronology and a high resolution molluscan record due to low sedimentary budgets and decarbonation.

Here we present the results obtained in a slope context at Amiens-Renancourt 2 (Somme, France) in the western suburb of Amiens. This site is located in the close vicinity of the historical site of Amiens-Renancourt 1 recently re-investigated for chronostratigraphy and palaeoenvironment and which provided a late Gravettian archaeological occupation famous for its ornaments and female statuettes. Amiens-Renancourt 2 was studied thanks to a new archaeological excavation in 2011 and 2012. To accurately document the chronostratigraphic and palaeoenvironmental context of the human settlement, a high resolution multi-proxy study was thus performed including sedimentology, magnetic susceptibility, total organic carbon content, calcimetry,

micromorphology, malacology, radiocarbon (bone, earthworm calcite granules) and luminescence (quartz) dating.

The occupation is located in a 150-cm-thick sequence of calcareous loessic slope deposits trapped at the foot of a chalky scarp and covering an alluvial terrace and topped by 2.5 m of laminated loess. The sequence of calcareous loessic slope deposits was formed by aeolian deposits but also by colluvial processes. The multi-proxy analysis of the sediments demonstrates the increasing influence of aeolian deposition at the expense of colluvial processes from the base to the top, but no clear cyclicity has been highlighted, rather shifts. The molluscan study reveals a contrasted record with three phases of very high abundance increases marking phases of climatic improvements. Their molluscan compositions differ, highlighting specific environmental signatures: bushy, herbaceous and palustral. The human occupation took place in the herbaceous one. Conversely, harsher phases represented by very thin low abundance phases appear poorly recorded. Based on the lithic industry and bone remains, the settlement appears as a hunting place (flint knapping and butchery activities) attributed to the early Gravettian (Maisierian).

Numerical ages indicate that the loamy sequence deposited between about 35 and 30 ka. Correlation are proposed between the molluscan record and the NGRIP succession of stadial and interstadial phases. The occupation occurred around 32 ka and would be contemporary from GI-5.2 or possibly GI-6. This settlement thus pre-dates the Amiens-Renancourt 1 settlement contemporaneous from GI-3 by about 5 ka. This site also contributes to demonstrate the discontinuous occupation of this area located at the borders of human territories during the Upper Palaeolithic, in relation to short phases of climatic improvement and the concomitant presence of vegetation allowing the expansion of large herbivores.

Consequently, Amiens-Renancourt 2 provides the most detailed and complete chronostratigraphical, sedimentological and molluscan records for the late Weichselian Middle Pleniglacial in northern France. The slope context however results in a different pedosedimentary record and dynamics than during the contemporaneous development of the top of the Saint-Acheul/Villiers-Adam soil complex.

Bioturbation in loess-paleosol sequences: To which extent does it disturb sedimentary, paleoenvironmental and paleoclimatic records?

¹Wiesenberg, G. L. B., ^{2,3}Baykal, Y., ⁴Georgieva – Ishlyamska, B., ⁴Ishlyamski, D., ⁴Jordanova, D., ⁴Jordanova, N., ^{3,5}Hambach, U., ¹Martinengo, S. ^{3,6,7}Robu, M., ¹Rowley, M., ¹Trott, A., ⁵Veres, D., ⁸Gocke, M.I.

¹*Department of Geography, University of Zurich, Switzerland*

²*Department of Physics, Technical University of Denmark, Denmark*

³*Romanian Academy, Cluj-Napoca Branch, Romania*

⁴*National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Bulgaria*

⁵*BayCEER, University of Bayreuth, Germany*

⁶*“Emil Racoviță” Speleology Institute, Romanian Academy, Romania*

⁷*Research Institute of the University of Bucharest, Romania*

⁸*Institute of Agricultural Engineering, University of Bonn, Germany*

*guido.wiesenberg@geo.uzh.ch

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Loess-paleosol records provide important terrestrial archives for Quaternary paleoclimate and paleoenvironment evolution. In central and eastern Europe, the continuous sedimentation of loess-type sediments covering more than 600.000 years in conjunction with the paleosols developed therein allow for detailed studies of climate

and environmental histories. However, often loess-paleosol sequences are found in temperate to semi-arid continental conditions. Under these conditions, burrowing organisms (e.g., insects, snails, mammals, earthworms) serve as very important soil architects that not only produce biopores, but also lead to redistribution of particulate material ranging up to several meters vertically and laterally. The same applies to plant roots, although the active movement of particulate matter through roots is limited, but they also produce and use existing pore systems and lead to redistribution of mineral matter by dissolution and reprecipitation. There have been long debates, if these bioturbations and redistributions are relevant for loess-paleosol records, i.e. to which extent they may disturb any archived signals. By combining multiscale and multidimensional field and laboratory techniques including detailed field assessments, synchrotron-based analyses, inorganic and organic proxies such as stable isotopes, elemental composition and many more, we will provide current-day insights into the significance of biopores for paleoenvironmental and paleoclimatic reconstructions as well as chronostratigraphy of loess-paleosol sequences located in Bulgaria, Germany, Hungary, Romania, and Serbia.

Investigating Bioturbation-Driven Element Redistribution and Calcium Speciation in the Kolobar Loess–Palaeosol Sequence Using Synchrotron-based Spectromicroscopy

Martinengo, S.¹, Wiesenberg, G. L, B.¹, Spielman-Sun, E.², Trott, A.¹,
Jordanova, D.³, Veres, D.⁴, Georgieva–Ishlyamska, B.³, Baykal, Y.⁵, Robu,
M.^{4,6,7,8}, Ishlyamski, D.³, Jordanova, N.³, Hambach, U.⁴, & Rowley, M. C.^{1*}

¹Department of Geography, Universität Zürich, Switzerland.

²Stanford Synchrotron Radiation Lightsource, SLAC National Accelerator
Laboratory, California, United States of America.

³National Institute of Geophysics, Geodesy and Geography, Bulgarian
Academy of Sciences, Bulgaria.

⁴Cluj-Napoca Department, “Emil Racoviță” Institute of Speleology, Romanian
Academy, Romania/

⁵Department of Physics, Technical University of Denmark, Denmark.

⁶“Emil Racoviță” Institute of Speleology, Romanian Academy, Bucharest,
Romania

⁷Research Institute of the University of Bucharest, Bucharest, Romania

⁸“Sabba S. Stefanescu” Institute of Geodynamics, Romanian Academy,
Bucharest, Romania

* mike.rowley@geo.uzh.ch

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The loess-palaeosol sequences (LPS) of the Lower Danube-Black Sea region constitute
a continuous terrestrial archive of Quaternary climate and environmental change in

southeastern Europe. Despite their potential for reconstructing past hydroclimate, vegetation dynamics, and landscape evolution, detailed geochemical characterisation of these archives remains limited. The Kolobar LPS in northeastern Bulgaria represents a novel and unexplored sequence that combines glacial–interglacial records with extensive, exceptionally well-preserved bioturbation features. The effects of this bioturbation on the elemental redistribution and metal speciation remain poorly understood, and synchrotron-based spectromicroscopy has rarely been applied to investigate microscale geochemical heterogeneity within LPS archives.

To address this knowledge gap, we employed synchrotron-based spectromicroscopy to assess the influence of bioturbation on microscale elemental distributions and calcium (Ca) speciation within the Kolobar sequence. Intact samples from bioturbated regions were prepared as 20 μm -thick, thin sections and analysed at beamline 14-3b of the Stanford Synchrotron Radiation Lightsource using micro-X-ray fluorescence coupled with micro-X-ray absorption near-edge structure spectroscopy ($\mu\text{-XRF/XANES}$). This enabled the high-resolution mapping of elemental distributions and Ca speciation of the thin sections across bioturbation features. The $\mu\text{-XRF/XANES}$ analysis revealed distinct geochemical signatures and patterns of calcite distribution associated with different bio-pores. Here, we present these initial findings and discuss their implications for understanding bioturbation-driven geochemical redistribution in LPS. We also discuss future directions for integrating synchrotron-based observations into palaeoenvironmental reconstructions and analyses.

Magnetic signature of loess in the northern Tien Shan piedmont, eastern Kazakhstan

¹*Ghafarpour, A., ¹Lauer, T., ¹Appel, E., ²Spasov, S., ³Nigmatova, S.,
¹Böhme, M., and ⁴Fitzsimmons, K.

¹*Department of Geosciences, Eberhard-Karls-University of Tübingen,
Tübingen, Germany*

²*Royal Meteorological Institute of Belgium, Geophysical Centre, rue du
Centre Physique, 1, 5670 Dourbes, Belgium*

³*Institute of Geological Sciences K. Satpaeva, Ministry for Education and
Science of the Republic of Kazakhstan, Almaty, Kazakhstan*

⁴*School of Earth Atmosphere and Environment, Monash University,
Victoria, Australia*

*amin.ghafarpour@sedgeo.uni-tuebingen.de

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The major northern hemisphere climate systems, including the mid-latitude westerlies and Siberian high, intersect over central Eurasia; the thick piedmont loess of this region therefore represents a potential archive of dynamical changes in these systems over long time scales. In this study we focus on loess deposits along the northern Tien Shan piedmont in eastern Kazakhstan, where wind trajectory models suggest a stronger influence of the Siberian High and polar jet than the better studied westerly-dominated Ili basin further south. In particular, we investigate the properties of ubiquitous magnetic minerals in the loess: their concentration, mineralogy and thermal properties are closely linked to environmental conditions prevailing during soil formation. we propose that the post-~39 ka variations in loess magnetic properties might reflect changing contributions from different sediment source regions, because the observed increase in magnetic signal associated with higher sand content cannot be attributed to pedogenic magnetic enhancement. We suggest that post-~39 ka variations in loess magnetic properties reflect changes in the relative contributions of different sediment sources, since the observed increase in magnetic concentration with higher sand content cannot be explained by the classic pedogenic magnetic enhancement model.

Loess and Paleosol Sequences are key archives within a global iron cycle: an illustration from Suhia Kladenetz (Bulgaria) /INVITED/

Lagroix, F.

Université Paris Cité, Institut de physique du globe de Paris, CNRS, F-75005 Paris, France

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Mineral dust is a key component in the global iron cycle with the atmosphere as the conveyor belt transporting emitted particles from the continents to the oceans or elsewhere on land. Mineral dust represents two thirds of the total aerosol mass in the atmosphere and ranges from particle sizes less than a micron to one hundred microns. While in the atmosphere and once deposited, mineral dust impacts significantly the Earth system, its climate and biogeochemical cycles. Historically, earth system models only considered mineral dust finer than 10 microns for their greater shortwave radiation absorption and greater distance transport potential. Current observations point to a dramatic underestimation of coarser atmospheric dust, which is likely to bias earth system model results. Loess is mineral dust deposited on continental surfaces encompassing short to long-range transported particles dependent on environmental conditions. Loess is one of the few archives capable of recording past atmospheric circulation and together with its intercalated paleosols, archive locally past climate changes.

Loess and paleosol sequences (LPS) of Eastern Europe are excellent archives of past climate change. Millennial-scale climate variations have been demonstrated in loess units from the last (MIS 4-2) and penultimate (MIS 6) glacial periods. Such observations in even older loess units are extremely rare, mainly due to sampling strategies and/or geological constraints (e.g. sedimentation rates, weathering).

The 27 m long Suhia Kladenetz (SK) loess and paleosol sequence was sampled continuously at a 2 cm resolution, resulting in 1336 sampling depths. Magnetic, colorimetric and granulometric properties were studied. These highlighted the Mid-Brunhes climatic transition, as well as millennial-scale climatic variations during MIS 4-2, MIS 6, and 12 stages. The SK LPS will be used to demonstrate the development

and quantification of a paleoprecipitation record for the last 800 thousand years. Two approaches were undertaken. For the first approach, variations in goethite concentration, determined via the diffuse reflectance spectroscopy (DRS), are demonstrated to be a tracer of water availability. The pedogenic nature of the goethite in the MIS 12 loess unit is demonstrated by granulometric and magnetic data and shown to accompany decalcification of the horizon in question and re-precipitation of calcite in the underlying horizon. Variations in goethite concentration are thereafter converted into absolute values of mean annual precipitation (MAP) via a transfer function relating the sample's maghemite content to MAP. For the second approach, a climofunction relating the pedogenic enhancement of modern topsoils developing within loess across northern Bulgaria to modern-day precipitation was developed. The climofunction is then applied to the full SK LPS. The quantified paleoprecipitation record obtained through both approaches are compared and evaluated against modeled MAP data and other regional paleoclimate record.

Paleowind directions, paleosecular variations and relative paleointensity from MIS 6 loess at Harletz, NW Bulgaria

^{1*}Dragomirov, D., ¹Guyodo, Y., ¹Lagroix, F., ²Jordanova, D., ²Jordanova, N.,
³Antoine, P., ^{4,5}Rousseau, D.-D., ³Moine, O., ^{4,6}Hatté, C.

¹ *Université Paris Cité, Institut de Physique du Globe de Paris, CNRS, Paris, France*

² *National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Sofia, Bulgaria*

³ *Laboratoire de Géographie Physique, CNRS, Université Paris 1, UPEC, Thiais, France*

⁴ *Institute of Physics-CSE, Silesian University of Technology, Gliwice, Poland*

⁵ *Géosciences Montpellier, Université de Montpellier, Montpellier, France*

⁶ *Laboratoire des Sciences du Climat et de l'Environnement, CEA, CNRS, UVSQ, Université Paris-Saclay, Gif-sur-Yvette, France*

*dragomirov@ipgp.fr

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Loess-paleosol sequences are key continental archives of environmental, climatic and geomagnetic variability. In Europe, high-resolution loess studies mainly concern the Last Glacial, whereas detailed penultimate glacial records remain scarce. The Harletz sequence in northwestern Bulgaria provides a rare high-resolution Marine Isotope Stage (MIS) 6 archive, with an unusually thick Upper Saalian (L2) loess sequence of approximately 10 m (Antoine et al., 2019, Rousseau et al. 2020). This study tests whether L2 preserves a primary sedimentary fabric suitable for paleowind reconstruction, stable characteristic remanent magnetization (ChRM) directions for paleosecular variation (PSV), and relative paleointensity (RPI) proxies.

Alternating-field demagnetization was performed on oriented samples and ChRM directions were determined by principal component analysis. ARM and IRM were acquired and demagnetized after NRM, allowing RPI proxies to be calculated from

NRM/ARM and NRM/IRM slope regressions. In parallel, anisotropy of magnetic susceptibility (AMS) was used to characterize the sedimentary fabric and evaluate the reliability of the magnetic lineation.

AMS results indicate a weak but coherent foliation-dominated aeolian fabric in L2. Filtering based on $k_{\min}$ inclination and $k_{\max}$ uncertainty ε_{12} isolates the best-resolved magnetic lineations. Between 12.5 and 7.5 m depth, the inferred paleowind direction shifts from SE to S around 11.3 m, then returns toward SE, coinciding with changes in clay-content trends.

ChRM directions are stable and normal-polarity, while the NRM/IRM RPI proxy shows long-period variations comparable to the Black Sea RPI record of Nowaczyk et al. (2021). An age-depth model was developed using major transitions in the Harletz IRM_{2T}/χ_{lf} record, interpreted as a detrital versus pedogenic magnetic proxy, with EPICA Dome C dust flux used only as a broad low-frequency reference. Tie points were placed preferentially on proxy transitions rather than extrema, and the model was refined using Black Sea inclination and RPI records.

Overall, the Harletz L2 loess preserves both depositional and geomagnetic information, showing that high-resolution continental loess archives can record atmospheric circulation changes and geomagnetic-field variability during MIS 6.

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Nowaczyk *et al.* (2021) A high-resolution paleosecular variation record for marine isotope stage 6 from Southeastern Black Sea sediments. *JGR Solid Earth*, 126, e2020JB021350.

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Rock magnetic study of the Dejvice loess/paleosol sequence (Prague, Czech Republic)

Chadima, M.^{1,2}

¹*AGICO, Inc., Brno, Czech Republic*

²*Institute of Geology of the Czech Academy of Sciences, Prague, Czech Republic*

chadima@agico.cz

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We present an enviro-magnetic and magnetic fabric study of the Dejvice loess/paleosol sequence with an aim to demonstrate how rock magnetic methods can be effective tools for characterizing sedimentary, pedogenic, and post-depositional processes during paleoenvironmental reconstructions. This study covers the 15-meter-long loess/paleosol section which was recently temporarily accessible during the construction works in the Vienna House Diplomat Hotel in Prague. The exposed part of the sequence contained at least four different paleosol horizons and covered the time interval from ca. 130 ky to recent. For the purpose of this study, 425 orientated samples (8 ccm) were collected evenly covering the studied section.

In general, loess sequences contain variable amount of detrital magnetic particles derived from the source material of the aeolian dust during cold glacial or stadial phases. In addition, in warmer (interglacial and interstadial) periods, pedogenesis results in formation of paleosol horizons which are magnetically enhanced by the in-situ neo-formed nanoscale ferromagnetic particles.

The applied rock-magnetic techniques included measurements of (1) magnetic susceptibility (MS), (2) frequency-dependent susceptibility (kFD), (3) out-of-phase

magnetic susceptibility (opMS), and (4) viscous magnetization (Mv). While MS very sensitively reflects the relative amount of all magnetic particles, the other methods (kFD, opMS, and Mv) mirror solely the contribution of the neo-form nanoscale particles. In addition to these rock magnetic parameters, (5) anisotropy of magnetic susceptibility (AMS) was measured in order to obtain magnetic fabric reflecting the preferred orientation of magnetic minerals. Magnetic fabric can be primarily interpreted in terms of paleotransport directions and it may provide some evidence for post-depositional reworking and/or redeposition such as pedogenic (e.g., bioturbation and vertical material migration) and sheet-wash processes.

All paleosol horizons possess significantly higher values of MS, kFD, opMS and Mv. This indicates that the increased amount of magnetic particles in paleosols is exclusively due to the magnetic enhancement caused by the neo-formation of nanoscale particles during pedogenesis. In addition, the values of kFD, opMS, and Mv mutually intercorrelate very tightly. This indicates that all these independent methods are reliable proxies for the quantification of ultra-fine particles in loess/paleosols horizons.

In addition of the paleotransport direction, the magnetic fabric reflects secondary sedimentary processes. This involves the displacement of clastic particles by water and the redeposition along the slope. The direction of movement of these sediments corresponds to the current geomorphology of the surroundings. We can conclude that the sediments of the section was not solely deposited by aeolian processes.

