Past and future climate projections and their relevance for human society – a journey in time

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Present climate change issues have reached the top on the agenda of decision makers on national, regional and global level. Climate science directly contributes to socio-economic planning in our society despite the unavoidable uncertainties associated to the research tools we have used. The presentation reviews the research related to climate modeling as a tool for generating knowledge applied to past and present climate changes in Earth and human history and associated uncertainties from the perspective of future society development. The presentation shows that, in the context of adaptation to present climate change, ignoring knowledge together with related uncertainties about past and future climate might lead to high social, economic and environmental costs.

Vegetation and climate history in the Carpathians during MIS 3-2 – a multi-proxy study of a sediment sequence from Mohoş crater, Romania

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We present a new record of vegetation and climate history derived from a multiproxy investigation of sediments recovered from the in-filled Mohoş crater (46°05' N; 25°55' E) located within the Ciomadul volcano complex (Romania). To date, the 30-m long sediment core, covering MIS 3 to present provides one of the longest lacustrine records from the Carpathian region. The sequence consists of an upper peat unit of Holocene age, and underlying lacustrine sediments inter-bedded with several tephra layers. Ciomadul volcano, hosting the superimposed craters of Mohoş and Sf. Ana, is the youngest volcanic edifice in the Carpathian-Balkan region. Thus, tephra-analysis on the Mohoş sediments gives valuable insights into the volcanic history of that region during MIS 3, mainly arising from the younger crater of Sf. Ana and possibly from several secondary domes. The past vegetation and climate history of the Mohoş sediment sequence has been reconstructed by applying a multi-proxy approach of lower resolution palynological analyses and geochemical, and sedimentological investigations in combination with high-resolution multi-sensor core logging and ITRAX XRF scanning. Chronological control of the sediment sequence is based on radiocarbon and luminescence dating. Palynological data yield arboreal pollen (AP) mainly consisting of Pinus, whereas Artemisia and Poaceae dominate the non-arboreal pollen (NAP). The fluctuations in the AP/NAP curve suggest marked changes in the landscape openness during MIS 3-2. All parameters exhibit a major change at the transition from peat to lacustrine sediments. Low TOC values coupled with low TOC/N ratios in the lacustrine sediments could be interpreted as reflecting limited productivity (mainly aquatic), and/or high rate of organic matter mineralisation in the water and sediment column driven by biogeochemical forcing, likely as a result of proximal volcanic activity. Based on available data, responses of this mid-altitude site (1050 m a.s.l.) to past climate oscillations since MIS 3 are discussed. We further discuss results of tephra-analyses on the Mohoş sediment record and their correlation to proximal and medial-distal pyroclastic deposits originating from this volcanic field.

Acknowledgements

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Paleoenvironmental anaysis of two loess profiles at the Ságvár Lyukas Hill in western Hungary

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Paleoenvironmental investigations are undertaken for two loess profiles at the Ságvár Lyukas Hill in western Hungary. The site is known for its Upper Paleolithic findings (Lengyel, 2008-2009). It is located ca. 12 km south-east of Siofok at Lake Balaton within a loess landscape, which exhibits dominantly northwest-southeast striking valleys. Figure 1 shows a loess map with the location of the site. Granulometric, geochemical, rock magnetic and luminescence analyses were carried out showing weak variations.