Filling the gap between loess regions of the European Loess Belt - the loess-palaeosol profile of Dejvice (Czech Republic)

¹ *Kolaříková, K., ²Kolařík, P., ³Bradák, B., ⁴Lauer, T. and ¹Strouhalová, B.

¹ *Department of Physical Geography and Geoecology, Faculty of Science, Charles University, Albertov 6, 128 00, Prague, Czechia*

² *Department of Transport and Logistics, Institute of Technology and Business in České Budějovice, Faculty of Technology, Czechia*

³*Faculty of Ocean Science and Technology, Kobe University, 5-1-1 Fukae-Minamimachi, Higashinada-ku, Kobe 658-0022, Japan* ⁴*Universität Tübingen, Schnarrenbergstr. 94-96, 72076 Tübingen, Germany*

*kristyna.flasarova@seznam.cz

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Loess-paleosol sequences (LPS) play a key role in recording terrestrial paleoenvironmental information across the European Loess Belt (ELB). While the western and eastern regions, as well as the Danube Basin, have been extensively studied, the transition zone corresponding to the territory of Czechia remains sparsely covered by modern high-resolution research, particularly regarding archives predating the Last Glacial cycle. This study aims to fill this gap by presenting a comprehensive paleoenvironmental reconstruction of the 15-meter-thick Dejvice sequence in Prague. A high-resolution multi-proxy approach was applied, integrating fine-grain pIRIR290 optically stimulated luminescence (OSL) dating, grain-size distribution, magnetic susceptibility (χ_{lf} , $\chi_{fd}\%$), total organic carbon (TOC), stable carbon isotopes ($\delta^{13}C_{org}$), micromorphology, and paleomalacology. The exposed sequence comprises 17 distinct lithostratigraphic units spanning the last two glacial-interglacial cycles, from Marine Isotope Stage (MIS) 7 to MIS 2. The base of the profile captures older cycles, featuring a weakly developed chernozem and a Paleo Fluvisol with a syngenetic ice-wedge

pseudomorph assigned to MIS 7, followed by MIS 6 loess (dated up to 151 ± 11 ka). The MIS 6 sequence is notably characterized by an unusually thick (4 m) tundra gley with large smooth-surfaced loess dolls, indicating extreme glacial conditions and robust permafrost presence. The subsequent Upper Paleosol Complex (MIS 5) displays strong pedogenic magnetic enhancement driven by the neoformation of ultra-fine superparamagnetic grains. Strikingly, this MIS 5 sequence is highly condensed due to erosional hiatuses; it contains only one well-developed Haplic Chernozem and one Haplic Luvisol (dated $\sim 123\text{--}125$ ka), entirely lacking the PK II paleosols and intervening loess typical for Central European sequences. The overlying MIS 4 unit consists of a sandy colluvium (up to 48% sand) disrupted by large epigenetic composite-wedge pseudomorphs and polygons, reflecting severe permafrost conditions (mean annual air temperature ≤ -4 °C) and solifluction during the MIS 4/3 transition. MIS 3 is characterized by weak interstadial pedogenesis marked by localized TOC increases (up to 0.53%) and lighter $\delta^{13}\text{C}_{\text{org}}$ values (-25.1‰). The sequence is topped by MIS 2 loess (25.0 ± 1.6 ka) and tundra gleys containing a typical cold-steppe malacofauna, including *Succinella oblonga* and *Pupilla loessica*. Despite the presence of numerous hiatuses and erosional events, the Dejvice profile provides a uniquely preserved, continuous multi-proxy terrestrial record for Central Bohemia. By documenting paleoclimatic shifts predating the Last Glacial Maximum, this study successfully establishes an environmental link between the western and eastern domains of the ELB.

Sanzhiyka - a new key loess-palaeosol sequence in the western Black Sea region

^{1*}Hlavatskyi, D., ^{2,3} Bonchkovskiy, O., ¹ Bakmutov, V., ¹ Cherkes, S.,
^{3,4} Kravchuk, I., ¹ Poliachenko, I., ¹ Shpyra, V.

¹*Institute of Geophysics of the National Academy of Sciences of Ukraine, Kyiv, Ukraine*

²*Institute of Geography of the National Academy of Sciences of Ukraine, Kyiv, Ukraine*

³*Ukrainian Researchers Society, Kyiv, Ukraine*

⁴*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*

*hlavatskyi@gmail.com

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The western shore of the Black Sea preserves remarkably thick and stratigraphically complete Quaternary loess-soil archives critical for reconstructing Eurasian palaeoclimates. This study presents a multi-proxy investigation of the entire 33-meter-thick Sanzhiyka loess-palaeosol sequence (Odesa region, Ukraine), which records continuous sediment accumulation over the past 900 ka. By integrating detailed palaeopedological (micromorphology, colorimetry, grain-size), and rock magnetic methodologies, we reconstruct environmental dynamics across the Middle to Upper Pleistocene, focusing on critical climate changes since the Mid-Pleistocene Transition. The sequence is characterized by a high-resolution alternation of loess units and well-developed pedocomplexes. Throughout the sequence, each pedocomplex consists of 3-4 soils, averages 2.5 meters in thickness, contrasting with relatively thin loess beds—with the notable exception of the prominent, 5-meter-thick Dnipro loess (L2, MIS 6). Pedological features reveal a variety of soil types (Chernozems, Cambisols and Calcisols), predominantly formed under steppe vegetation. The warmest, most humid interglacial display pronounced rubification, deep carbonate leaching and occasional accumulation of illuvial clay coatings accumulation in the Lower Zavadivka unit (S4, MIS 11). Deep leaching in the Haplic Chernozem of S1 reflects the expansion of forest-steppe vegetation during MIS 5e, whereas rubification features in S2 indicate the warm

interglacial conditions of MIS 7. The four soils with superimposed Bk horizons within S3 indicate substantial shifts in moisture regime under temperate climate during MIS 9. The uppermost soils (MIS 5a and MIS 3), represented by Calcisols, demonstrate a clear trend towards aridification by the end of the Pleistocene.

Magnetic susceptibility (χ) and its frequency-dependence factor increase substantially within the palaeosols, representing the varying phases and intensity of pedogenesis. The χ variations track marine isotope stages with exceptional fidelity, delineating precise sub-stage climate optimums (such as within MIS 9 and MIS 7 pedocomplexes). Rock magnetic parameters prove that the magnetic enhancement is dominated by fine-grained magnetite with a prominent contribution of superparamagnetic particles formed due to active pedogenic processes. Palaeomagnetic analyses confirm the deposition of the upper section during the Brunhes chron, with ongoing magnetostratigraphic studies targeted at detection of the Matuyama/Brunhes boundary in the lower sequence. Ultimately, this 900 ka multi-proxy framework resolves distinct macro-types of regional palaeoenvironmental trends, tracking the long-term climatic transition from subhumid, subtropical conditions to increasingly arid, temperate regimes.

Holocene soil evolution on loess in south Poland – old concepts and new models /INVITED/

Kabala, C.* Krupski, M.

Wrocław University of Environmental and Life Sciences, Institute of Soil Science, Plant Nutrition and Environmental Protection, Grunwaldzka 53, 50-357 Wrocław, Poland

*cezary.kabala@upwr.edu.pl

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Patches of Chernozems and Phaeozems still occur in the Luvisol-dominated loess belt of south-west Poland, beyond the climate-controlled chernozemic zone of Eurasia. Moreover, chernozemic soils are typically buried under Neolithic long barrows in the region, which allows to suspect a greater contribution of chernozemic soils in Central Europe in the Neolithic period, even in the Holocene climatic optimum. This raises several questions: about the stages of soil development since Late Pleistocene, persistence of Chernozems under extremely unfavourable climatic conditions and vegetation, and the stages of their final transformation into clay-illuvial soils in Central Europe. Research was carried out in nine burial mounds representing Late Neolithic, Early Medieval and possibly Bronze Age periods, located in the Muszkowice and Głubczyce Forests on late-Pleistocene loess in south-west Poland. The C14 age (i.e., mean residence time) of organic matter in the least transformed buried Chernozems indicated Late-Pleistocene and Early Holocene origin of their humus-rich topsoil horizons. The following subsequent stages of Chernozem transformation (degradation) since the Neolithic period have been documented: (a) Endocalcic/Haplic Phaeozems, (b) Luvic Phaeozems, (c) Luvisols with very dark humus-illuvial horizons, (d) Luvisols with dark brown humus-illuvial horizons, and (e) ‘typical’ Albic Luvisols. Luvic Phaeozems existed at least until the Bronze Age (early 2nd millennium BC), and the maximum time for transformation into Luvisols was estimated at 2300 years. However, the transformation/degradation of Chernozems cannot be demonstrated as a single scenario. The ‘rapid transformation’ with Luvisol formation before the Early Medieval

period under presumably continuous afforestation was accompanied by ‘zero transformation’ with the persistence of Chernozems and Phaeozems in areas continuously occupied and cultivated from the Neolithic period to the present. The complementary model of ‘intermittent transformation’ assumes that afforestation and agriculture replaced each other for certain periods between the Neolithic and Early Medieval periods. The latter model explains the various stages of soil transformation under Early Medieval barrows and a transitional morphology (Phaeozems/Luvisols) of some surface soils that appear in the loess belt of SW Poland.

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Holocene Transformation of Agriculturally Used Loess Areas: A Chronological Perspective Based on Examples from Southern Poland

Poreba¹, G., Malik², I., Moska¹, P., Mroczek³, P., Szymak¹, A., Wojtalak¹, A., Śnieszko⁴, Z.

¹ *Silesian University of Technology, Department of Geochronology and Environmental Isotopes, Gliwice, Poland*

² *Faculty of Natural Sciences, University of Silesia, Sosnowiec, Poland*

³ *Faculty of Earth Sciences and Spatial Management, Maria Curie-Skłodowska University, Lublin, Poland*

⁴ *Institute of Geography, Kazimierz Wielki University, Bydgoszcz, Poland*

*grzegorz.poreba@polsl.pl

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Since the onset of agricultural activity on loess-covered landscapes, the natural circulation of matter on hillslopes has been profoundly altered. Disturbance of the natural vegetation cover by agricultural practices has increased the susceptibility of soil material to detachment and transport by raindrop splash, sheet wash, and rill erosion. Today, nearly all agricultural loess areas in Poland are affected by water-induced soil erosion, resulting in the accumulation of colluvial deposits at the footslopes.

The highest rates of soil redistribution occur during intense rainfall events and rapid snowmelt. During such episodes, only part of the eroded material is deposited locally, whereas most of it is transported into river valleys. Between these extreme events, soil is gradually redistributed over short distances by sheet wash and agricultural tillage. The proportion of sediment retained on slopes and accumulated at their foot depends on slope geometry, land use, and climatic conditions. Ephemerally drained dry valleys are widespread within the Polish loess and contain the thickest Holocene colluvial sequences. In many studied profiles, these deposits overlie buried soils that developed

under natural environmental conditions prior to the onset of agricultural activity. Less frequently, colluvial units are separated by younger buried soils representing periods of hillslope stability. Consequently, Holocene colluvial deposits record phases of accelerated soil erosion associated with agricultural land use, whereas buried soils document intervals of reduced erosion and landscape stabilization.

A major challenge in the investigation of Holocene colluvial deposits is the absence of diagnostic sedimentological features allowing individual colluvial units to be correlated with archaeologically recognized phases of agricultural activity. In areas subjected to repeated cycles of cultivation, reconstruction of hillslope history based solely on lithological characteristics is therefore extremely difficult. Colluvial deposits with similar sedimentological properties may have accumulated during different periods, while deposits of different lithology may have formed contemporaneously. Until now, the chronological framework of colluvial sequences has been based mainly on radiocarbon dating of buried soils underlying the colluvium and, occasionally, on archaeological artefacts recovered from their basal parts.

Optically Stimulated Luminescence (OSL) dating offers one of the most promising approaches for establishing the chronology of Holocene colluvial deposits. Radiocarbon dating of soil organic matter within colluvium is often unreliable because much of the organic material has been redeposited. Likewise, the age of isolated organic macro-remains, such as charcoal fragments, does not necessarily correspond to the time of sediment deposition. In contrast, OSL dating enables direct determination of the depositional age of sediments based on quartz grains and can be applied to samples collected from any part of a sediment profile.

This presentation summarizes the results of OSL dating of colluvial deposits collected from loess profiles located in southern Poland, where agricultural activity has persisted since the Neolithic and where the archaeological record is well established. For the youngest deposits, OSL chronology is complemented by analyses of the fallout radionuclides ^{137}Cs and excess ^{210}Pb ($^{210}\text{Pb}_{\text{ex}}$) as well as by dendrochronology. The presentation will discuss the physical principles of OSL dating, analytical procedures, and the main limitations associated with the interpretation of luminescence ages. The obtained results demonstrate that, despite certain limitations, OSL provides the only method currently available for direct dating of Holocene colluvial deposits and constitutes a powerful tool for reconstructing the history of soil erosion in agricultural landscapes.

Can stacks of palaeosols in a Pleistocene loess-palaeosol sequence be regarded as temporal soil catenas and do spatial pedofacies changes in palaeosols exist?

¹Hambach, U., ¹Veres, D., ²Zeeden, C., ³Obreht, I., ⁴Baykal, Y., ⁵Jordanova, D., ⁶Wiesenberg, G., ⁵Georgieva – Ishlyamska, B., ⁵Ishlyamski, D., ⁶Trott, A., ⁵Jordanova, N., ⁵Dimov, D., ¹Faragau, A., ⁶Rowley, M., ⁷Robu, M., ⁸Marković, S.B., ⁹Lehmkuhl, F.

¹Romanian Academy Cluj-Napoca Branch, Cluj-Napoca, Romania

²Leibniz Institute for Applied Geophysics, Hannover, Germany

³Institute for Geosciences, Johannes Gutenberg-University Mainz, Mainz, Germany

⁴Department of Physics, Technical University of Denmark, Roskilde, Denmark

⁵National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Bulgaria

⁶Department of Geography, University of Zurich, Switzerland

⁷“Emil Racoviță” Speleology Institute, Romanian Academy, Bucharest, Romania

⁸Serbian Academy of Arts and Sciences, Knez Mihajlova 35, 11000 Belgrade, Serbia

⁹Department of Geography, RWTH Aachen University, Aachen, Germany

*ulrich.hambach@uni-bayreuth.de

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In southeastern Central Europe, substantial, decametre thick loess-palaeosol sequences (LPS) can be observed. They are widespread in dry landscapes that are presently characterized by steppe and/or forest-steppe climates, forming extensive loess plateaus which are the most important sinks for aeolian dust on the Eurasian continent. Here, soils form predominantly accretionary, driven by both bioclimatic factors and wind-

blown dust input contemporaneous to soil formation. This contrasts with other parts of these loess landscapes where ecosystems increasingly resemble those of Atlantic-influenced Western Europe and Holocene soils have developed on Upper Pleistocene or older loess—often under forest ecosystems with minimal input of windblown dust. These differences in recent loess landscapes of southeastern Central Europe result in regional variations in pedofacies and thus in soil type areas and their characteristic soil catenas, best preserved in loess plateaus.

Similar variations in pedofacies can be identified in Pleistocene LPS dating back at least to the Middle Pleistocene. In contrast to a spatial soil catena, these variations are the direct result of temporal climate changes at the respective sites. Here, the different soil types often formed as soil complexes (SCs) under predominantly accretionary regimes are separated not only spatially within a landscape but also temporally by phases of loess accumulation, and the resulting LPS are excellent archives of Pleistocene continental climate evolution.

Spatial variations in bioclimate and in sedimentation and erosion dynamics play a decisive role in determining what ultimately remains of a soil formation phase. Furthermore, alongside erosion, sediment-starved conditions are also observed in Holocene soil catenas as well as in lateral variations of LPS, where even merging of palaeo-SCs of different ages and splitting of same-age SC have been documented (e.g. Danube banks, Black Sea coastal cliffs). Comparable to the temperature-controlled treeline in alpine and polar regions, in recent loess landscapes of southeastern Central Europe there is also a relatively pronounced lower treeline driven by moisture conditions which marks the transition from dry steppe to lush forest environments, which consequently also leads to spatial variation in soil formation.

Here we present conceptual ideas based on field observations and literature reviews. We assume that spatial and temporal differences, as well as similarities, in pedofacies are currently overlooked in the study of interglacial palaeo-SCs in southeastern Central Europe. Failure to recognize such pedofacies variations carries the risk of erroneous profile correlations, leading to incorrect chronostratigraphic and palaeoclimatic conclusions.

High-resolution MIS 3-2 loess-palaeosol record at the Novostav site (NW Ukraine): evidence from palaeopedology, malacology, and microtheriology

^{1,2}*Bonchkovskiy, O., ³Molnar, D., ⁴Popova, L., ⁵Hlavatskyi, D., ^{2,6}Kravchuk, I.,

¹*Institute of Geography of the National Academy of Sciences of Ukraine, Kyiv, Ukraine*

²*Ukrainian Researchers Society, Kyiv, Ukraine*

³*Geotrekkerz, Schwanden, Switzerland*

⁴*I. I. Schmalhausen Institute of Zoology of the National Academy of Sciences of Ukraine, Kyiv, Ukraine*

⁵*Institute of Geophysics of the National Academy of Sciences of Ukraine, Kyiv, Ukraine*

⁶*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*

*geobos2013@gmail.com

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The Novostav loess-palaeosol sequence is situated in the central part of the Volyn Upland (NW Ukraine) on the slope of a dry valley. This Upper Pleistocene sequence comprises a Marine Isotope Stage (MIS 5) pedocomplex containing large mammal remains, a relatively well-developed MIS 3 Cambisol, and stratified MIS 2 loess. On a subtle terrace of the dry valley, an exceptionally detailed MIS 3-2 loess-palaeosol record was preserved, consisting of 11 incipient soils interbedded with thin loess units. These palaeosols include tundra-gleys (predominantly older units) and incipient Bw horizons (predominantly younger units). The brown soils are readily distinguished from loess by colorimetric proxies, notably elevated a^* and b^* values in the CIELAB system. The incipient Bw horizons exhibit slightly increased carbonate leaching, reflected in reduced LOI₉₅₀ values. Both loess and incipient soils display a silty loam particle-size distribution with elevated U-ratio values. While the microfabric of the tundra-gleys largely resembles that of loess, the incipient Bw horizons exhibit brown humus pigmentation, evidence of carbonate leaching, and biogenic voids (channels and

chambers) with occasional passage features. Tundra-gleys and loess units show distinct micromorphological indicators of frost action features, including platy microstructure, frost-shattered sands, vesicles and silt capping.