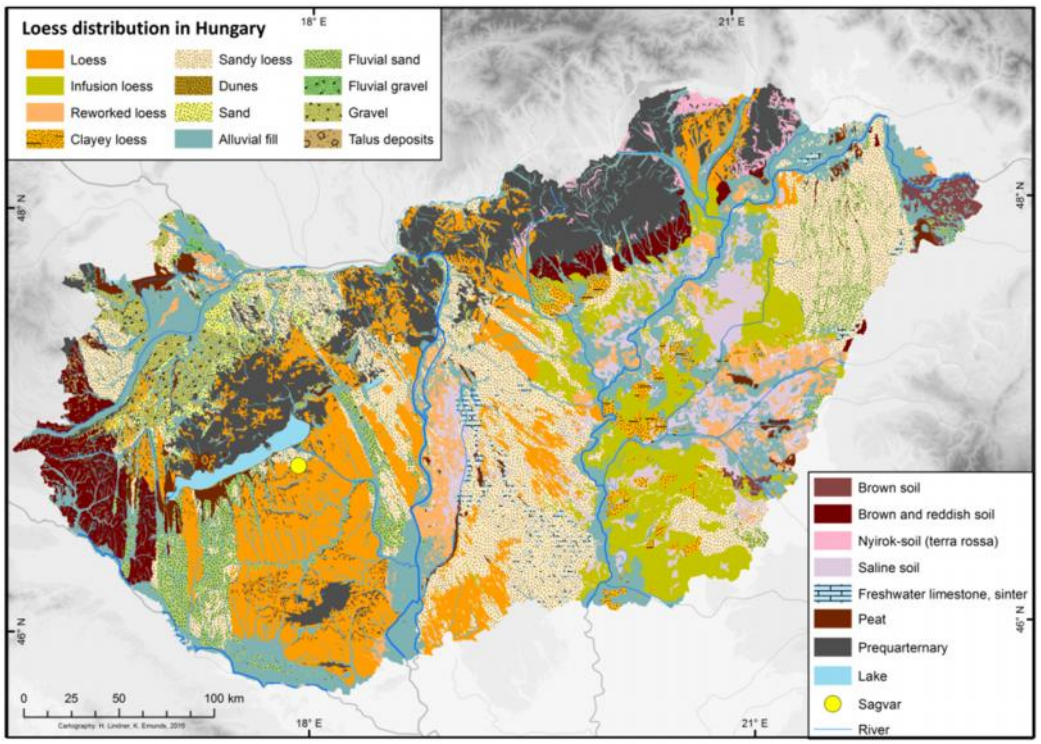

Fig. 1 Map shows the loess distribution of Hungary and the location of the investigated section (yellow circle). The map is based on the geological map of Hungary (Péter, 2005).

Firstly, grain size measurements were conducted by using a Laser Diffraction Particle Size Analyzer (Beckman Coulter LS 13 320 PIDS). For the calculation of the grain size distribution the Mie theory was used. Median grain sizes show no clear pattern, and vary around 51µm

for both profiles. Fine grains <5μm contribute ~11% in the first profile and 12-18% in the second profile. Coarse grains >200μm contribute less than 0.5% in both profiles.

Secondly, geochemical composition was determined by X-ray fluorescence. At the first profile carbonate contents vary around 19%, silica oxides contribute with 55%. The second profile shows greater variations throughout the profile: stronger carbonate concentrations are found in the upper part of the profile (20%), where the silicate content is weakest (54%). The lower part exhibits carbonate contents of 16%, and silicate contents of ~58%. Iron concentrations show a similar trend as the fine grain size fraction <5μm.

Thirdly, frequency dependent magnetic susceptibility (χfd) measurements were carried out. They show a background magnetic susceptibility of ca. 30*10-8 m^3/kg (Ságvár I) and 25 *10-8 m^3/kg (Ságvár II). The magnetic susceptibility is clearly enhanced in the cultural layer sampled in the first profile. At Ságvár II the magnetic susceptibility shows a semi-sinusoidal pattern with maxima at ~ 60 and 190 cm, and minima around 110 and 220 cm.

Finally, preliminary luminescence data is presented. Polymineral fine grains (4-11μm) of four samples were measured with the pIRIR290 protocol (cf. Thiel et al., 2011); dose rates were calculated by means of radionuclide concentrations, conversion and attenuation factors (Liritzis et al., 2013; Guerin et al., 2012; Huntley and Baril, 1997; Bell, 1980), an assumed water content of 10±5%, and the cosmic dose rate (after Prescott and Hutton, 1994). Prior to the measurement of the equivalent dose, dose recovery and preheat plateau tests were performed. Dose recovery ratios, preheat plateaus, recycling ratios, negligible recuperation, and low residuals underline the good behavior of the samples. The samples were dated to 21.5±1.7 ka, 22.6±1.8 ka, 23.8±1.9 ka, and 24±1.9 ka. The narrow time range of the ages might explain the low variability within the other proxies investigated. Ages are in agreement with previously published 14C data (Lengyel, 2008-2009).