The MIS 3-2 loess-palaeosol record yields a rich malacofauna comprising seven terrestrial gastropod species. *Pupilla sterrii* is the dominant taxon throughout the sequence, particularly in the middle and lower units, whereas *Succinella oblonga* predominates in the upper units, including the incipient brown soils. Other species include *Pupilla alpicola*, *Trochulus hispidus*, *Columella columella* etc. Small mammal remains also occur at the Novostav site, although their preservation is poor due to repeated freeze-thaw cycles. The assemblage is dominated by tundra-steppe species such as *Stenocranius gregalis*, *Lagurus lagurus*, *Dicrostonyx* sp., *Spalax* sp. etc. These malacological and microtheriological records match regional MIS 2 patterns and reflect the Late Pleniglacial interstadial-stadial cycling.

Thus, the Novostav site provides a unique MIS 3-2 palaeoenvironmental archive for Europe. It documents the transition from pronounced palaeoclimatic oscillations during late MIS 3 to the establishment of the cold, arid conditions characteristic of tundra-steppe landscapes during MIS 2. The upper part of the Novostav record represents comparatively milder and more humid conditions, which favored both the expansion of more diverse malacofaunas and the formation of incipient brown soils. To evaluate how these local environments shifts relate to broader Middle and Late Pleniglacial climate oscillations, and to compare the Novostav record with the Greenland ice-core record (e.g. North GRIP $\delta^{18}\text{O}$ dust), absolute dating is required.

Pedogenic developmental variation through a novel Loess-Palaeosol Sequence in Kolobar, Bulgaria, since the Mid-Brunhes Event (430 kyr) assessed by geochemical proxies

¹Trott, A., ¹Buchmann, L., ²Georgieva–Ishlyamska, B., ^{3,5}Baykal, Y., ^{4,5,7,8}Robu, M., ²Ishlyamski, D., ²Jordanova, N., ^{5,6}Hambach, U., ⁵Veres, D., ²Jordanova, D., ¹Wiesenberg, G, L, B.*

¹Department of Geography, University of Zurich, Switzerland

²National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Bulgaria

³Department of Physics, Technical University of Denmark, Denmark

⁴“Emil Racoviță” Speleology Institute, Romanian Academy, Romania

⁵Romanian Academy, Cluj-Napoca Branch, Romania

⁶BayCEER, University of Bayreuth, Germany

⁷Research Institute of the University of Bucharest, Bucharest, Romania

⁸“Sabba S. Stefanescu” Institute of Geodynamics, Romanian Academy, Bucharest, Romania

*Andrew.trott@geo.uzh.ch

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The loess-palaeosol sequences of the Lower Danube–Black Sea (LDBS) region preserve a continuous, high-resolution record of regional climate change and environmental variability through the last >400 kyr. Throughout this period, the region has been variably influenced by multiple climate regimes, including the Mediterranean cyclonic region, central European westerlies, and western Asian continental air masses. However, despite its significance, geochemical characterisation of this region remains sparse, and high-resolution multi-proxy datasets are limited and climate predictions for this region remain poorly constrained.

Here, we present X-ray fluorescence (XRF) and complementary photospectrometry data at 2 cm resolution, alongside a novel age-depth model, for 12 m of a newly opened LPS near to the village of Kolobar, Bulgaria. Through these datasets, we aim to develop our characterisation of the sequence and provide insights into variations in pedogenic and weathering intensity, and dust provenance, providing a means to delineate palaeosol and loess units, and providing evidence of tephra layers. To achieve this, we apply a suite of geochemical indices, including the Chemical Proxy of Alteration (CPA) for silicate weathering intensity and Ti/Zr ratios for provenance shifts, with additional elements and elemental ratios (e.g. Fe/Mn, Ca/Ti, Cl) to assist in the characterisation of redox conditions and carbonate dynamics throughout the sequence.

We observe distinct variation between loess and intercalated palaeosols, reflecting differing pedogenic development and conditions. Rb/Sr indicates intense carbonate weathering in palaeosols, with loess units remaining comparatively enriched. This, alongside similar responses in the Mg/Ca ratio reflecting the leaching of carbonates, indicates increased moisture during periods of palaeosol development. Additionally, the Chemical Proxy of Alteration shows considerable scatter throughout the sequence yet shows consistently higher values in palaeosols with additional variation between palaeosol units. A pattern which is also seen within the Fe/Al ratio for pedogenic oxidation. This variation indicates varying pedogenic conditions with differing units experiencing differing degrees of clay formation, potentially as a result of palaeohydrological fluctuations between interstadials. Transitional zones show that the top of palaeosols into unaltered loess is typically sharp, on the order of 10 cm, whilst the base of the palaeosols transitions gradually into underlying loess. This differing behaviour suggests abrupt shifts in depositional material and/or environment were common from interglacial to glacial periods.

Despite the heterogeneous nature of the LPS, as reflected in weathering indices, the provenance of the material (as seen in the Ti/Al and Ti/Sr ratios) appears to be consistent throughout the sampled profile, suggesting a relatively homogenous parent material for the varying units. Together, these results demonstrate that the Kolobar sequence preserves a high-resolution, geochemically distinct record of glacial-interglacial pedogenic cycles, and establish XRF-based proxies as an effective tool for characterising palaeoenvironmental change in this previously understudied region.

Analyzing temporal changes in loess provenance using XRF geochemistry: insights from the Velika Vrbica loess section

Krsmanović, P.^{1*}, Thompson, W.², Perić, Z.M.³, Bosnić, M.¹, Ryan, C.S.³,
Lukić, T.¹, Marković, S.B.^{1,4,5}

¹ *Chair of Physical Geography, Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, Novi Sad, Serbia*

² *Nordic Laboratory for Luminescence Dating, Risø Campus, DTU Physics, DK-4000, Roskilde, Denmark*

³ *Department of Geology, Lund University, Sölvegatan 12, SE-22362 Lund, Sweden*

⁴ *Serbian Academy of Sciences and Arts, Kneza Mihaila 35, Belgrade, Serbia*

⁵ *University of Montenegro, Cetinjska 2, Podgorica, Montenegro*

*petarkrsm@gmail.com

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Major- and trace-element geochemistry has proven to be a valuable tool for addressing the question of loess provenance. However, few provenance studies have investigated temporal changes in loess provenance. This work presents a novel approach to analyzing loess provenance, particularly its temporal variability, by identifying reliable provenance proxies using the method of Fralick and Kronberg (1997), which was improved by providing it with an empirical framework. This method helps identify element ratios that are unaffected by weathering and grain-size sorting effects, meaning that sediments derived from a particular source should retain a relatively constant value of a given ratio regardless of grain size or degree of weathering. These ratios can therefore serve as provenance proxies, and their values in loess–paleosol sequences (LPSs) can be used to infer temporal changes in provenance.

The applicability of this methodology was illustrated on the Velika Vrbica LPS within the Lower Danube Basin, which spans from Marine Isotope Stage (MIS) 6 to the present. Reliable provenance proxies were identified using Danube sediments, which represent the main source of Danubian loess and whose provenance is assumed to be relatively constant. The analysis identified Zr/Al_2O_3 and TiO_2/Al_2O_3 ratios as the most reliable provenance proxies. Their variations within the Velika Vrbica LPS indicate that loess and Danube sediment provenance were most aligned during MIS 4 and especially during part of MIS 2, which is characterized by eolian sand. This eolian sand layer is almost entirely derived from nearby Danube alluvium. Colder and less vegetated conditions in the Danube Valley during glacial periods favoured aeolian deflation and subsequent redeposition of Danube sediments as loess. Moreover, loess is characterized by significantly higher concentrations of Zr and Ti compared to Danube sediments, pointing to the presence of additional loess sources, potentially derived from the Carpathians.

These results show that the proposed methodology can be used to reconstruct temporal changes in loess provenance, opening the door for further geochemically based temporal provenance reconstructions of loess, which are, compared to other methods such as zircon dating, relatively cheap and time-efficient, enabling high-resolution analysis.

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Frequency and age spectrum of Carpathian zircons deposited in the Boyanychi loess section (W Ukraine) and in the modern alluvial sediments of the Vistula River

Nawrocki, J.^{1,2*}, Pańczyk, M.¹

¹*Polish Geological Institute – National Research Institute, Rakowiecka 4, 00-975 Warszawa, Poland*

²*Institute of Earth and Environmental Sciences, Maria Curie-Skłodowska University in Lublin, Kraśnicka 2d, 20-718 Lublin, Poland*

*jerzy.nawrocki@pgi.gov.pl

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A provenance study was carried out on MIS12, MIS10, MIS8, MIS6, MIS4 and MIS2 loess deposits cropping out in the Boyanychi village (W Ukraine). The modern alluvial sediments from the Vistula riverbed were also sampled for this purpose in eight localities situated in the upper and middle river sections. The U-Pb ages of detrital zircons were determined using a SHRIMP IIe ion microprobe. Good quality results were obtained from 1651 grains. Zircons from both sedimentary environments yield predominantly Cadomian (c. 530-650 Ma) and Variscan (c. 310-340 Ma) ages. Proterozoic Scandinavian zircons became dominant only in the northernmost fluvial site (c. 30 km north –west of Warsaw). All studied aeolian sediments from the Boyanychi section represent mountain provenance-river transport mode of loess origin. Similar age spectra characteristics for the fine- and coarse-grained zircons can indicate predominance of the local transport of detrital material. Almost the same age spectra observed in the loess of different age can indicate a substantial redeposition of sediment or similar alimentation areas with primary source of zircons in the Carpathians. Slight differences may be associated with some variability of glaciers extend and consequently migration of alimentation sites.

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Loess and Palaeolithic sites in Poland: An Overview of the Recent Research /INVITED/

Wiśniewski, A.^{1*}, Moska, P.², Jary, Z.³

¹*Institut of Archaeology, University of Wrocław, Szewska 48, Wrocław, Poland*

²*Institute of Physics, Institute of Physics/Division of Geochronology and Environmental Isotopes, Silesian University of Technology, Konarskiego 22B, Gliwice, Poland*

³*Institute of Geography and Regional Development, University of Wrocław, pl. Uniwersytecki 1, Wrocław, Poland*

*andrzej.wisniewski@uwr.edu.pl

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Loess is an integral component of Palaeolithic sites in southern Poland. However, the broader significance of this has rarely been discussed. In this paper, we adopt an approach pioneered by L. Zoller and others, treating loess not merely as cover layers, but as a means of considering the topography prior to, during and after the formation of Palaeolithic sites. When discussing this issue, we aim to highlight three key aspects: i. Geochronological findings; ii. The results of sedimentological analyses; iii. The reconstruction of taphonomic processes.

This issue will be discussed using several sites as examples. One of these is the Trzebnica 2 site, which has for many years been regarded as the oldest site in Poland. Another site is Dzierżysław 1, which reveals a palimpsest of at least two, if not three, settlement episodes, ranging from the Middle Palaeolithic to the Early or Middle Upper Palaeolithic. The next site is Pietraszyn 11, which is also associated with at least two settlement phases, though these took place at the onset of the Last Glacial Maximum (LGM). Finally, we discuss the Henryków 15 site, which is associated with the Gravettian complex.

Our chronological studies indicate that the most common loess assemblage found in Palaeolithic sites consists of loess from the last glaciation, with a predominance of

sediments from the LGM. The presence of loess deposits, which have the potential to form the foundation for cultural layers, has been identified only incidentally. There is an absence of evidence to suggest human occupation during the period of loess deposition. In the majority of cases, loess manifests as a cover deposit. The time interval between loess deposition and the finds in the underlying strata varies, though there are no extended time gaps at the sites in question. With regard to the formation of sites resulting from sedimentary processes within loess deposits, it is imperative to emphasise the presence of traces of solifluction, and on occasion, water-induced slope processes. Various density-layering structures and pseudomorphs formed by ice wedges are also observed. Despite these diverse changes, loess, in conjunction with lacustrine sediments, constitutes the optimal environment for the preservation of Palaeolithic artefacts in Poland.

Does the Dupljaja loess sequence (southeastern Carpathian Basin) record evidence for the Danube Paleolithic corridor "opening"?

Marković, S.B.^{1,2,3*}, Hao, Q.⁴, Ludwig, P.⁵, Zeeden, C.⁶, Perić, Z.M.⁷, Mihailović, D.⁸, Radović, P.⁸, Roksandić, M.⁹, Lindal, J.⁹, Krsmanović, P.¹, Baykal, Y.^{10,11}, Vandenberghe, J.¹², Bosnić, M.G.¹, Soreghan, G.¹³, Marković, R.S.¹⁴, Cai, B.^{15,16}, Li, M.^{4,15,16}, Moska, P.¹⁷, Lukić, T.¹, Timar-Gabor, A.^{18,19}, Gavrilov, M.B.¹, Sipos, G.²⁰

¹ Chair of Physical Geography, Dept. of Geography, Tourism and Hotel Management, Faculty of Sciences, Univ. of Novi Sad, , Novi Sad, Serbia; ² Serbian Academy of Arts and Sciences, Knez Mihajlova 35, 11000 Belgrade, Serbia; ³ University of Montenegro, Cetinjska 2, 81000 Podgorica, Montenegro; ⁴ State Key Laboratory of Lithospheric and Environmental Coevolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China; ⁵ Institute of Meteorology and Climate Research Troposphere Research, Karlsruhe Institute of Technology, Wolfgang-Gaede-Strasse 1, 76131 Karlsruhe, Germany; ⁶ Leibniz Institute for Applied Geophysics, Stilleweg 2, 30655 Hannover, Germany; ⁷ Lund Luminescence Laboratory, Department of Geology, Lund University, Sölvegatan 12, SE-223 62 Lund, Sweden; ⁸ Dept. of Archaeology, Faculty of Philosophy, Čika Ljubina 18-20, 11000 Belgrade, Serbia; ⁹ Dept. Anthropology, University of Winnipeg, 515 Portage Avenue, Winnipeg, MB, R3B 2E9, Canada; ¹⁰ Dept. of Physics, Technical University of Denmark, Risø Campus, Denmark; ¹¹ Dept. of Earth Sciences, Uppsala University, Uppsala, Sweden; ¹² Dept. of Earth Sciences, Vrije Universiteit, De Boelelaan 1100, 1081 HV Amsterdam, The Netherlands; ¹³ School of Geosciences, University of Oklahoma, 100 East Boyd Street, Norman, OK 73019, United States; ¹⁴ Dept. of Geography and Tourism, Natural Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia; ¹⁵ Key

Laboratory for Humid Subtropical Eco-Geographical Processes of the Ministry of Education, Fujian Normal University, Fuzhou 350007, China;

¹⁶*Institute of Geography, Fujian Normal University, Fuzhou 350007, China;*

¹⁷*Division of Geochronology and Environmental Isotopes, Institute of Physics*

– Centre for Science and Education, Silesian University of Technology,

Gliwice, Poland; ¹⁸ *Faculty of Envir.Science and Engineering, Babes-Bolyai*

University, Cluj-Napoca, Romania; ¹⁹ *Interdisciplinary Research Institute on*

Bio-Nano-Sciences, Babes-Bolyai University, Cluj-Napoca, Romania; ²⁰ *Dept.*

of Physical Geography, University of Szeged, Egyetemut 2-6, Szeged, Hungary

**baca.markovic@gmail.com*

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The Dupljaja loess-palaeosol sequence in the southeasternmost sector of the Banat Loess Plateau, Serbia, is of significant palaeoenvironmental importance. Situated within the southeastern Carpathian (Middle Danube) Basin, it provides valuable insights into the climatic evolution during the last glacial period and role of the southeastern Carpathians as a potential migration corridor for early humans across Europe.

The stratigraphic pattern of the Dupljaja section mirrors analogous profiles in the northern Serbia, based on luminescence dating and the correlation of magnetic record with the Marine Oxygen Isotope stratigraphy. Importantly, the grain size data from the section provides crucial insight into regional dust accumulation dynamics. Three distinct depositional modes are identified: finer modes were dominant in the Holocene and late last glacial intervals, whereas a coarser mode prevailed in the Marine Isotope Stage (MIS) 3 interval. To better understand these variations in grain size records, we have undertaken a comparative analysis of regional palaeoclimate model data between the Last Glacial Maximum (LGM) and typical Greenland Stadial and Interstadial conditions. Model results indicate slightly drier regional climate conditions during the LGM than during stadial, while granulometry data suggests that the deposition of coarser loess during MIS 3 is related to drier conditions in the local source area (the Danube River alluvial plain), resulting in coarser material available for aeolian action. We propose that the drier hydroclimate of the Danube Palaeolithic corridor associated with steppic environmental conditions between ~53–37 ka may have facilitated migrations of anatomically modern humans from Asia into Europe.

Late Quaternary atmospheric dynamics recorded in the Shankerpora loess-paleosol sequence, Kashmir Valley, Northwestern India

Amiri, Z.^{1*}, Meister, J.², Tsukamoto, S.¹, Dar, R.A.³, Ryzner, K.¹, Mir, J.A.³, Mir, S.H.³, Shah, R.A.⁴, Zeeden, C.¹

¹ *LIAG-Institute for Applied Geophysics, Hannover, Germany.*

² *Paleoecology and Environmental History, Kiel University, Germany.*

³ *Department of Earth Sciences, University of Kashmir, Srinagar, India.*

⁴ *Islamic University of Science and Technology, Awantipora, Pulwama, INDIA*

*Zaniar.Amiri@liag-institut.de; zaniar.amiri2020@gmail.com

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Loess-paleosol sequences (LPS) are among the most valuable terrestrial archives for reconstructing Quaternary paleoclimate and paleoenvironmental dynamics. These aeolian deposits preserve quasi-continuous records of the influence of climatic variability on pedogenesis across glacial and interglacial cycles. The present study was conducted at the Shankerpora LPS, located in the Kashmir Valley, northwestern India, where the section spans approximately 19 m, resting on fluvial material deposits and comprising ten paleosol horizons intercalated within aeolian loess. This region is governed by two major atmospheric systems, the Indian Summer Monsoon and the mid-latitude westerlies, which together constitute the primary sources of precipitation in the Valley. This study evaluates the effects of climatic variability on the geophysical and sedimentological characteristics of the loess deposits by examining key proxies including color, grain-size distribution, magnetic susceptibility, and OSL dating.

Results reveal a pattern of elevated magnetic susceptibility and increased clay content within paleosol horizons, a trend also reflected in the redness index. Field observations, supported by magnetic susceptibility and color measurements, identified ten well-

developed paleosol horizons intercalated within the loess sequence, indicative of landscape stability and intensified pedogenesis during relatively warm and at least partly interglacial periods. Notably, even the loess layers display evidence of incipient pedogenic formation processes, expressed as diffuse iron and manganese oxide accumulations along ped surfaces and the early development of weak pedostructure. This pervasive, low-intensity alteration suggests that moisture levels throughout the depositional and post-depositional history of the sequence were sufficiently elevated to initiate early-stage soil formation even during glacial phases conventionally associated with cold and arid conditions. Preliminary OSL ages indicate that the three uppermost paleosols formed during MIS 5, suggesting that the lowermost part of the Shankerpora section likely extends back to MIS 9.

These findings suggest that the Shankerpora LPS faithfully shows shifts between monsoon-dominated interglacials and westerly-influenced glacial phases, establishing Kashmir as a key location for reconstructing late Quaternary atmospheric dynamics at the interface of two major climate systems.

The palaeoenvironmental record of the loess-palaeosol succession of Eastern Ukraine

Gerasimenko, N.P.

Taras Shevchenko National University of Kyiv

n.garnet2@gmail.com

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Lithopedological and pollen studies of the sites from northeast Ukraine to the Pry-Azov Upland, supported by TL-chronology, form the bases for these reconstructions. The names of time units follow the Pleistocene framework of Ukraine (Veklich, Ed., 1993), but their chronological positions are in part changed because of new data. The oldest Beregove unit consists of Mediterranean soils, formed under light subtropical forest. The Kryzhanivka unit includes red-colored clayey soils, developed under broad-leaved woodland and forest-steppe. The Siversk and Berezan loess-like deposits formed under boreal forest-steppe, and the Illichiv loess under xeric steppe. The M/B reversal has been proved at the base of the Shyrokyne unit (Glavatsky, Bakhmutov, 2020). From bottom to the top, it includes Chromic Luvisols of broad-leaved forest, Chromic Cambisols of warm-temperate forest-steppe and Vertisols of open landscapes. The thin loess within Shyrokyne allows correlation of its late interglacial with the MIS 17.

Between Shyrokyne and the Lower Zavadiivka unit (the Holsteinian/MIS 11), two interglacials and three cold periods occurred. The oldest Martonosha Chromic Cambisols (MIS 15) formed under *Pinus Strobus* woodland with some subtropical trees (warm-temperate climate). The Lubny Luvisols of temperate forest were replaced by forest-steppe Chrenozems. The relatively cool climate of Lubny times corresponds to the MIS 13. The Pryazov loesses formed under subperiglacial steppe, the Sula and Tyligul loesses under periglacial tundra-steppe in the north, and cold steppe in the south. Two interglacials came between MIS 11 and the Dnipro glaciation (Gerasimenko et al., 2023). These interglacials were separated by cold Middle Zavadiivka and Oril times (with typical loesses, cryoturbations, tundra-steppe). The Lower Zavadiivka unit, with the Holsteinian pollen succession, consists of lower Luvisols and upper Phaeozems of a warm-temperate climate. Each of the two next interglacials (Upper Zavadiivka/MIS 9 and Potyagailivka/MIS 7) included two soils of the climatic optimum, followed by an interstadial soil). The lower Luvisols, Albic Luvisols and Haplic Luvisols were formed under broad-leaved forests, the upper Chernozems under forest-steppe of a temperate climate.

The Kaidaky times (TL 132 ± 15 ka to 110 ± 8 ka), following the Dnipro glaciation, has the pollen succession of the last interglacial and includes Luvisol, Retisol and leached Chernozem, developing consequently. Due to the small thickness of the overlying Tiasmyl loess (TL 98 ± 10 ka, MIS 5d), the following Lower Pryluky Retisol often overprints the Kaiyaky Chernozem, which obtained a prismatic structure. Then, the later phases of the interglacial pollen succession visually appear in the Bt horizon of the Lower Pryluky soil. The Lower Pryluky Chernozem (MIS 5c, TL 95 ± 6 ka) mostly indicate forest-steppe of a temperate climate. At the Upper Pryluky times (TL 82 ± 7 ka, MIS 5a), boreal forest on Cambisols was replaced by grassland on Chernozems. The steppe of MIS 5b was arid and cold (cryoinvolutions). Periglacial and subperiglacial steppe existed during the Uday stadial (MIS 4, TL 70 ± 9 ka to 60 ± 8 ka), and south-boreal forest-steppe alternated with boreal steppe during the Vytachiv unit (TL 47.5 ± 4 ka to 30.2 ± 2 ka, MIS 3). The latter includes 3-4 interstadial soils and thin loess beds in between. The lower Cambisols formed in more humid climate than the upper ones (Eutric Cambisols), or Calcaric Cambisols in the xeric southern steppe. Ground wedges and involutions of the Vytachiv stadials were dense but not deep. The thickest Bug loess (MIS 2) accumulated under periglacial steppe, mesophytic in the north. Several incipient soils in its lower part were slightly humified but, in the eastern Ukraine, not strongly gleyed. The uppermost of them, formed under boreal forest-steppe, yielded OSL dates 17.5 ± 1.6 ka, 16.5 ± 1.4 ka, which allows its correlation with the Upper Dofinivka steppe soils in the south. There, the Lower Dofinivka soils (TL 21.5 ± 2 ka) were better developed. Both Dofinivka interstadials and the next Prychornomorsk stadial are the parts of MIS 2. The Prychornomorsk steppe was more xeric than that of the Bug times.

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Coarse fragments and soil classification: conceptual and taxonomic challenges from a Brazilian perspective

**^{1,3}Delpupo, C., ²Souza-Junior, V.S., ²Carvalho, A., and ³Lim, A.*

¹ Geography Department, Federal Institute of Minas Gerais, Ouro Preto, Brazil

² Agronomy Department, Federal Rural University of Pernambuco, Recife, Brazil

³ Geography Department, University College Cork, Cork, Ireland

**carolinedelpupo@gmail.com*

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Soil classification systems have historically been developed under a fine earth paradigm, in which diagnostic criteria and taxonomic decisions are primarily based on properties of particles smaller than 2 mm. Within this framework, coarse fragments are frequently treated as accessory components, despite their strong influence on soil morphology, physical behaviour, hydrological response, rooting conditions and land use suitability. This conceptual bias becomes particularly evident in soils developed under strong lithological control, where coarse materials constitute a substantial proportion of the soil volume. This study presents a critical review of the role attributed to coarse fragments in soil classification systems, using the Brazilian Soil Classification System (SiBCS) as a case study to explore broader conceptual and taxonomic challenges. The analysis examines how gravel, stones and rock fragments are defined, quantified and incorporated into the SiBCS, assessing their function as diagnostic attributes, qualifiers or descriptive properties, and their effectiveness in representing soil-forming processes and functional behaviour. Attention is given to the extent to which coarse materials are integrated into taxonomic decision pathways, rather than being restricted to complementary descriptive information. These aspects are discussed in a comparative perspective with the World Reference Base for Soil Resources (WRB) and the USDA Soil Taxonomy, focusing on differences in conceptual treatment, taxonomic relevance and classification logic associated with coarse materials. The comparison indicates that the WRB explicitly incorporates coarse fragments through

qualifiers that acknowledge their influence on soil properties, behaviour and management, while Soil Taxonomy integrates coarse materials mainly as modifiers affecting subgroup-level classification and interpretative statements. In contrast, the SiBCS tends to treat coarse fragments in a more limited or secondary manner within its hierarchical structure, which may reduce the visibility of their role in pedogenesis and landscape-scale soil differentiation. This approach can constrain the representation of soils formed under shallow profiles, high skeletal content and strong inheritance from parent material, commonly found in mountainous, ferruginous, volcanic and semi-arid environments. The study argues that a more explicit, process-oriented and interoperable integration of coarse fragments into soil classification frameworks is necessary to better capture soil variability across contrasting environments. Strengthening the conceptual role of coarse materials would improve taxonomic consistency, enhance comparability among national and international systems, and contribute to ongoing discussions on the evolution, harmonisation and future development of soil classification systems.

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Contemporaneous loess deposition and soil pedogenesis from the Kashmir Valley, western Himalaya: Multiproxy records since 300 ka

Achyuthan, H.^{1**}, ² Lone, A.M., ³ Shah, R.A., ⁴ Pirzomwalla, S. and ⁵ Ali, A.

¹*Centre for Environmental Studies, Anna University, Chennai 600025, India*

²*Department of Civil Engineering, Manipal Institute of Technology,
Manipal, 5761004 India*

³*Mantaqi Centre for Science and Society, Islamic University of Science and
Technology, Awantipora, Pulwama, 192122, India*

⁴*Institute for Seismological Research, Gandhinagar, Gujarat, 382009, India*

⁵*Higher Education Department, Jammu and Kashmir, 190001, India*

*hachyuthan0@gmail.com

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The loess-paleosol sequences (LPS) of the Kashmir Valley, western Himalaya, comprises a critical yet insufficiently understood archive of late Quaternary climate dynamics, soil alteration and landscape evolution. This study employs a multi-proxy approach to investigate aeolian dynamics, pedogenic alterations, and clay mineral transformations in LPS from key sites—Wanihama, Anchar, Manasbal, Shankarpura, Patan, Choori, Alochibagh, and Burzahama of Kashmir Valley, western Himalaya. Optically Stimulated Luminescence (OSL) dating indicates that the deposits were formed between approximately 300 and 14 ka. Our multiproxy records reveal that clay mineral assemblages in the parent loess of these key deposits are dominated by illite > chlorite > smectite > kaolinite, with chlorite-to-smectite transformations reflecting varied climatic conditions. Pedogenic processes are evidenced by the development of argillic and calcic horizons, classifying the soils as xeric or udic Alfisols. Paleosols,

thicker than the loess layers, exhibit multiple pedocomplexes, particularly at Shankarpura, Patan, Manasbal, and Anchar, suggesting intervals of enhanced vegetation cover and soil pedogenesis during ameliorated climate conditions. Further, the presence of N₂-type CaCO₃ nodules, corroborated by $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ isotopic data, indicates episodic leaching and carbonate reprecipitation, linked to changes in pedogenic processes. Micromorphological features, such as calcite nodules, iron oxide coatings, and root traces, further point to alternating wet and dry phases, facilitating soil formation under variable climatic regimes. Our findings collectively demonstrate that loess deposition and pedogenesis were concurrent processes, driven by complex sedimentological and climatic interactions since the past 300 ka.

Palaeolithic Cultural Horizons within the Loess–Palaeosol Sequence of Western Ukraine

^{1,2}*Tomeniuk, O., ¹Bogucki, A., ²Koropetskyi, R.

¹*Ivan Franko National University of Lviv, Lviv, Ukraine*

²*I. Krypiakevych Institute of Ukrainian Studies of NAS of Ukraine*

*olena.tomeniuk@lnu.edu.ua

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In the west of Ukraine, Palaeolithic sites are predominantly associated with the Pleistocene periglacial loess–palaeosol sequence, which forms an almost continuous mantle across the Volhynian and Podillian uplands, the Male Polissian Ridges (Pasmove Pobuzhzhia), and the high river terraces of the Fore-Carpathian region. The sequence attains a maximum thickness of 50 m, as recorded in the Halych section.

The distinguished Ukrainian archaeologist O. Sytnyk identified several Palaeolithic regions within this territory, each generally comprising a number of Palaeolithic clusters (Sytnyk, 2000, 2015; Koropetskyi et al., 2024). The present study considers only the archaeological sites located within these defined clusters. The Podillian region includes the Ternopil cluster (including the sites of Ihrovytsia I, Velykyi Hlybochok I, Proniatyn I, etc.), the Buhliv cluster (Buhliv V, Vanzhuliv, etc.), and the Kremenets cluster (Kulychivka, etc.). The Dniester region comprises the Halych cluster (including the sites of Halych I and II, Yezupil I–III, Mariampil I and V, and Kolodiiv), the Molodovo cluster (Molodovo I and V, Korman IV, Ketrosy, Oselivka, Doroshivtsi, etc.), and the Kasperivtsi cluster (Kasperivtsi, etc.). The Volhynian region is represented solely by the Lypa cluster (Lypa I, VI, etc.).

The earliest (Stage I) phase of human occupation in the study area is associated with the Korshiv fossil soil complex (MIS 7), identified *in situ* at the Velykyi Hlybochok I Palaeolithic site (Cultural Layer III) (Koropetskyi et al., 2024) and, possibly, at the Buhliv V site (Cultural Layers I and II). In our view, this horizon marks not only the earliest human occupation of the region but also the beginning of the Middle Palaeolithic in the Volhynian-Podillian area.

The subsequent (Stage II) occupation phase is associated with the Ternopil subhorizon of the Middle Pleistocene (MIS 6). It has been identified at the Velykyi Hlybochok I site (Cultural Layer IIIB). The third occupation phase is linked to the Horokhiv fossil soil complex (MIS 5) and includes the sites of Vanzhuliv I, Ihrovytsia I, Yezupil I, and others. The cultural horizons of these sites are generally associated with the solifluction unit overlying the Horokhiv complex and exhibit evidence of redeposition. The fourth occupation phase corresponds to the Dubno fossil soil (MIS 3). This phase includes the lower cultural layers (III and IV) of the Kulychivka site at Kremenets (as well as, probably, the redeposited material from Cultural Layer II of the same site) and Cultural Layer II at Velykyi Hlybochok I. Sites attributed to the fifth occupation phase include Vanzhuliv I (Cultural Layer II), Lypa I, Lypa VI (Cultural Layers V–IIa), and Ihrovytsia I (Cultural Layers I and IA). From a geological perspective, this phase is associated with deposits occurring between the Dubno and Rivne fossil soils (spanning the late MIS 3 to MIS 2 interval). The sixth occupation phase corresponds to the final stage of the Last Glaciation (MIS 2) and includes the sites of Velykyi Hlybochok I (Cultural Layer I), Vanzhuliv I (Cultural Layer I), Barmaky (Cultural Layer II), Lypa VI (Cultural Layers I and II), and Kulychivka (Cultural Layer I).

In summary, the Pleistocene loess–palaeosol sequence constitutes a reliable archive of the history of human occupation in western Ukraine. Nevertheless, not all chapters of this history have yet been fully deciphered.

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Analysis of the condition of Lipnik Dam (Ruse Region, Bulgaria) following the extreme rainfall event of 2025

¹**Mihova, L.A., ²Nedelcheva, M.I.*

¹*University of Architecture, Civil Engineering and Geodesy, Sofia*

²*Geological Institute, Bulgarian Academy of Sciences, Sofia*

*l_mihova@yahoo.com

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Lipnik Dam is an earth-fill embankment constructed between 1956 and 1959. The dam is 280 m long, 13 m high, and has a crest width of 12.5 m. The embankment consists of heterogeneous fill materials, including clayey loess, loess-like clay, silty clay, and organic clay. Subsequently, the upper part of the downstream slope was raised to widen the crest by 3.5 m using clayey loess and loess-like clay.

During the extreme rainfall event exceeding 200 mm between 7 and 10 October 2025, a partial slope failure occurred on the downstream face of the dam. Approximately 70 m of the slope collapsed, with the displaced soil mass extending to a depth of 2.5–3.0 m and reaching the slope toe. The primary triggering factor was the saturation of the embankment material, which increased its self-weight while significantly reducing its shear strength. Additional contributing factors included cracks in the pavement along the dam crest, insufficient compaction of the underlying fill, and an inadequate drainage system, all of which promoted rainwater infiltration into the embankment.

Following the failure, comprehensive field investigations and laboratory testing were conducted to characterize the geological materials of both the embankment and its foundation and to determine their geotechnical properties. Two-dimensional finite element models were developed using Plaxis 2D to investigate the failure mechanism and assess the stability of the dam. The material parameters were calibrated through back-analysis of the observed failure using two numerical approaches: (1) simulation of slope instability assuming a phreatic surface extending throughout the downstream

slope; and (2) fully coupled hydro-mechanical analysis considering transient rainfall infiltration and progressive pore-water pressure development within the embankment.

The stress-deformation behaviour and stability of the embankment were analysed under both static and seismic loading conditions in accordance with the requirements of Eurocode 7 and Eurocode 8.

Deformations of a high-rise building caused by inappropriate foundation design in collapsible loess soil (block "Russia", Ruse, Bulgaria)

** Petrova, V., Evlogiev, Y., Nedelcheva, M.*

Geological Institute – Bulgarian Academy of Sciences, Bulgaria

**vanushka@gmail.com*

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This paper presents an engineering geological and geotechnical investigation of the ground foundation and structural deformations of the 12-story residential building Block "Russia" in Ruse, Bulgaria. Built in the period 1967–1968 based on a standardized design template, the building is situated on the fifth loess terrace of the Danube River, under highly complex engineering geological conditions. These conditions are characterized by the presence of Type II collapsible loess with a collapsible zone thickness of up to 14.5 m and intense anthropogenic wetting, further compounded by high regional seismicity (Intensity VIII on the *MSK-64* scale and a magnitude of $M=7.4$). The foundation was executed without any anti-collapse ground improvement, using isolated pad footings at a depth of -6.10 m. This resulted in a contact pressure of $p=0.3$ MPa, which is double the allowable design bearing capacity for this loess foundation ($R_0=0.15$ MPa).

The primary causes of the severe structural deformations are defined as a combination of structural design deficiencies (incorrect foundation type and excessive loading) and complex engineering geological conditions. The dynamics of the moisture regime within the loess massif were thoroughly traced. Following a major water utility network failure in 1992, localized wetting was recorded beneath the eastern section of the building down to a depth of 17 m (with water content reaching $w_n=27-28$ %). This led to a drastic reduction in the deformation modulus beneath this part of the structure, dropping to 5–6 MPa. Investigation data from 2011 and 2019 indicate a steady trend toward gradual drainage and normalization of the collapsible layer's properties, returning to average values of $E_0=13.4$ MPa.