References

Bell, W.T., 1980. Alpha attenuation in Quartz grains for thermoluminescence Dating. Ancient TL 12, 4-8.

Guerin, G., Mercier, N., Nathan, R., Adamiec, C., Lefrais, Y., 2012. On the use of the infinite matrix assumption and associated concepts: a critical review. Radiation Measurements, 47, 778-785.

Huntley, D.J., Baril, M.R., 1997. The K content of the K-feldspars being measured in optical dating or in thermoluminescence dating. Ancient TL 15, 11-13.

Lengyel, György (2008-2009): Radiocarbon dates of the "Gravettian Entity" in Hungary. In: PREAEHISTORIA vol. 9-10 (2008-2009), Ed. Ringer, A., ARCHAEOLINGA Foundation, Budapest.

Liritzis, I., Stamoulis, K., Papachristodoulou, C., Ioannides, K., 2013. A re-evaluation of radiation dose-rate conversion factors. Mediterranean Archaeology and Archaeometry 13, 1-15.

Péter, Scharek (2005). Magyar Állami Földani Intézet, Felelós kladó: Brezsnyánzky Károly Igazgató, 1:100,000.

Prescott, J.R. and Hutton, J.T., 1994. Cosmic ray contributions to dose rates for luminescence and ESR dating: Large depths and long-term time variations. Radiation Measurements, 23, 497-500.

Thiel, C., Buylaert, J.-P., Murray, A.S., Terhorst, B., Hofer, B., Tsukamoto, S., Frechen, M., 2011. Luminescence dating of the Stratzing loess profile (Austria) –Testing the potential of an elevated temperature post-IR IRSL protocol. Quaternary International, 234, 23-31.

PMIP4 simulations: what is new?

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The Paleoclimate Modeling Intercomparison Project (PMIP) enters its fourth phase. Five PMIP periods have been retained for tier one simulations as part of CMIP6 (coupled model intercomparison project, phase 6): the last millennium, the mid-Holocene (6ka BP), the Last Glacial maximum (21ka BP), the Last Interglacial (127ka BP) and the Pliocene (3 Ma BP). The talk will review the rationale behind these simulations and highlight what would be needed from the paleoclimate community to fully benefit from this huge simulation effort. The discussion will also discuss how this suite of PMIP4CMIP6 experiments is connected to several other periods and sensitivity experiments as part of PMIP. I propose to illustrate some of the new challenges that can now be tackled to improve the understanding of the rate of climate change, major feedbacks and the interplay between climate trends and climate variability

Fungi in perennial cave ice

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Screening of 1000-years old ice layers from the perennial ice block in Gheţarul de la Scărişoara Cave (Romania) revealed the presence of a diverse fungal community. The ice layers were deposited annually by freezing of percolating water containing debris from the surface. Using molecular techniques, based on DGGE fingerprinting of 18S rRNA gene fragments and sequencing, we detected fungi in presently-forming (*i.e.*, 1-year old) and in 400 and 900 years old ice layers, respectively. The fungal community profiles in enriched cultures were relatively different compared to those derived from the corresponding environmental ice samples. The community profiles of fungi cultivated at 15°C were more complex compared to the DGGE profiles of fungi cultivated at 4°C. The fungal community was dominated by sequences belonging to the cryophilic yeast *Mrakia stokesii* in all ice samples. Another cryophilic fungus, *Mrakia gelida*, was only identified in recent ice samples. Sequences of more ubiquitous fungi *Aureobasidium pullulans*, *Teberdinia hygrophila*, *Hyphoderma praetermissum*, *Leucosporidium yakuticum*, *Candida* sp., *Cercomonas* sp., *Thelebolus* sp., alongside several yet uncultured fungi, were also identified.