Long-term precision geodetic monitoring (1967–2019) registered highly non-uniform settlement of the building, which was further accelerated by strong regional seismic

events (the earthquakes of 1977, 1986, and 1991). By 2019, the cumulative settlement at the western facade amounted to 305 mm, whereas at the eastern facade, it reached 802 mm. This differential settlement of nearly 500 mm caused a severe tilting of the building block, resulting in a total vertical axis deviation of 697 mm toward the southeast. Analysis of the time-settlement curve reveals that after 2004, the deformation process entered a sub-horizontal phase of slow attenuation.

Using the layer-by-layer summation method, a theoretical model was calculated for the maximum vertical deformation (combined settlement and collapse) under a hypothetical full water saturation of the active zone (22 m), amounting to 496 mm beneath the central section and 441 mm beneath the eastern section of the building. Based on this geotechnical diagnosis, radical structural recommendations have been proposed. These include an urgent overhaul of the water supply and sewerage infrastructure, the continuation of annual monitoring, and the execution of a deep ground improvement project for the loess foundation via area-wide grouting using cement-ash mixtures (root-like micropiles down to a depth of 15 m).

Collapse-induced settlement of a loss terrain within urban infrastructure due to technogenic wetting

Evlogiev, Y., Petrova, V., Nedelcheva, M.

Geological Institute – Bulgarian Academy of Sciences, Bulgaria

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The reason for this study is the deformations that occurred due to the collapse settlement of the loess base on Nikolaevska Street, Ruse. The reason for this was a cast-iron water pipe (Ø 250 mm) that ruptured on March 4th, 2009. The deformations affected 5 two-story residential buildings on the western side of the street and one on the opposite side - the Said Pasha Mosque.

The cracks formed on the terrain (asphalt, sidewalks on the street and courtyards) have openings ranging from 1 to 2-3 cm. They outline an ellipse with diameters of 25 and 40 m, with the long axis oriented along the street. The resulting over-wetting caused the loess massif to collapse under its own weight. In the center of the ellipse, at the accident area, the measured settlement for a period of 2 months were 32 mm, without taking into account the one that occurred on 04.03.2009. The total settlement around the accident area should be about 20 cm. As a result, the roadway has undergone visible settlement within the extent of the elliptical subsidence zone. In the lowest depressed part, a suffusion cavity developed and was filled with 8 m³ of concrete.

The buildings affected by deformations were built at the beginning of the last century. Their foundations are strip, made of stone masonry and are laid at a depth of 2.50 m below the ground surface. Two of the residential buildings are built with reinforced-concrete load-bearing structures. Deformations are observed in the stairwells. The other three buildings and the mosque have load-bearing brick walls and steel-wooden floor structures. Here the deformations are concentrated on the facade walls facing Nikolaevska Street. The cracks are 1-2 cm wide. Their orientation indicates settlement of the buildings toward the site of the pipeline failure.

In this part of the city, the terrain belongs to the so-called "three-loess terrace" T_3 . Here, the loess-soil complex is 20 m thick. Down to a depth of 16 m, the loess mass is macroporous with a fragile structure. It consists of yellowish silty-sandy to sandy loess horizons (L_1 , L_2), separated by fossil soil Fs_1 - dark brown loess-like clay. From 16 to 20 m, the loess mass is without macropores and has a denser structure. It consists of the loess-like clay Fs_2 and the clay loess L_3 . At greater depth beneath L_3 lies the alluvium of terrace T_3 (gravel and sand), which overlies Aptian limestone.

The collapsible loess zone extends to a depth of 16 m. Within its range, the loess is collapsible, both under additional load from buildings and structures and under its own weight when wet. Two subzones are distinguished in it:

- The upper one is up to a depth of 8.0 m. It exhibits more pronounced collapsibility characteristics – relative collapse coefficient $\delta_{col,0,2}=4.7\%$ at $p=0.2$ MPa. At natural water content $w=18.4-20.6\%$ it has a compression modulus $M_{0,2}=6.2$ MPa at $p=0.2$ MPa, deformation modulus $E_0=12.0$ MPa and design load $R_0=0.15$ MPa;
- The lower collapsible subzone is at a depth of 8-16 m. The collapsibility characteristics have lower values $\delta_{col,0,2}=3.3\%$. With an established natural water content of $w=16.4\%$, it has $M_{0,2}=8.0$ MPa at $p=0.2$ MPa, $E_0=16.0$ MPa and $R_0=0.18$ MPa.

The total expected collapse and settlement due to wetting from geological load for the entire zone is about 30-40 cm. A similar collapse settlement was recorded in the garden opposite the library due to a failure of the water supply network.

During construction and operation, the buildings were in good condition. They were founded in the upper subzone of the collapsible loess with natural water content and the above-mentioned indicators. The water-main failure caused waterlogging to 27-32%. This waterlogging probably began several months before the failure. These values significantly exceed the critical value $w=23\%$ for the onset of settlement/collapse. Down to a depth of 5 m, the loess transitioned into a very soft consistency state, whereas in the lower part of the collapsible zone it became soft consistency state. As a result, the strength-deformation indicators decreased by about two times - $E_0=6-8$ MPa, $R_0=0.06-0.09$ MPa, which led to the collapse settlement of the terrain, together with the buildings.

Loess Geoheritage and Accessible Geotourism in Kłodzko for Seniors and Persons with Disabilities

^{1*} Widawski, K., ² Jary, Z.

¹ *Department of Regional Geography and Tourism, University of Wrocław, Poland*

² *Department of Physical Geography, University of Wrocław, Poland*

*krzysztof.widawski@uw.edu.pl

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The Kłodzko Valley represents one of the most significant areas of silt cover occurrence in the Sudetes and their foreland. Loess and loess-like deposits serve as a valuable archive of Quaternary environmental changes and constitute a vital element of the region's geomorphological heritage. Loess and silt deposits belong to those abiotic nature components that—despite their high scientific value—relatively rarely become subjects of tourist interest or geotouristic interpretation.

In the landscape of the Kłodzko Valley, loess formations coexist with a rich cultural and historical heritage, providing an essential backdrop for the development of settlement and urban spatial planning. A unique example of the mutual relationship between the geological environment and human activity is found in Kłodzko's underground facilities, which have functioned within the city since the Middle Ages. Their genesis and functionality remain indirectly linked to local geomorphological and geological conditions, including the presence of silt covers that shaped the city's settlement environment. Despite this, the loess context is currently almost entirely absent from the tourist interpretation of these sites.

While loess represents a crucial environmental archive of the Quaternary and a significant component of geoheritage in many European regions, it remains relatively

unrecognized in public consciousness. Often, however, its presence influenced settlement patterns and the creation of sites that are now major tourist attractions, such as Kłodzko's undergrounds. Today, these are recognized cultural attractions, yet their interpretation focuses primarily on historical and military aspects, leaving the geological and geomorphological determinants in the background.

The aim of this article is to evaluate the potential of Kłodzko's two primary underground tourist products—the Underground Tourist Route and the Kłodzko Fortress undergrounds—as tools for popularizing loess heritage and as geotouristic products accessible to persons with disabilities and seniors. The study assumes that loess should be treated as an equal element of geoheritage, requiring appropriate interpretation to reveal its significance for landscape evolution and human activity. The research involves an analysis of both sites' preparedness to serve persons with motor, sensory, and cognitive disabilities, as well as seniors, focusing on infrastructure, traffic organization, and heritage interpretation methods. Furthermore, the degree of geological content in the current tours is assessed, alongside opportunities to expand the narrative to include loess-related issues.

Contemporary loess geotourism should extend beyond natural exposures to include cultural sites tied to geological conditions. In this context, the concept of accessible geotourism gains particular importance, ensuring equal access to geoheritage for all. Kłodzko's undergrounds can thus enable the popularization of knowledge about loess among individuals who face difficulties accessing classical geological sites due to mobility limitations or age. The research results indicate directions for developing geotouristic interpretation, such as enriching guide narratives and utilizing diverse interpretative tools. This article represents an attempt to integrate loess heritage into mainstream geotourism and identifies methods for its effective popularization among a broad audience.

Abstracts – posters

The Loess-soil Complex in Northeastern Bulgaria – Geomorphology, Lithology and Stratigraphy

/INVITED/

Evlogiev, Y.

Geological Institute – Bulgarian Academy of Sciences, Bulgaria

*evlogiev.yordan@gmail.com

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Quaternary studies in the Lower Danube Plain are presented against the background of climatic events and processes that occurred at that time in Northern Europe. In Northeastern Bulgaria, these events determined the principal stages in landscape evolution: Pliocene denudation surface (PDS); Old Pleistocene level (OPL); river terrace spectrum with loess cover from T_7 to T_1 and two floodplain terraces - T_0^1 , T_0 .

In Northern Bulgaria, loess accumulation occurred through two wind corridors: from northwest - west - caused by the North European continental ice sheet; from north-northeast - connected with the continental ice sheet in Eastern Europe. During different ice ages, the two aeolian corridors were not equally loaded with fine-grained material. This resulted in lithostratigraphic differences that allowed the distinction of five loess regions.

Loess region of Northeastern Bulgaria:

- In Northeastern Bulgaria, loess accumulation is carried out by the north-northeast transporting aeolian corridor;
- Within the limits of the PDS, the loess section begins with red loess-like clays (RC) at its base. These are overlain by eight loess horizons (L) separated by fossil soils (Fs). The L_7 loess horizon is absent in the area. The Brunhes/Matuyama boundary (0.781 Ma) is established between Fs_7 and L_8 (Vyatovo and Kaolinovo). The L_8 loess horizon and the red loess-like clays (RC) of the pedocomplex were formed during the Matuyama geomagnetic chron. In the upper part of the RC, the Jaramillo subchron (0.99-1.07 Ma) is established, and below it, the Olduvai (1.77-1.95 Ma). Based on these studies, we assume that the loess accumulation on the PDS began before 2.59 Ma. The RC pedocomplex is 2.59-0.82 Ma old, and the loess horizons and fossil soils located above it are 0.82 Ma-8.0 Ka old;
- On the OPL, loess accumulation began after the regression of the Paleodanube – 0.82 Ma ago. Here, eight loess horizons, separated by fossil soils, overlie alluvial sediments dated between 2.59-0.82 Ma. Their stratigraphy is identical to that

observed on the PDS. The Brunhes/Matuyama boundary is established between Fs_7 and L_8 (Nikolovo);

- The PDS pedocomplex and the OPL alluvium are synchronous during accumulation – the former accumulated on the denudation surface, while the latter – within the waters of the Paleo-Danube and the tributaries;

- The loess cover overlying the alluvium of the river terraces formed during the Brunhes geomagnetic chron. Each loess accumulation was formed with the corresponding glacial/stadial period, and the fossil soils – with the corresponding interglacial/interstadial intervals. Following alluvial deposition, Terrace T_7 has experienced seven glacial periods and therefore contains seven loess horizons, while terrace T_1 – only one;

- Loess horizons L_8 , L_6 , L_5 , L_4 , L_3 and L_2 correlate with Marine Isotope Stages (MIS) 20, 16, 12, 10, 8 and 6 ($\delta^{18}O$ - ODP 677). The youngest loess horizons L_1 and L_1^1 correlate with MIS 4, 2 and the lower part of MIS 1. Loess accumulation continues throughout the Boreal and Preboreal. In Northeastern Bulgaria L_7 is absent in all sections;

- Among the fossil soils, Fs_7 , Fs_5 , Fs_3 and Fs_1 exhibit interglacial characteristics. They correspond to MIS 19, 13-15, 9 and 5. The soils Fs_6 , Fs_4 , Fs_2 and Fs have an interstadial origin and correspond to MIS 17, 11, 7 and 3.

Black Sea Loess Region;

It differs from other loess regions in the source of deflation - During the cold stages of the glacial Pleistocene, loessic fine-grained material was deflated from the exposed Black Sea shelf during periods of sea-level regression. This region includes loess exposures occurring as a narrow coastal strip (1–2 km wide) along the Black Sea coast north of Cape Shabla. A borehole drilled near the “Kosmos” campsite revealed that L_4 , L_5 , L_6 , L_7 and L_8 are absent from the section, but their place is marked by erosional discontinuities (hiatuses). The soil complex is complete, without gaps. Typical reference levels are L_2 and Fs_5 , which are readily distinguishable from other horizons. The stratigraphy of the loess complex corresponds to that of the Northeastern Bulgaria region. After clarifying the lithostratigraphic structure of the paleomagnetic section of Bolshakov (1996), it became evident that the Brunhesian-Matuyama boundary falls between Fs_7 and Fs_{ai} , or more likely in the lower part of Fs_7 . In the Black Sea region, the loess complex from L_1 to Fs_7 was formed during the Brunhes geomagnetic chron, and the red clay (Fs_{ai}) underlying Fs_7 was formed at the end of the Matuyama chron. This stratigraphic information proves that the region was dry and an area of loess accumulation since the onset of the glacial Pleistocene. The terrain belongs to the OPL, formed by the Black Sea and lowered from an elevation of approximately 120 m to about 1 m during the Pleistocene (result of a collapsed tectonic block).

Loess-Palaeosol-Sequences at the Kaiserstuhl – Towards a million years record at the interface of the Atlantic and Mediterranean climate systems

¹Vinnepand, M. ¹Hofmann, F.M., ¹Gegg, L., ¹Fülling, A. and ¹Preusser, F.

¹Albert-Ludwigs-Universität Freiburg, Institute of Earth and Environmental Sciences, Chair of Sedimentology, Albertstraße 23b, 79104 Freiburg i.Br.

*mathias.vinnepand@geologie.uni-freiburg.de

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In Europe, few studies are available that deal with the long-term propagation of climate change and associated terrestrial system response at the interface of the Atlantic and Mediterranean system. The existing work does not predate the Last Interglacial which strongly limits our understanding of how both systems contracted and expanded during glacial-interglacial cycles. A better understanding of the interaction of the Atlantic and Mediterranean systems converging along the Rhône-Rhine axis may be achieved, if loess-palaeosol-sequences (LPS) from the Upper Rhine Graben are integrated that are most likely to comprise much of the last million years. Thick LPS of the Kaiserstuhl area (southern Upper Rhine Graben) are suited best to hinge archives along the Rhine River (dominated by Atlantic marine-temperate climate) with those found along the Saône-Rhône axis (rather Mediterranean influence). For this the most favorably complete record is the 30 m thick Riegel LPS that will be subject to detailed investigations in the coming years in the framework of the international KaiserLink project (funder: DFG).

While this master-record will serve as a most valuable reference profile and dating-based correlation target, previous work has highlighted the enormous potential of other LPS in the surroundings which are likely to cover specific time intervals in a higher resolution. Here we present a field- and literature-review based assessment of the potentials of LPS in the Southern Upper Rhine Graben for this task. We critically assess

and re-calibrate existing dating results and process geochemical and geophysical data (mostly obtained in the 1980s) using state of the art quality criteria and multivariate statistics. Together with the outcomes of the crucial KaiserLink project, this will provide a valuable framework towards the acquisition of a million years record at the interface of the Atlantic and Mediterranean climate systems.

Earthworm biospheroids as radiocarbon chronological markers in the Süttő loess-paleosol sequence, Hungary

^{1*,2} Kertész, T., ¹Buró, B., ²Jull, A.J. T., ³Horváth, E., ³Bartha, G., ¹Molnár, M.

^{1*}*Isotope Climatology and Environmental Research Centre, Institute for Nuclear Research, H-4026, Bem tér 18/c, Debrecen, Hungary*

²*University of Debrecen, Doctoral School of Earth Sciences, H-4001, Egyetem tér 1, Debrecen, Hungary*

³*Eötvös Lóránd University, Department of Physical Geography, H-1117, Pázmány Péter sétány 1/c, Budapest, Hungary*

*kertesz.titanilla@atomki.hu

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Reliable chronological frameworks are essential for interpreting paleosol development, sedimentary processes, paleoclimatic changes, and landscape evolution. Radiocarbon (¹⁴C) dating is one of the most widely used methods for establishing the age of Quaternary sedimentary sequences; however, its application is often limited by the absence or poor preservation of suitable organic macroremains, such as wood, charcoal, plant detritus, mollusk shells, or other datable materials.

In loess–paleosol sequences, secondary carbonates may provide an alternative chronological archive. Among these, earthworm biospheroids are of particular interest. These millimetre-scale calcitic granules are produced by lumbricid earthworms and may be preserved within paleosol horizons. Due to their small size, typically about 0.5–2.0 mm in diameter and approximately 1–2 mg in mass per granule, their radiocarbon analysis requires highly sensitive AMS measurement, particularly gas ion source (GIS) AMS techniques.

Following a successful series of ¹⁴C measurements on recent biospheroids from Chernozem soils in eastern Hungary (Kertész et al., 2025), conducted at the HEKAL AMS Laboratory in Debrecen, we extended the approach to fossil biospheroids preserved in paleosol layers dated between 15,000 and 30,000 years BP. The study focuses on the loess–paleosol profile of Süttő, Hungary. A high-resolution chronological framework was established for a 6-meter-thick section using continuous

sampling (every 10 cm, ~2.5–3 kg/sample), and integrated into the broader Quaternary paleoenvironmental evolution of the region.

The results highlight the potential of earthworm biospheroid radiocarbon dating to improve chronological control in sedimentary settings where conventional organic dating materials are rare or absent. This approach may contribute to a more detailed understanding of paleosol formation, sediment accumulation, and paleoenvironmental change in loess dominated landscapes.

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Quantitative Climate Signals in European Loess–Palaeosol Systems: Insights from Modern Soil Calibration

¹Ryzner, K., ^{1,2}Vinnepand, M. ³Bosnić, M.G., ⁴Stojakowits, P., ³Gavrilov, M.B.,
³Marković, S.B., ¹Amiri, Z., ¹Müssener, H., ¹Zeeden, C.

¹LIAG-Institute for Applied Geophysics, Stilleweg 2, 30655 Hannover, Germany

²Albert-Ludwigs-Universität Freiburg, Institute of Earth and Environmental Sciences, Chair of Sedimentology, Albertstraße 23b, 79104 Freiburg i.Br.

³Chair of Physical Geography, Faculty of Science, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

⁴Augsburg University, institute of Geography, Alter Postweg 118, 86159, Augsburg.