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Coring and chronology of Mohoș peat bog, East Carpathians

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This work focuses on building a high-resolution age-depth model for quantitative paleoclimate study from the Mohos peat bog, East Carpathians. Peats are important archives for Quaternary science, because they preserve environmental changes. To study the chronology of peat profiles the key is in the precise coring and reliable dating. However, many studies dealing with coring and radiocarbon dating of peat deposits they often shown problems with the proper methods and material.

With our novel coring technique we reached undisturbed and uncompressed peat cores from the Mohos bog. A 10 meter deep peat profile was drilled in 2012 using a modified technique of a piston corer. The core presents a continuous peat profile from the last 11.500 cal. yr BP.

After subsampling ash content and loss-on-ignition (LOI) were measured. The chronology was based on AMS radiocarbon analyses of the separated *Sphagnum* samples from different depths of the profile. The peat samples were wet sieved (280-40 μm) to avoid contamination by rootlets and mud. Dry *Sphagnum* samples for AMS dating were prepared using the classical acid-base-acid (ABA) method completed with an oxidative bleaching step to get clean cellulose. *Sphagnum* cellulose samples were converted to CO2 and later graphite and measured by EnvironMICADAS accelerator mass spectrometry (AMS) in Hertelendi Laboratory (Debrecen, Hungary). The age-depth model was obtained with the use of BACON software.

Fine peat accumulation rate changes (sections with lowest accumulation values) were observed along the profile. Ash content is between 0.02 and 8 %. Based on the chronology in further studies we want to focus special intervals to investigate environmental changes in the Holocene.

Enhanced cooperation among climate and paleoclimate communities with specific opportunities for the Pannonian Basin

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International cooperation among acronym organizations, in this case WCRP and PAGES, often exists more easily in paper agreements than in practical reality. Fortunately, reality offers several opportunities. In the realm of climate modeling, the paleoclimate community has developed the Paleoclimate Modeling Intercomparison Project (PMIP) as a valued and endorsed component of CMIP6 - the sixth phase of WCRP's Coupled Model Intercomparison Project (Eyring et al. 2015). PMIP represents a mutual effort to analyze climate system response to forcings and major feedbacks for past climates outside the range of recent variability and to thereby better assess the credibility of current climate models. A second opportunity for collaboration emerges from the refined WCRP Grand Challenge on 'Water Availability for the Bread Baskets of the World'. This Grand Challenge addresses the changing water availability due to climatic change in major food producing regions of the world, including, as first example, the Pannonian Basin of central Europe. Water availability in this context relates to both availability for humans and their agricultural and consumption needs, as well as the ecological environment and its needs. The challenge lies in understanding, quantifying and predicting present and future water resources from the mountainous periphery to the central agricultural zones. I suggest that paleoclimate records of precipitation, developed from local proxies, would add a very positive and informative historical context to the study. I hope to stimulate additional ideas and collaborative activities.

Landscape transformations and archaeological settlements in the Upper Danube Delta during Early to Middle Holocene: a palaeoecological insight

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The recents discovery of Chalcolithic sites in the upper Danube Delta at Taraschina – Mila 23 and Dâmbul localities (Romania) attest that this area was inhabited at least 6500 years ago. Here we propose a multidisciplinary approach to highlight the relationship between human activities and palaeogeographic transformations of the Danube Delta and its connexion with North Black Sea during Early to Middle Holocene.

In order to provide evidence for palaeoenvironmental changes and landscape evolution of this area, sedimentological analysis, geochemical (XRF) analyses and Magnetic Susceptibility have been carried out. More than 200 cumulated core length have been retrieved on the archaeological sites and surrounding wetlands. Palaeoecological (ie. pollen and phytolith) analyses have been also performed on selected cores. Pollen data are rare within de Danube Delta because of poor pollen preservation in the Delta sequences. However, since the Bronze Age, pollen results record a mixed deciduous forest dominated by *Quercus, Fagus, Carpinus, Tilia*. Poaceae pollen dominates, suggesting the presence of a large reed formation. Phytoliths are very abundant and exceptionally well preserved in the archaeological sequences, as well as in the sequences extracted around the site. Palaeoecological data revealed past vegetation dynamics of this area, while phytolith results agree with archaeological data, underlying the human presence and environmental change since Chalcolithic. The phytolith assemblages from Taraschina tend to demonstrate that Chalcolithic populations were able to grow cereal in this area. The analysis of the upper parts of cores reveals a gradual decline of the phytoliths characterizing cereal processing. Concurrently, the markers of aquatic environment, such as sponge spicules and diatoms, display an important increase, related to local hydrological variations. So, allows to document significant environmental changes in the Taraschina area, related to both anthropic and hydro-geomorphologic origins. From these data, we suggest a rapid adaptation of the Chalcolithic societies to environmental changes.

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Millennial-scale changes in temperature during Termination 1: a case study from the western South Atlantic and the adjacent continent

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During Termination 1, millennial-scale weakening events of the Atlantic meridional overturning circulation (AMOC) supposedly produced major changes in sea surface temperatures (SSTs) of the western South Atlantic, and in mean air temperatures (MATs) over southeastern South America. It has been suggested, for instance, that the Brazil Current (BC) would strengthen (weaken) and the North Brazil Current (NBC) would weaken (strengthen) during slowdown (speed-up) events of the AMOC. This antiphase pattern was claimed to be a necessary response to the decreased North Atlantic heat piracy during periods of weak AMOC. However, the thermal evolution of the western South Atlantic and the adjacent continent is so far largely unknown. Here we address this issue, presenting high-temporal-resolution SST and MAT records from the BC and southeastern South America, respectively. While our SST record is based on Mg/Ca analyses performed on shallow-dwelling planktonic foraminifera, our MAT record is based on continentally derived lipid analyses. Our SST record from the BC in the western South Atlantic shows a marked positive anomaly during HS1. This is the first record that corroborates model suggestions that the surface layer of the BC acted as an important conduit and storage volume for part of the heat not transported to the North Atlantic under a sluggish AMOC. Thus, the BC was of paramount importance in propagating southwards the thermal bipolar seesaw signal of HS1. We note an in-phase behavior with an existing SST record from the NBC, contradicting previous assumptions of a BC–NBC anti-phase. Additionally, a similar SST evolution is shown by a southernmost eastern South Atlantic record, suggesting a South Atlantic-wide pattern in SST evolution during most of Termination 1. Over southeastern South America, our MAT record shows a two-step increase during Termination 1, synchronous with atmospheric CO_2 rise (i.e., during the second half of HS1 and during the Younger Dryas), and lagging abrupt SST changes by several thousand years. This delay corroborates the notion that the long duration of HS1 was fundamental in driving the Earth out of the last glacial.

Interactions between humans and environment in Middle Holocene: comparative study of two Chalcolithic sites to the East of Carpathians

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Archaeobotanical, archaeozoological and archaeological studies carried out in Chalcolithic sites to the East of Carpathians (i.g. Poduri-*Dealul Ghindaru*, and Hoiseşti), contributed to reconstruct the environmental context of the settlements, and to evidence diverse human activities in the area.

The Chalcolithic site of Poduri-*Dealul Ghindaru*, located in eastern Romania, in Subcarpathians (Bacău County), has levels belonging to Cucuteni Chalcolithic culture (approx. 4800-3600 cal. BC). During the excavation campaigns, large quantities of artefacts (pottery, grindstones, cereal remains, animal remains, etc.) have been discovered. Archaeobotanical researches emphasized a productive environment, with sustenance strategies based on cereals cultivation – especially wheat and barley. Palynological analysis testified the presence of cereals pollen (*Triticum*-type and *Hordeum*-type). Macro-remains of some other cultivated and spontaneous plants (e.g. *Pisum sativum*, *Coriandrum sativum*, *Rumex acetosella*, *Prunus domestica*) have been identified in archaeological sediments. The majority of animal remains are from domestic mammals, with the predominance of cattle (*Bos taurus*), sheep (*Ovis aries*) / goat (*Capra hircus*), and pig (*Sus domesticus*). Hunting of wild mammals was quite important in the settlement economy, and as game species, red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*) were dominant.