* Kamila.Ryzner@liag-institut.de

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Loess–palaeosol sequences (LPS) preserve some of the most continuous terrestrial records of Pleistocene environmental change and are central archives for reconstructing past climate dynamics across Eurasia. However, robust quantitative palaeoclimate reconstruction requires better-constrained proxy systems and improved understanding of how soil properties respond to climatic and hydrological forcing across environmental gradients.

This study evaluates the climatic sensitivity and transferability of commonly applied loess proxies using modern loess-derived topsoils from the Upper Danube Basin (Germany) and Middle Danube Basin (Serbia). These regions span contrasting temperature and precipitation regimes and therefore provide a natural framework for testing soil–climate relationships under different environmental conditions. The dataset combines rock magnetic parameters, colour indices, and grain-size distributions analysed through both single-proxy and multivariate statistical approaches.

Our results show that individual proxies capture climate-related variability only moderately well, whereas multi-proxy transfer functions significantly improve predictive performance. At the same time, strong regional dependencies and nonlinear proxy behaviour indicate that magnetic signals are partly influenced by local effects including heterogenous sediment sources, pedogenesis, and possible erosion-related disturbance of modern surface soils. These findings demonstrate both the potential and limitations of widely used loess-based climate proxies, particularly when applied across large spatial scales where substantial variations in sediment provenance may obscure climatic signal.

Ongoing work extends this calibration framework along a transect across the Danube catchment (Germany, Austria, Hungary, Serbia, and Romania) and integrates modern soils with interglacial palaeosols, particularly units attributed to Marine Isotope Stage 5. Rather than assuming direct correspondence between modern and fossil soils, our study investigates the extent to which climate-sensitive relationships among soil properties are preserved through time and whether they can be transferred to palaeosol records.

By integrating modern calibration datasets with spatially distributed LPS records, this study advances the quantitative interpretation of European loess–palaeosol systems and contributes to a more robust reconstruction of Pleistocene terrestrial environments.

Ice wedge pseudomorphs mark the degradation of permafrost in southwestern Poland

¹Sowińska, Z., ¹Jary, Z.

*¹Institute of Geography and Regional Development, University of Wrocław,
Poland*

**zuzanna.sowinska@uwr.edu.pl*

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The origin of loess covers of southern Poland is connected to the Pleistocene glaciations. The particular environment of this period, characterized by cold climate, intense erosion and scarce vegetation, left various relict structures, some of them preserved in loess. Frost processes, geli- and solifluction, and thermokarst, are one of the most common processes of the periglacial period.

The largest structures associated with the periglacial environment are ice wedge pseudomorphs, often used as indicators of past permafrost extent. Their interpretation is dual, as they are marks of not only previous frost processes, but also of subsequent climate amelioration and permafrost termination.

Ice wedge pseudomorph morphology depends primarily on the type of sediment in which it is formed. Due to the potential high ground ice content, fine-grained materials like clay and silt can melt almost as long as the ice wedge itself. During melting, pressure increases significantly in the pores of the soil, often leading to dynamic filling of the post-ice wedge void. Another important factor is topography, as the position of the ice wedge on slope or below it conditions the growth of ice and its melting. Since ice wedge pseudomorphs are highly dependent on the particular site they are in, they make for a unique record of the changing climate.

Two ice wedge pseudomorphs were recently documented in Trzebnica Hills and Niemcza-Strzelin Hills (southwestern Poland). Their structure bears marks of thermokarst processes, and is likely the result of at least two stages of melting. The ice wedge pseudomorph in Trzebnica (Trzebnica Hills) is especially deformed by intense thermokarst, most likely as a result of water stagnation at the site. The second structure located in Henryków (Niemcza-Strzelin Hills) shows possible reactivation of frost processes near the end of its forming.

OSL and radiocarbon dating results point to final permafrost degradation after 15-16 ka, at the end of the Late Weichselian (MIS 2). Potential stages and processes of ice wedge pseudomorphs formation are discussed, as an attempt to interpret the complicated process of ice wedge melting and preservation.

A Geomorphological Perspective on Contemporary Fluvial–Aeolian Sediment Transfer in the Yarlung Tsangpo Valley (Southern Tibetan Plateau)

¹Korabiewski, B.

Department of Physical Geography, Institute of Geography and Regional Development, University of Wrocław, Wrocław, Poland

*bartosz.korabiewski@uwr.edu.pl

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Understanding contemporary sediment transfer pathways is essential for interpreting the origin of aeolian sediments and recognising modern dust-source environments relevant to loess research. High-altitude river valleys represent particularly dynamic geomorphological settings, where sediment derived from mountain slopes is transferred, temporarily stored and repeatedly remobilised by interacting hillslope, fluvial and aeolian processes. Recent studies from the Yarlung Tsangpo Valley have substantially improved our understanding of river-fed dune systems and fluvial–aeolian sediment interactions. The present contribution complements these studies by considering these processes from a broader geomorphological perspective focused on landscape-scale sediment transfer.

This poster discusses contemporary sediment transfer pathways based on geomorphological field observations made along the Yarlung Tsangpo Valley in southern Tibet. These observations are used to explore the spatial relationships between sediment sources, fluvial transport, temporary sediment storage and aeolian remobilisation within a high-altitude geomorphic system..

Field observations document a continuous sequence of interconnected geomorphological environments extending from weathering and hillslope sediment supply through alluvial fans, braided river channels and extensive floodplains to deflation surfaces, active aeolian transport, vegetation-associated sand accumulations, dune fields, dust storms and dust devils. Considered together, these environments illustrate successive stages of sediment redistribution rather than isolated geomorphic

phenomena. The observations also highlight the influence of vegetation establishment and engineering measures on reducing sediment mobility within the valley floor. The presented observations support an integrated geomorphological interpretation of contemporary sediment transfer within the Yarlung Tsangpo Valley and highlight the value of field observations for recognising modern dust-source environments. The observations may contribute to a broader discussion on source-to-sink relationships, sediment redistribution and the role of high-altitude fluvial systems in supplying material for aeolian transport on the southern Tibetan Plateau.

A 13,000-year record of glacier fluctuations at YuzhuFeng glacier (Kunlun Mountains) inferred from periglacial loess grain size

^{1,2}Zhang, Y. ¹, *Fang, X., ² Zeeden, C.

¹*Institute of Tibetan Plateau Research, Chinese Academy of Sciences, 100101 Beijing, China*

²*LIAG-Institute for Applied Geophysics, 30655 Hannover, Germany*

*fangxm@itpcas.ac.cn

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The cryosphere is an integral component of Earth's climate system. Its evolution is closely linked to variations in the Himalayan glaciation, surface erosion, weathering, and desertification. It exerts profound influences on the Asian monsoon and global climate. Reconstructing glacial history has traditionally relied on moraine dating; however, this approach is often compromised by the destruction of older moraines during subsequent glacial advances and by the inherently discontinuous nature of moraine deposition, making it challenging to obtain long, continuous records of glacier change. In this study, we investigated a series of glacial sediments at YuzhuFeng glacier in the Kunlun Mountains together with a loess section (XDT) located less than 10 km from the glacier. Our results show that grain-size variations in the XDT loess can be used to infer the activity of the YuzhuFeng glacier. Glacier fluctuations modulated the intensity of local katabatic winds, which in turn controlled the grain size of the loess deposited. The grain-size record indicates that over the past ~13,000 years the YuzhuFeng glacier reached its maximum extent during the Younger Dryas (YD), and that multiple glacial advances occurred in the mid to late Holocene. This study highlights the potential of periglacial loess grain-size proxies for unraveling glacial evolution.

Coarse silt from the Sahara: long-range dust transport to Central Europe in April 2026

¹ Raczyk, J., ¹Skurzyński, J., ¹Jary, Z., ²Kenis, P.

¹*Department of Physical Geography, Institute of Geography and Regional Development, University of Wrocław, 34 Cybulskiego St., 50-205 Wrocław*

²*Łukasiewicz Research Network – PORT Polish Center for Technology Development, 147 Stalowicka St., 54-066 Wrocław*

jerzy.raczyk@uwr.edu.pl

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Saharan dust events (SDEs) are recorded over Europe several times a year, reflecting the long-range atmospheric transport of fine mineral material from North Africa. These events affect both terrestrial and marine geosystems by supplying inorganic nutrients such as Fe, K, Ca, P and various trace elements, which may stimulate biological productivity.

One such event was recorded in Central Europe on 15 April 2026, when the advection of southern air masses resulted in the deposition of a yellowish-beige dust layer. The material was mechanically collected from a reference surface of 2.2 m². A total mass of 0.231 g was obtained, corresponding to an accumulation rate of 0.105 g/m². The sample was analysed by laser diffraction using a Mastersizer 2000, and by morphological and microchemical analyses using SEM-EDS at the Łukasiewicz Research Network — PORT in Wrocław.

Laser diffraction confirmed the silty character of the deposit. The grain-size distribution was unimodal, with a median particle diameter d_{50} of 31.35 µm, placing the material within the coarse silt fraction. Ultrasonic dispersion caused only a slight shift of the grain-size curve towards finer fractions, indicating a low proportion of aggregates. SEM-EDS observations revealed the dominance of angular, poorly rounded quartz grains. The presence of gypsum/anhydrite and characteristic iron oxide coatings, together with other mineralogical features, supports the Saharan provenance of the

material. At the same time, numerous particles of anthropogenic origin were also identified in the analysed sample.

These observations demonstrate that long-range atmospheric transport may effectively involve not only fine dust, but also coarse silt particles. This has important implications for interpreting ancient dust-generating processes and the accumulation mechanisms of loess deposits. Moreover, the coexistence of Saharan and anthropogenic particles highlights the complex, mixed character of contemporary atmospheric deposits.

The relation between loess and dunes in south-west Poland: evidence of a shift in atmospheric circulation at the end of the last glaciation?

¹Lopuch, M., ^{1*}Krawczyk, M., ¹Jary, Z., ¹Raczyk, J.

*¹Institute of Geography and Regional Development, University of Wrocław,
Poland*

**michal.lopuch@uwr.edu.pl*

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South-western Poland, located entirely beyond the extent of the Last Glacial Maximum (LGM), preserves sedimentary archives that enable palaeoenvironmental reconstructions of processes operating in the foreland of the Scandinavian Ice Sheet during the last glaciation. Particularly valuable insights are provided by the mosaic distribution of aeolian deposits, comprising both thick loess covers and numerous dune fields. Recent dating of these deposits has allowed the establishment of a continuous chronology spanning 24–10 ka, indicating that loess accumulation preceded dune formation.

The loess, most likely deposited on the southern slopes of the Trzebnickie Hills under downwind conditions, points to the persistence of northerly katabatic winds until approximately 15 ka. In contrast, nearby dunes dated to ~14–13 ka display eastward-oriented morphologies, indicating the predominance of westerly circulation. This shift coincides with the development of the Baltic Ice Lake, highlighting the importance of environmental changes in the ice-sheet foreland for the propagation of northerly winds and suggesting a broader reorganization of atmospheric circulation during the Late Glacial period. Although some of the obtained results support this interpretation, several of the investigated sites do not provide unequivocal evidence for this hypothesis, underscoring the need for further research.

Initial insights from alkane- and organic geochemical proxies of a novel loess-palaeosol sequence from Kolobar, Bulgaria

¹Trott, A.*, ¹Rowley, M., ¹Martinengo, S., ²Georgieva – Ishlyamska, B.,
^{3,5}Baykal, Y., ^{4,5,7}Robu, M., ²Ishlyamski, D., ^{5,6}Hambach, U., ⁵Veres, D.,
¹Wiesenberg, G, L, B.

¹*Department of Geography, University of Zurich, Switzerland*

²*National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Bulgaria*

³*Department of Physics, Technical University of Denmark, Denmark*

⁴*“Emil Racoviță” Speleology Institute, Romanian Academy, Romania*

⁵*Romanian Academy, Cluj-Napoca Branch, Romania*

⁶*BayCEER, University of Bayreuth, Germany*

⁷*Research Institute of the University of Bucharest, Romania*

*Andrew.trott@geo.uzh.ch

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Lipid biomarkers preserved within loess-palaeosol sequences can help to disentangle shifts the chemical signatures of past vegetation composition and microbial processing, offering molecular-level evidence of environmental and ecological changes. One such sequence is currently investigated through the LOEs-CLIMBE project (*Shedding Light on Lower Danube–Black Sea Region Palaeoclimate since the Mid-Brunhes Event by Novel Loess-Palaeosol Records*). One such sequence has recently been opened at a

quarry proximate to the village of Kolobar, Bulgaria, offering a rare opportunity to study unaltered organics in an sequence that preserves a signal traceable back to >400 kyr.

Here we present the first results of this nature from this project. We here combine *n*-alkane analysis with Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) and high-resolution bulk Elemental Analysis – Isotope Ratio Mass Spectrometry (EA-IRMS) to reconstruct shifts in vegetation type and carbon dynamics at Kolobar, Bulgaria, covering multiple glacial-interglacial cycles. Together, these proxies will allow us to characterise organic matter sources, assess the degree of post-depositional degradation, and provide a framework for interpreting vegetation and carbon cycle dynamics across multiple glacial-interglacial cycles in the LDBS region.

First results clearly indicate higher organic carbon and lipid concentrations in the paleosols compared to loess. Throughout the six investigated major palaeosols and intercalating loess sequences carbon concentrations varied, arguing for different intensities of soil formation and organic matter input and preservation over time. This variation is also reflected in the distribution of alkanes, with variation in decomposition apparent between loess and palaeosols interpreted as reflecting variations in climate, including variation in palaeohydrology and dust deposition rates. Elemental analysis has been conducted in high-resolution on the sequence and future work will utilise TOC data to identify regions of interest for further lipid biomarker analysis.

New insights into Pleistocene environmental dynamics recorded on the Titel Loess Plateau, Serbia

¹*Steuck, E.**, ²*Zeeden, C.*, ³*Hambach, U.*, ⁴*Schulte, P.*, ⁵*Fischer, P.*, ⁶*Obreht, I.*, ⁷*Marković S.B.*, ¹*Lehmkuhl, F.*

¹*Department of Geography, RWTH Aachen University, Aachen, Germany*

²*Leibniz Institute for Applied Geophysics, Stilleweg 2, 30655, Hannover, Germany*

³*Romanian Academy Cluj-Napoca Branch, Republicii 9, 400015 Cluj-Napoca, Romania*

⁴*LVR-State Service for Archaeological Heritage, Department of Prospection, Bonn, 53115, Germany*

⁵*Institute of Geography, Johannes Gutenberg-University Mainz, Johann-Joachim-Becher-Weg 21, 55128 Mainz, Germany*

⁶*Institute for Geosciences, Johannes Gutenberg-University Mainz, Johann-Joachim-Becher-Weg 21, Mainz, Germany*

⁷*Serbian Academy of Arts and Sciences, Knez Mihajlova 35, 11000 Belgrade, Serbia*

* eva.steuck@geo.rwth-aachen.de.

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This study focuses on the Titel loess–paleosol sequence (Vojvodina, Serbia) aiming to improve the understanding of paleoenvironmental and paleoclimatic conditions, particularly during the penultimate glacial cycle. We apply a high-resolution multi-proxy approach, including grain-size, geochemical, sediment color, and rock-magnetic analyses. The data align with the established chronostratigraphic framework for Serbian loess, spanning the interval from Marine Isotope Stage (MIS) 7 to the Holocene (Marković et al. 2015).

Enhanced weathering during relative moister and warmer periods promoted the formation of paleosols during MIS 7, 6, 5, 3 and 1. Within the L2 loess layer roughly corresponding to MIS 6, a distinct tephra layer serves as an important stratigraphic marker dating to approximately 164 ka (Jordanova et al. 2022). The younger MIS 6 interval (~160–135 ka) exhibits relatively stable depositional conditions, reflected in weaker proxy fluctuations. In contrast, the older interval (~190–160 ka) shows more

dynamic climate conditions, including phases of increased moisture availability, indicated by geochemical ratios such as Sr/Ca and Ba/Sr, and an altered sedimentary structure that may signal the onset of pedogenesis – a feature not yet reported for regional loess–paleosol sequences from this time period.

However, as known from other paleoclimatic archives, the last glacial cycle, in contrast to the penultimate, exhibits drastic climate fluctuations, with stadial–interstadial alternations on millennial timescales.

Our findings will improve the regional stratigraphic framework and refine our understanding of climate variability in the Carpathian Basin in particular during the penultimate glacial cycle.

Exploring the landscape setting: First results of geomorphological and sedimentological investigations of the mammoth bone site Dolní Věstonice I (Czech Republic)

Ohler, S.^{1*}, Lehmkuhl, F.¹, Schulte, P.¹, Novák, M.², Wilczyński, J.³, Händel, M.⁴

¹ *Department of Geography, RWTH Aachen University, Wüllnerstr. 5b, 52056 Aachen, Germany*

² *Institute of Archaeology, Czech Academy of Sciences, Čechyňská 363/19, 60200 Brno, Czech Republic*

³ *Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Sławkowska 17, 31-016 Kraków, Poland*

⁴ *Austrian Archaeological Institute, Austrian Academy of Sciences, Dominikanerbastei 16, 1010 Vienna, Austria*

*Svenja.ohler@geo.rwth-aachen.de

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In 2022, new excavations were conducted at the Gravettian site of Dolní Věstonice (DV) I, famous for its large accumulation of mammoth bones. The site is situated on a gentle, loess-covered slope below a limestone cuesta. Preliminary results on the geomorphological setting and the sedimentary record indicate that the slope profile was shaped by several large mass movements and that the mammoth bone accumulation is located in a depression formed by these landslides. Post-occupationally, the more differentiated paleo-landscape was smoothened by a subsequently deposited loess cover. The mammoth bone deposit was affected by short-distance slope transport, weathering, and pedogenesis before burial. The resulting loess sequence illustrates periods of landscape instability, indicated by undulations, cryoturbation, and displacements, and periods of landscape stability, indicated by weak soil horizons and ice-wedge pseudomorphs. Landscape instability can occur during more humid periods, resulting in smaller mass movements, such as solifluction. In contrast, landscape

stability occurs during cold, arid periods with more continental conditions, as evidenced by the ice wedge pseudomorphs. These field observations are supported by high-resolution (2 cm) laboratory analysis on grain size distribution, colour variations, geochemical composition and OSL dating applied to decode the loess-paleosol sequence (LPS). Three partially overlapping profiles (DV I-1, DV I-2, DV I-3) of the archaeological site were integrated into a single composite depth sequence by determining a linear depth offset that minimizes multi-proxy dissimilarity within zones of overlap, with all proxy signals normalized to a pooled robust z-score prior to alignment. This composite can then be compared to DVI-4, a reference profile from the same site but located outside any visible landslide influence, and to the nearby site DV II (Antoine et al., 2013). The sections of both sites show a stratigraphic discontinuity around the Gravettian occupation and the onset of more continuous loess sedimentation towards the end of MIS 3. However, DV I preserves a more articulated record during the Upper Pleniglacial, with more pronounced pedogenic horizons and better-expressed periglacial features such as cryoturbation structures and ice-wedge pseudomorphs.

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Preliminary Environmental Magnetic Evidence from a Possible Dust-Dominated Sequence in Central Anatolia, Türkiye

¹Makaroğlu, Ö.*, ¹Kaya, N., ²Karşlıoğlu, Ö., Erturaç, K. ^{3,4}

¹ *Department of Geophysical Engineering, İstanbul University-Cerrahpaşa, İstanbul, Turkey*

² *Department of Geological Engineering, İstanbul University-Cerrahpaşa, İstanbul, Turkey*

³ *Gebze Technical University, Institute of Earth and Marine Sciences, Gebze, Kocaeli, Türkiye*

⁴ *Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Geochronology & Geology, Burgos, Spain*

* ozlemm@iuc.edu.tr

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Central Anatolia represents one of the least investigated regions in Eurasia with respect to terrestrial dust archives. Although several studies have proposed the occurrence of aeolian deposits in the region, their origin, depositional history, and paleoenvironmental significance remain poorly constrained. Here, we present preliminary environmental magnetic results from a sedimentary succession exposed in the Nallıhan region of Central Anatolia, Türkiye, to evaluate whether the sequence records periods of dust-dominated accumulation.

The exposed succession exceeds 5 m in thickness and consists of alternating grey-yellow and reddish-brown fine-grained deposits. A representative 175-cm-long profile was sampled at 5-cm intervals for detailed environmental magnetic analyses and lithological description. High-resolution environmental magnetic analyses included low-field magnetic susceptibility (κ_{LF}), natural remanent magnetization (NRM), anhysteretic remanent magnetization (ARM), isothermal remanent magnetization

(IRM_{1000mT} and IRM_{-300mT}), and the calculation of S-ratio and HIRM. These measurements were used to investigate changes in magnetic mineral concentration, grain size, and depositional processes throughout the sequence.

The studied section is composed of three main lithological units and includes several reddish horizons that may reflect enhanced pedogenic modification. The studied section comprises alternating reddish-brown and grey-yellow fine-grained deposits interrupted by a distinct gravelly horizon. Reddish horizons occur at 0–50 cm and 100–120 cm depth and display features suggestive of palaeosol development. Massive grey-yellow silty units are present between 50–100 cm and 160–175 cm depth. The fine-grained succession is interrupted by a ~35 cm thick, poorly sorted polygenic gravel layer between 125 and 160 cm depth, indicating a fluvial depositional episode.

Environmental magnetic parameters exhibit pronounced stratigraphic variations that broadly correspond to the lithological units identified in the profile. The reddish palaeosol-like horizons are characterized by elevated κ_{LF} , ARM, and SIRM values, indicating enhanced concentrations of ferrimagnetic minerals and an increased contribution of fine-grained magnetic particles reflected by higher ARM values. In contrast, the grey-yellow silty units generally display lower magnetic concentrations. The intervening gravelly fluvial horizon is clearly distinguished by abrupt shifts in κ_{LF} , ARM, and SIRM, indicating a short-lived change in sediment source and depositional regime. Despite these variations, consistently high S-ratio values (0.80–0.98) indicate the persistent dominance of low-coercivity ferrimagnetic minerals throughout the sequence. The correspondence between lithological changes and magnetic signatures suggests that the reddish palaeosol-like horizons and grey-yellow silty units may represent phases of alternating pedogenic modification and dust accumulation, although the investigated deposits cannot yet be unequivocally classified as a classical loess–palaeosol succession. Instead, the sequence appears to record the combined influence of dust input, pedogenic processes, and episodic fluvial reworking.

However, further grain-size, mineralogical, geochemical, and chronological investigations are required to determine the origin and paleoenvironmental significance of these deposits.

Magnetic Proxy of Eurasian Loess Revealing Enhanced Physical Erosion Since the Mid-Pleistocene Transition

^{1,2}Ning, W. ^{1,2*} Zan, J., ³Heller, F., ^{1,2}Fang, X.

¹*State Key Laboratory of Tibetan Plateau Earth System and Resources Environment, Institute of Tibetan Plateau Research, CAS, Beijing 100101, China*

²*University of Chinese Academy of Sciences, Beijing 100049, China*

³ *ETH-Zentrum, Zürich, 8092, Switzerland*

*zanjb@itpcas.ac.cn.

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Eolian loess deposits contain valuable information about past climate changes and erosion history in dust source regions. In contrast to the extensive investigations of paleoclimatic implications of Eurasian loess, continental erosion information in the loess deposits has received less attention, particularly on the global or hemispheric scales. The present study combines citrate-bicarbonate-dithionite (CBD) magnetic mineral extraction procedures and linear regression of magnetic parameters to analyze Eurasian loess. We find that lithogenic susceptibility of Quaternary loess deposits in Central Asia, Europe and the Chinese Loess Plateau shows synchronous long-term increases since ~0.6–0.5 Ma, suggesting intensive glacial erosion and/or river incision to have occurred in the surrounding mountains of dust source regions after the mid-Pleistocene climate Transition. The dramatic increase in lithogenic susceptibility of Eurasian loess provides new insights into the close relationships between global climate changes and dust source erosion since the late Cenozoic.

Local and Regional Controls on Magnetic Susceptibility Records in the Lower Danube Loess Region

¹Ishlyamski, D., ¹Jordanova, D., ¹Jordanova, N., ²Veres, D., ^{2,3}Baykal, Y.,
⁴Wiesenberg, G., ⁴Trott, A., ¹Georgieva – Ishlyamska, B., ^{2,5,6,7}Robu, M.,
²Hambach, U.

¹ *National Institute of Geophysics, Geodesy and Geography, Bulgarian
Academy of Sciences, Acad. G. Bonchev, block 3, 1113 Sofia, Bulgaria*

² *Romanian Academy Cluj-Napoca Branch, Institute of Speleology, Clinicilor
5, 400006 Cluj-Napoca, Romania*

³ *Department of Physics, Technical University of Denmark, Frederiksborgvej
399, 4000 Roskilde, Denmark*

⁴ *Department of Geography, University of Zurich, Winterthurerstrasse 190,
8057 Zürich, Switzerland*

⁵ *“Emil Racoviță” Speleology Institute, Romanian Academy, Bucharest,
Romania*

⁶ *Research Institute of the University of Bucharest, Bucharest, Romania*

⁷ *“Sabba S. Stefanescu” Institute of Geodynamics, Romanian Academy,
Bucharest, Romania*

*dishlyamski@geophys.bas.bg

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Magnetic susceptibility (χ) is basic magnetic property of the matter, reflecting the content of strongly magnetic minerals. Magnetic susceptibility is sensitive to pedogenic and weathering processes and is widely used as a proxy for reconstructing past environmental and climatic conditions. In soils with good drainage, χ is utilized as proxy for climate conditions, showing linear relationship with mean annual precipitation and temperature. However, reliable interpretation of the pedogenic magnetic susceptibility as paleoclimate proxy needs careful consideration of site-

specific conditions. The role of local factors was investigated by comparing the absolute magnetic enhancement and depth variations of magnetic susceptibility in three profiles comprising the Holocene soil (S0) and the first loess horizon (L1) from the surroundings of the village of Kolobar, in Northeastern Bulgaria. Located less than 1 km apart, the three sampling stations occupy similar geomorphological environments. The Kolobar profiles display nearly identical χ patterns throughout the S0–L1 interval, showing high similarity in both the general susceptibility trend and the low-amplitude variations within L1. A sharp transition between S0 and L1 is consistently identified in all three profiles, suggesting the presence of an erosion at the local scale. Such sharp S0–L1 transition is not observed in the magnetic susceptibility record from another location (OV site), situated approximately 10 km northwest of Kolobar. In addition, the OV profile is characterized by a lower maximum magnetic enhancement ($80 \times 10^{-8} \text{ m}^3 \text{ kg}$) compared with approximately $110 \times 10^{-8} \text{ m}^3 \text{ kg}$ in the Kolobar profiles. These differences may reflect spatial variations in dust input during the soil formation period and the influence of local climatic conditions. Regional-scale factors were evaluated by comparing magnetic susceptibility records from three sites in NE Bulgaria: Kolobar, General Toshevo and Kaolinovo, situated approximately 20–50 km apart. Differences in profile differentiation, L1 thickness, maximum magnetic enhancement and low-amplitude susceptibility variations indicate substantial spatial variability in sediment accumulation among the investigated sites. The investigated records preserve a common stratigraphic pattern, whereas the magnitude of magnetic enhancement differs between the studied locations. Regional records also differ in the features of the first loess horizon (L1). These results demonstrate that the values of magnetic susceptibility are primarily controlled by regional environmental conditions, whereas local site-specific conditions exert only a secondary influence.

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High-resolution magnetic and geochemical study of magnetic depletion in the S4 paleosol of the Kolobar loess–paleosol sequence (NE Bulgaria).

Georgieva – Ishlyamska, B.¹, Trott, A.², Jordanova, N.¹, Jordanova, D.¹, Veres, D.³, Baykal, Y.^{3,4}, Robu, M.^{3,5,6}, Hambach, U.^{3,7}, Ishlyamski, D.¹, Wiesenberg, G.²

¹ *National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Acad. G. Bonchev, block 3, 1113 Sofia, Bulgaria*

² *Department of Geography, University of Zurich, Winterthurerstrasse 190, 8057 Zürich, Switzerland*

³ *Romanian Academy Cluj-Napoca Branch, Institute of Speleology, Clinicilor 5, 400006 Cluj-Napoca, Romania*

⁴ *Department of Physics, Technical University of Denmark, Frederiksborgvej 399, 4000 Roskilde, Denmark*

⁵ *“Emil Racoviță” Speleology Institute, Romanian Academy, Bucharest, Romania*

⁶ *Research Institute of the University of Bucharest, Bucharest, Romania*

⁷ *BayCEER, Universität Bayreuth, Bayreuth, Germany*

*bojurkageorgieva97@abv.bg

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Loess–paleosol sequences (LPSs) are valuable terrestrial archives for reconstructing Quaternary environmental and climatic change. In southeastern European LPSs, soil horizons generally exhibit enhanced magnetic susceptibility due to the formation of fine-grained ferrimagnetic minerals. Under specific paleoenvironmental conditions, however, paleosols may exhibit magnetic depletion.

To investigate the processes responsible for magnetic depletion, this study focuses on the fourth paleosol (S4) of the Kolobar loess–paleosol sequence in northeastern Bulgaria. The entire sequence was continuously sampled at 2 cm resolution, while the present study focuses on a 3 m thick interval comprising the L4 loess, the S4 Vertisol and the underlying S5 paleosol. The L4–S4–S5 interval was investigated using an integrated mineral magnetic and geochemical approach, including magnetic susceptibility, laboratory remanences (ARM and IRM), grain-size-sensitive magnetic ratios (ARM/ χ , ARM/IRM), S-ratio, and FeO concentrations determined by XRF analysis. Evaluation of the content of organic matter was achieved using Loss on Ignition (LOI) data. Magnetic proxies consistently indicate depletion of the pedogenic ferrimagnetic fraction within the S4 paleosol relative to the underlying S5 paleosol and the overlying L4 loess. The coupled decrease in magnetic susceptibility and FeO content throughout S4 indicates mobilization and partial removal of secondary pedogenic iron oxides during Vertisol development. Lower ARM/ χ values indicate a trend of depletion of fine-grained pedogenic ferrimagnetic particles along depth, whereas increasing ARM/IRM ratio and decreasing S-ratio suggest a progressively greater relative contribution of true single domain magnetite and high-coercivity minerals toward the base of the paleosol. In contrast to the L4 loess, where FeO is negatively correlated with IRM, the S4 Vertisol exhibits a positive linear relationship between FeO and IRM. This contrast suggests that iron in L4 is predominantly hosted by the paramagnetic phyllosilicate matrix, whereas in S4 it is mainly associated with secondary pedogenic iron oxides that were subsequently mobilized and partly removed during Vertisol development.

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The potential of micromorphological analysis for determining the genesis of fossil soils in Ukraine

Doroshkevych S.P., Matviishyna Zh.M.

Institute of Geography of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

dsp.paleo@gmail.com

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Micromorphological analysis plays an important role in palaeopedology, as it provides valuable insights into the genesis of fossil soils. Soil micromorphology as a scientific discipline was pioneered by Walter L. Kubiena in the 1940s. Significant contributions to its subsequent development were made by Roy Brewer, Ewart A. FitzPatrick, A. Jongerius, Libuše Smolíková, Peter Bullock, Teresa Madeyska, Olena Parfyonova, Kateryna Yarilova, Richard A. Kemp, Arnt Bronger, J.B. Dalrymple, Maria Bronnikova, Georges Stoops, Vera Marcelino, Paul Goldberg, Daniela Sauer, and many others. Among Ukrainian researchers engaged in the micromorphological investigation of modern and fossil soils, particular attention should be paid to the contributions of Zhanna Matviishyna, Anatolii Travleiev, Nataliia Bilova, Volodymyr Yakovenko, Serhii Karmazynenko, Oleksandr Parkhomenko, Serhii Doroshkevych, Anatolii Kushnir, and others.

Micromorphological analysis is particularly important in identifying diagnostic features of primary soil-forming processes preserved in Quaternary deposits of different ages. These features, detected under a microscope in thin sections of soils with an intact structure, are direct paleogeographic indicators of factors of ancient soil formation and, accordingly, reflect the natural conditions of the time of formation of fossil soils in the past. Against this background, it is important to consider in greater detail the potential of micromorphological analysis for the diagnosis of elementary pedogenic processes in Pleistocene palaeosols. The interpretations presented below are based on the original micromorphological investigations of Pleistocene fossil soils from approximately twenty Quaternary sections in Ukraine, the majority of which are situated within the Southern Bug River basin (Doroshkevych, 2018).

Several examples illustrate the application of micromorphological analysis to the genetic identification of fossil soils exposed in the Yakushyntsi Quaternary section (Vinnytsia Region, Ukraine). In this section, three paleosols horizons corresponding to the Vytachiv (vt; MIS 3), Pryluky (pl; MIS 5a-c) and Kaydaky (kd; MIS 5e) stages of the Pleistocene occur beneath the modern Holocene (hl) soil (Stratigraphic Scheme of the Quaternary Deposits of Ukraine, 1993). Micromorphological analysis of the Vytachiv palaeosols revealed clear evidence of several elementary pedogenic processes. Clay enrichment is indicated by a silty-plasmic microfabric and the dense packing of mineral grains within an iron-rich clay plasma. Vertic processes are expressed by rounded segregation features together with nodules and ooids developed within the clay plasma. Ferrugination and gleying are evidenced by iron-manganese pedofeatures (micro-ortsteins), frequently displaying concentric internal structure. Carbonate accumulation is manifested by the cementation of the plasma with microcrystalline calcite, whereas carbonate translocation is reflected by the concentration of calcium carbonate pedofeatures around voids. The occurrence of these diagnostic micromorphological features made it possible to identify the investigated palaeosols genetically and to classify them as specific Cambic Calcisols (Ochric, Vertic) according to the WRB system. These soils developed under alternating humid and dry environmental conditions and have no modern analogues within the present-day soil cover of Ukraine.

Overall, micromorphological analysis represents one of the most powerful tools for investigating the genesis of fossil soils. The identification of diagnostic pedofeatures in thin sections of undisturbed soil material provides direct evidence of past pedogenic processes, allowing their sequence and relative intensity to be reconstructed. This substantially enhances the reliability of genetic interpretation and classification of paleosols and contributes to more robust palaeoenvironmental reconstructions. Active biogenic-accumulative processes, including humification and humus accumulation, are recognized microscopically by the presence of simple and compound microaggregates, a well-developed network of interconnected voids, and a humus-clay plasma. Eluvial processes, such as podzolization and lessivage, are expressed by the degradation of microaggregates and the occurrence of bleached plasma domains within eluvial horizons, together with clay coatings (argillans) formed by the illuviation of colloidal clay material and concentrated on void walls in the corresponding illuvial horizons of fossil soils.

An Anthropogenic Water System in Mačva: OSL and Radioisotope Evidence from Bitva, Jerez, and Obrovčine Channels

Poręba, G.¹, Moska, P.¹, Marković, S.B.², Wojtalak, A.¹, Szymak, A.¹, Kršmanović, P.², Filipović, V.³, Živanović, S.³

¹ Silesian University of Technology, Department of Geochronology and Environmental Isotopes, Gliwice, Poland; ² Chair of Physical Geography, Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Serbia; ³ Institute of Archaeology, National Institute of the Republic of Serbia, Belgrade, Serbia

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The Mačva region preserves a dense network of natural channels situated between the Drina and Sava rivers. Numerous Late Neolithic and Early Eneolithic archaeological sites, particularly settlements of the Obrovac type, are distributed along these channels. Obrovac settlements are surrounded by trenches that were presumably connected to channel systems within the Mačva region, suggesting a close relationship between hydrological features and prehistoric settlement patterns. To evaluate the chronology and origin of these channel systems, geoarchaeological investigations were undertaken at selected locations within the Bitva, Jerez, and Obrovčine areas.

Three sediment profiles were collected from the beds of the channels located at Bitva, Jerez, and Obrovčine for Optically Stimulated Luminescence (OSL) dating. In addition, two samples were obtained from the channel banks to provide supplementary chronological information. Sediment samples were also collected for grain-size analysis and for the determination of ^{137}Cs and ^{210}Pb activities.

Preliminary results suggest that the channels may have been in use during historical times; however, the thickness of anthropogenic deposits identified within the investigated sections appears to be relatively limited.

Stratigraphic relationships between Neolithic and Chalcolithic sites and their host loess-soil sediments near the village of Koprivets, Ruse region

¹Evlogiev, Y., ²Vaisov, Iv., ²Popov, V.