Hoiseşti site (Iaşi County) is located in NE Romania, within the Moldavian Plain, to the left of the lower course of the Bahlui River. The settlement belongs to Cucuteni culture (4350/4325-4050 B.C.). Pollen analysis highlights the salinity of the soils from this area (very high percentage of Chenopodiaceae pollen). Cereal pollen is absent but the presence of certain ruderal taxa indicates an anthropic context. Pollen of deciduous trees taxa (e.g. *Quercus*, *Tilia*), is present suggesting the proximity of the forest. Archaeozoological data show the animal husbandry was an important occupation; the pig remains (*Sus domesticus*) are dominant, while cattle (*Bos taurus*) and sheep/goat (*Ovis aries/Capra hircus*) come on the second place.

The main results converge to conclude that these two Chalcolithic settlements are different in terms of human activities and influences on environment. Agricultural activities (cereals cultivation and animal husbandry) were an important component of settlement economy at Poduri-*Dealul Ghindaru*. Chalcolithic settlement from Hoiseşti most probably was situated in a forested, humid and fragmented area, with alkaline soil, inappropriate for cereal cultivation. The wild resources constitute a significant part of the diet, so we consider the Chalcolithic community from Hoiseşti as a group of small-scale agriculturalists.

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Using testate amoebae to infer Holocene palaeohydrological history in the Northern Carpathians, Romania

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Keywords: palaeohydrology, testate amoebae, radiocarbon dating, peat, Holocene, Romania

As natural and anthropogenic ecosystems are entirely dependent on the local water availability, understanding past changes in hydro-climate is a priority in research concerning past climate variability. For this purpose, ombrotrophic bogs are most suitable for hydro-climate reconstructions as they are entirely dependent on water from precipitations.

We used radiocarbon dating, testate amoebae (TA) and pollen analysis of a peat profile extracted from an ombrotrophic bog (Tăul Muced) located in the Rodna National Park, Romania, to identify major changes in the wet-dry ecological gradient over the last 8000 years. We performed a quantitative reconstruction of the local depth to water table (DWT) and pH variation using the transfer function developed on a Polish modern testate amoebae data set and compared our reconstruction with other palaeohydrological studies in this region. The pollen record was used to determine regional vegetation dynamics as well as the potential impact of humans on peatland dynamics.

Based on the changes in TA assemblages over tine we identified six main wet-dry stages in the mire surface conditions. Wet mire surface conditions with a pH between 2 and 4.5 were recorded between 4600-2750 and 1300-400 cal. yr BP by the occurrence of *Archerella flavum*, *Amphitrema wrightianum* and *Hyalosphenia papilio*. Dry mire surface conditions and pH between 2.5 and 5 were inferred by the dominance of *Nebela militaris*, *Difflugia pulex* and *Phryganella acropodia* between 7550-4600, 2750-1300 and 0-50 cal. yr BP. In the period between 400 and -50 cal. yr BP, the surface of the bog is characterized by a rapid shift from dry to wet conditions. The surrounding landscapes were forested (primary *Picea abies)* throughout the entire period. A distinct decline in the forest extent, in particular of *P. abies* started at 1000 cal yr. BP and intensified over the past 100 years, coinciding to an increase in pollen types associated with human impact. This suggests that at least until 100 years ago, human activities likely have not significantly affected the water table of this bog.