¹GI - BAS, ²NAIM – BAS

*evlogiev.yordan@gmail.com

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In the Lomovete Valley and the adjacent plateau territories, 121 prehistoric settlements have been registered, of which 31 are open settlements and 90 settlement tells, dating back to the Neolithic and early Chalcolithic periods.

The Early Neolithic open settlements at Koprivets, Cherven, Orlovets and Pomochitsa are located on the lower slopes, close to the floodplain terraces. The Late Neolithic settlements occupy their higher parts and the low plateaus, reflecting changes in the environment.

The transition between the Neolithic and the Chalcolithic was accompanied by climatic and landscape changes that influenced the development and spatial organization of settlements. During the Chalcolithic, multi-layered settlement tells were built on the floodplain river terraces.

The Early Neolithic settlements in the area lie in the upper part of the first loess horizon (L₁). They are sealed by the carbonate horizon of the contemporary soil (Cs) and belong to phase I of the Koprivets culture (8150–8000 BP). The stratigraphy of the site shows, that the loess accumulation gradually subsided during the Preboreal and Boreal, and the carbonate horizon of the contemporary soil formed after this period. The data suggests that the accumulation of the transitional and humus horizons of the soil began during the early Atlantic (about 8000 BP).

The settlements from the late stages of the Early Neolithic and Late Neolithic (the Samovodene–Ovcharovo, Hotnitsa I and Hotnitsa II cultures) are dated in the interval 7600–7400 to 7140–7030 BP. They are located in the lower part of the contemporary soil (Cs) and correspond to the early Atlantic stages.

The Chalcolithic settlement tell near Koprivets is located on the floodplain terrace T₀¹ of the Baniski Lom River. The settlers appeared after the river retreated from the terrace

(about 6000 BP). During the establishment of the settlement, stone slabs were laid on the alluvial clays, probably with insulating function. Simultaneously with the accumulation of anthropogenic layers in the tell, the contemporary soil (Cs) around it was formed. The intensive development of soil formation began around 6000 BP and continues to this day.

Based on the studied sections in the region, a local paleoclimatic curve has been reconstructed. The humus, illuvial and carbonate horizons of the contemporary soil, as well as the uppermost part of the loess horizon L_1^1 , have been analyzed. The established fluctuations are correlated with the Preboreal, Boreal, Atlantic, Subboreal and Subatlantic.

Relationships between Neolithic-Chalcolithic sites and their host sediments allow geological, archaeological, and paleoclimatic data to be linked for dating events during the Holocene:

- The accumulation of the loess horizon L_1^1 was completed at the end of the Boreal, around 8000 BP;
- Weak loess deposition continues throughout the Subboreal at a rate of 1 cm/100 yr, as evidenced by a sterile layer 28 cm thick above the last fifth horizon of the Chalcolithic settlement tell (5500 BP);
- It is important to note that the earliest Neolithic layer at Koprivets, dated to 8150–8000 BP, is located in the upper part of L_1^1 and is sealed by the carbonate horizon of the contemporary soil;
- The formation of the illuvial horizon is associated with the beginning of the Atlantic (around 8000 BP), and of the humus horizon - with the Atlantic, Subboreal and Subatlantic.

Terrace T_0^1 is of Late Pleistocene and Early Holocene age and is 3–4 m above the average river level. Based on the studies of the settlement tell at Koprivets, built on the same terrace, the following stratigraphic and paleogeographic conclusions have been made:

- The channel alluvium on the T_0^1 terrace was accumulated at the end of the W_2 stadial recession, during the Preboreal and Boreal, whereas the floodplain facies formed during the early Atlantic;
- The Baninski Lom River retreated from the T_0^1 floodplain terrace with the onset of the Atlantic recession (6000 BP, archaeological data);
- The formation of Cs on the T_0^1 alluvium began after the river retreat and coincided with the appearance of the Chalcolithic settlers (6000 BP);
- During the Subboreal (5000-3000 BP) and Subatlantic (3000-present) the Baninski Lom River modeled the T_0 terrace and shaped its present-day bed.

Provenance and technological study of Iron Age ceramic amphorae from the northern Black Sea coast of Bulgaria

¹*Lesigyarski, D., ²Madzharov, K., ^{3,4}Bonev, V. and ¹Nikolova, A.

¹*National Institute of Geophysics, Geodesy, and Geography – Bulgarian Academy of Sciences*

²*National Archaeological Institute with Museum – Bulgarian Academy of Sciences*

³*Faculty of History, Sofia University “St. Kliment Ohridski”*

⁴*Center of Archaeometry with Laboratory of Conservation and Restoration, Sofia University “St. Kliment Ohridski”*

*dlesigyarski@geophys.bas.bg

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Determining the elemental and mineral composition of archaeological ceramic artifacts facilitates significantly the interpretation of origin, production technology, and trade of pottery vessels. In archaeometric studies, one of the most commonly used methods for determining the concentrations of chemical elements is X-ray fluorescence. On the other hand, magnetic analyses are highly efficient to recover the firing process and even to distinguish between specimens produced by different firing technologies.

In this study, we analyze a set of ceramic amphorae found in the ancient settlement of Bizone on the northern Bulgarian Black Sea coast. The finds are dated to the 4th century BCE and are characterized by the presence of four types of producer's stamps: Ἀριστοκράτης (A), Μένης (M), Σωκράτης (S), and Ἡρα (H). Such englyphic stamps are widespread in Northeastern Thrace, especially in the area of Bizone. They are usually associated with the so-called “Herakleian circle” with a West Pontic origin. To establish whether the analyzed amphorae fragments with different stamps were

produced from similar raw materials or by a similar technology, a complex methodology is applied, combining magnetic susceptibility measurements, XRF, and petrographic analyses.

The maximum firing temperatures ($T_{\max}$) achieved during the production process of the vessels in antiquity are determined for a total of 74 sherds by measuring the changes in the mass-specific magnetic susceptibility (χ) values during stepwise laboratory heating of the specimens from 300°C up to 920°C. A significant number of the sherds were fired up to 740°C and 800°C. The lowest median $T_{\max}$ value is obtained for the Σωκράτης (S) fragments (760°C), and the highest – for the Μένης (M) fragments (840°C). The specimens bearing the Ἀριστοκράτης (A) and Ἡρα (H) stamps are characterized by the same median $T_{\max}$ value, equal to 820°C. Generally, the graphical dependence of χ on the laboratory heating temperature is similar for all four types of sherds analyzed, suggesting cognate firing technology applied during their production.

The elemental composition is determined for 43 amphorae sherds and 7 clay samples collected from sources in the area of Bizone's remains. The studied ceramics are relatively rich in Ca, which shows concentrations between 6.5% and 12.4% for the entire collection. This calcium content is significantly higher than in the studied clays from the area of the archaeological site (between 1.3% and 3.9% Ca). Based on the obtained elemental concentrations and cluster analysis performed, it can be assumed that there are strong similarities in the elemental composition of the sherds carrying all four types of stamps. However, the analyzed clay samples form a separate cluster. In addition, results of the petrographic analysis indicate that the artifacts are of non-local origin and were likely imported from a production center where clay and temper rich in volcanic rocks were used. Such rocks are not present in the vicinity of the archaeological site of Bizone.

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A study of ceramic residues with FT-IR and Raman spectroscopy – preliminary report

¹Nikolova, A.*, ^{1,2} Bonev, V.

¹ Sofia University “St. Kliment Ohridski”, Faculty of History

²Centre of Archaeometry with Laboratory for Conservation and Restoration,
Sofia University “St. Kliment Ohridski”

*samra_2012@abv.bg

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FT-IR and Raman spectroscopy are non-destructive methods, suitable to classify residues on ceramic, tools and other archaeological artefacts (Łucejko et al., 2026) and even to suppose the receipt if there is a composite mixture. They can be used separately (Chen et al., 2021), but when combined, they can give more accurate picture of the nature of the residue.

This study demonstrates different scenarios for ceramic fragments found in archaeological context at Obretenik and Chirakman, North Bulgaria – from pure inorganic mineral matrix to complex mixtures of plant oils and most probably conifer resins, waxes. So, according the preliminary results, among the samples there are ceramic fragments with no organic signal and fragments from storage and transport vessels for (olive?) oil and wine retsina type, sealed with resinous covering (Zlateva and Rangelov, 2015). Even proteins can be traced in the composite residues on Chirakman sherds.

The most appropriate approach, a Gas chromatography-mass spectrometry (GG-MS) analyses, will be applied further to define the exact compounds of the complex organic residues (Polla and Springer, 2022; Roffet-Salque et al., 2017).

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Determination of the Properties of copolymer-stabilized loess under laboratory conditions

Zlatarov, A.A., Prof. Totsev, A.T.

*University of Architecture, Civil Engineering and Geodesy, Sofia,
Bulgaria*

* atanas.zlatarov@gmail.com

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This paper examines the potential use of an alternative to cement–loess stabilization for the improvement of loess soils-namely, their treatment with copolymers. This approach is of particular relevance, as approximately 90% of the territory of Northern Bulgaria is underlain by loess soils, where intensive construction of roads and motorways is currently taking place.

The paper presents selected laboratory tests carried out in the Geotechnical Engineering Laboratory at the University of Architecture, Civil Engineering and Geodesy. In relation to the stability of embankments constructed from loess soil, it is necessary to determine how the strength parameters-angle of internal friction and cohesion-change as a result of treatment. For this purpose, direct shear tests were performed on loess soil both without additives and with copolymer additives at different percentages. The amount of copolymer added is expressed as a percentage of the dry weight of the soil. Samples containing 2%, 4%, and 6% copolymer were tested. In order to determine the deformation characteristics of the soil, a series of compression tests was also conducted. As in the direct shear tests, loess soil was examined both in its natural state and with different copolymer contents-2%, 4%, and 6%.

LIST OF PARTICIPANTS

Loessfest 2026, Krapets 7 – 11 of September 2026, Bulgaria

No	name	affiliation	country	email
1	Amin Ghafarpour	Terrestrische Paläoklimatologie/Paläontologie Universität Tübingen	Germany	amin.ghafarpour@sedgeo.uni-tuebingen.de
2	Andrew Trott	Univ. Zurich	Switzerland	andrew.trott@geo.uzh.ch
3	Andriy Bogucki	Ivan Franko National University of Lviv	Ukraine	pleistocene@ukr.net
4	Andrzej Wisniewski	Univ. Wroclaw	Poland	andrzej.wisniewski@uwr.edu.pl
5	Anelia Nikolova	Sofia University "St. Kliment Ohridski" University of Architecture, Civil Engineering and Geodesy	Bulgaria	anikolova@abv.bg
6	Atanas Zlatarov	Univ. Wroclaw	Bulgaria	atanas.zlatarov@gmail.com
7	Bartosz Korabiewski		Poland	bartosz.korabiewski@uwr.edu.pl
8	Bozhurka Georgieva – Ishlyamska	NIGGG - BAS	Bulgaria	bojurkageorgieva97@abv.bg
9	Carola Lehmkuhl	Aachen	Germany	
10	Caroline Delpupo	Geography Department, Federal Institute of Minas Gerais, Ouro Preto	Brasil	carolinedelpupo@gmail.com
11	Cezary Kabala	Wroclaw University of Environmental and Life Sciences	Poland	cezary.kabala@upwr.edu.pl
12	Christian Zeeden	LIAG-Institute for Applied Geophysics, Hannover	Germany	christian.zeeden@liag-institut.de
13	Daniel Ishlyamski	NIGGG - BAS	Bulgaria	dishlyamski@geophys.bas.bg
14	Daniel Pschynov	Laboratory of Geotechnics and agroecology LTD	Bulgaria	laboratoriopogeotehnika@gmail.com
15	Daniel Veres	Romanian Academy Cluj	Romania	dsveres@gmail.com
16	Deyan Lesygiarski	NIGGG - BAS	Bulgaria	dekemvri14@abv.bg
17	Diana Jordanova	NIGGG - BAS	Bulgaria	diana_jordanova77@abv.bg
18	Dimo Dimov	NIGGG - BAS	Bulgaria	dimo@gea.uni-sofia.bg
19	Dmitro Hlavatskyi	Institute of Geophysics, Ukrainian Acad. Sci.	Ukraine	hlavatskyi@gmail.com
20	Dragomir Dragomirov	IPGP	France	dragomirov@ipgp.fr
21	Eva Steuck	Chair Physical Geography and Geoeology	Germany	eva.steuck@geo.rwth-aachen.de
22	France Lagroix	CNRS, IPGP	France	france.lagroix@cnsr.fr
23	Frank Lehmkuhl	Department of Geography, RWTH Aachen University, Germany	Germany	flehmkul@geo.rwth-aachen.de
24	Grzegorz Poreba	Silesian University of Technology, Gliwice	Poland	grzegorz.poreba@polsl.pl
25	Guido Wiesenber	Univ. Zurich	Switzerland	guido.wiesenber@geo.uzh.ch
26	Hema Auchyuthan	CENTRE FOR ENVIRONMENT STUDIES, Anna University	India	hachyuthan0@gmail.com
27	Ivan Vajsov	NAIM-BAS	Bulgaria	ivanvajsov@gmail.com
28	Jacek Skurzynski	Univ. Wroclaw	Poland	jacek.skurzynski@uwr.edu.pl
29	Jerzy Nawrocki	Polish Geological Institute	Poland	jerzy.nawrocki@pgi.gov.pl
30	Jerzy Raczky	Univ. Wroclaw	Poland	jerzy.raczky@uwr.edu.pl
31	Kamila Ryzner	LIAG Institute for Applied Geophysics	Germany	Kamila.Ryzner@liag-institut.de
32	Kristyna Kolarikova	Hannove Charles University	Czech Republic	kristyna.flasarova@seznam.cz
33	Krzysztof Widawski	Dept. Regional Geography and tourism, Univ. Wroclaw	Poland	krzysztof.widawski@uwr.edu.pl
34	Lena Mihova	Univ. of Architecture, Civil Engineering and Geodesy, dept. of Geotechnics	Bulgaria	l_mihova@yahoo.com
35	Marcin Krawczyk	Univ. Wroclaw	Poland	marcin.krawczyk2@uwr.edu.pl
36	Mariana Nedelcheva	Geological Institute, BAS	Bulgaria	mariana_nd@mail.bg
37	Martin Chadima	Institute of Geology of the Czech Academy of Sciences	Czech Republic	chadima@agico.cz
38	Mathias Vinnepand	Albert-Ludwigs-Universität Freiburg	Germany	mathias.vinnepand@geologie.uni-freiburg.de
39	Metodi Metodiev	NIGGG - BAS	Bulgaria	metodi24@abv.bg
40	Michał Łopuch	Univ. Wroclaw	Poland	michal.lopuch@uwr.edu.pl
41	Mike Rowley	Univ. Zurich	Switzerland	mike.rowley@geo.uzh.ch
42	Natalia Gerasimenko	Taras Shevchenko National University of Kyiv	Ukraine	n.gamet2@gmail.com
43	Neli Jordanova	NIGGG - BAS	Bulgaria	neli_jordanova@hotmail.com
44	Oleksandr Bonchkovskiy	Institute of Geography- National Academy of Sciences of Ukraine	Ukraine	geobos2013@gmail.com
45	Olena Tomeniuk	Ivan Franko National University of Lviv	Ukraine	olena.tomeniuk@lnu.edu.ua
46				
47	Olivier Moine	CNRS	France	Olivier.MOINE@lgp.cnrs.fr
48	Ozlem Makaroglu	Istanbul University-Cerrahpasa	Turkey	ozlemm@iuc.edu.tr
49	Petar Krsmanović	Physical Geography, Dept. Geography Faculty of Novi Sad	Serbia	petarkrsm@gmail.com
50	Petya Trifonova	NIGGG - BAS	Bulgaria	ptrifonova@geophys.bas.bg

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No	name	affiliation	country	email
51	Pierre Antoine	CNRS	France	pierre.antoine@lgp.cnrs.fr
52	Serhii Doroshkevych	Institute of Geography-National Academy of Sciences of Ukraine	Ukraine	dsp.paleo@gmail.com
53	Shiling Yang	Inst. of Geology and Geophysics, Chinese Acad. Sci.	China	yangsl@mail.iggcas.ac.cn
54	Sisi Liu	College of Geography and Environmental Sciences, Zhejiang	China	liusisi@zjnu.edu.cn
55	Slobodan Markovic	Univ. Novi Sad	Serbia	baca.markovic@gmail.com
56	Svenja Ohler	Physical Geography and Geoecology, RWTH Aachen University	Germany	svenja.ohler@geo.rwth aachen.de
57	Titanilla Kertész	Isotope Climatology and Environmental Research Centre, Institute for Nuclear Research	Hungary	kertesz.titanilla@atomki.hu
58	Ulrich Hambach	Universität Bayreuth; Romanian Academy Cluj	Germany	Ulrich.Hambach@uni-bayreuth.de
59	Vanushka Petrova	Geological Institute, Bulgarian Academy of Sciences	Bulgaria	vanushka@gmail.com
60	Valentina Spasova	Laboratory of Geotechnics and agroecology LTD	Bulgaria	laboratoriqpogotehnika@gmail.com
61	Wenxiao Ning	LIAG-Institute for Applied Geophysics; Institute of Tibetan Plateau Research of Chinese Academy of Sciences	China	zanjb@itpcas.ac.cn
62	Wenyang Jiang	Institute of Geology and Geophysics, Chinese Academy of Sciences	China	wjiang@mail.iggcas.ac.cn
63	Yanguang Zhang	LIAG- Institute for Applied Geophysics, Hannover	Germany	zhangyanguang@itpcas.ac.cn
64	Yordan Evlogiev	Geological Institute, BAS	Bulgaria	evlogiev.yordan@gmail.com
65	Yunus Baykal	Romanian Academy Cluj	Romania	yubay@dtu.dk
66	Zaniar Amiri	LIAG- Institute for Applied Geophysics, Hannover	Germany	Zaniar.Amiri@liag-institut.de
67	Zdzislaw Jary	Univ. Wroclaw	Poland	zdzislaw.jary@gmail.com
68	Zuzanna Sowirska	Univ. Wroclaw	Poland	zuzanna.sowirska@uwr.edu.pl

Field excursion & workshop –

10th of September 2026

Kolobar quarry

after Jipa, 2014