Our reconstruction, one of the few in the CE Europe, shows contrasting conditions to others records from NW Europe. However, it remains in relatively good agreement with palaeohydrological studies from the Central Eastern Europe. One of the most important aspects of our study is that it provides valuable information on changes in local hydrology. These puts an accent on the need of spanning TA based hydro-climate studies to a larger scale and to determine whether a regional modern data set for transfer function isn't more suited for our local climate reconstructions.

A MIS 5e high-altitude speleothem $\delta^{13}C$-$\delta^{18}O$ record from the Romanian Carpathians

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We present here a speleothem $\delta^{13}C$-$\delta^{18}O$ record from the Last Interglacial period that was retrieved from a small cave in the Făgăraş Mountains (2435 m asl). Current monitoring work shows that the average temperature inside the cave is ~3°C. Stalagmite M3-R2/1 is only 5 cm long and its growth model was calculated using six U-Th ages. According to this, the stalagmite formed between 125.5 (±1.3) and 123 (±1.3) ka, during the warmest stage of the Last Interglacial.

The $\delta^{18}O$ values show low variability in the first ~400 years of growth, followed by a series of rapid fluctuations with relatively higher amplitude. Overall, the values of the whole record show no trend and have an average of -8.4‰.

The $\delta^{13}C$ values, too, show low variability during the first ~400 years and a weak trend towards lighter values, from -7.8‰ to -8.4‰. After 125 ka there is a tendency towards more pronounced short-term fluctuations of up to 2.2‰ on a trend towards heavier values (from -8.4‰ to -6.0‰). Between 123.4 and 123.0 ka, one can identify three well-defined centennial-scale cycles with a period of ~150 years.

Drip water $\delta^{18}O$ seems to indicate that the stalagmite oxygen values are reflecting infiltration characteristics of the warm season, allowing us to obtain information about its length during the height of MIS 5e.

PAGES 2k - Overview of recent products and progress

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The goals of the PAGES 2k project include placing recent global change within the context of the past 2000 years (the 2k interval), and identifying the processes most likely to explain those observations. The 2k project is organized into 9 regional working groups and several transregional initiatives. We encourage an inclusive, international, community-driven, interdisciplinary and open source approach driven by workshops, searchable public metadatabases, virtual collaborations and peer reviewed publications. In this contribution, I will review products from Phase 1 (2006-2015) and progress in Phase 2 (2015-2016), including development of temperature, stable isotope and hydroclimate-relevant observational metadatabases; continental-scale surface temperature and regional and global scale sea surface temperature reconstructions and syntheses; comparison of observed and simulated temperatures; and assessment of the timing of the onset of industrial warming. More information is at: http://www.pages-igbp.org/ini/wg/2k-network/intro.

8.2 ka event and others cold climate oscillations in middle Holocene – evidence from Suchar Wielki Lake, NE Poland

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The best-known climate change in the middle part of the Holocene is an abrupt cooling around 8200 cal. yrs BP (e.g. O'Brien et al., 1995; Bond et al., 1997). This oscillation, known as the 8.2 ka event, was recognised in all most important past climate records, i.e. in the Greenland ice cores (GRIP and GRIP2) and in North Atlantic deep sea cores (O'Brien et al., 1995; Bond et al., 1997), and then it was demonstrated in many records in the world.

Fig. 1 Location of sites mentioned in the text: 1 – Conney Lough, Lake NCY1, Ireland (Ghilardi and O'Conell, 2013); 2 – Bog Brunnboden and Krummgampen, Austria (Kofler et al., 2005); 3 – Lake Preluca Tiganului, Romania (Feurdean et al., 2008); 4 – Lake Steregoiu, Romania (Feurdean et al., 2008); 5 – Bog from Ic Ponor, Romania (Grindean et al., 2015); 6 – Lake Suchar Wielki, Poland (Fiłoc et al., 2016).

However, on the European continent, many different records suggest that during climatic optimum of the Holocene not one, but several cold periods occurred between 9200 and 5800

cal. yrs BP. In Scandinavia, this is indicated, among others, by a 5 glacier advances (Nesje, 2009). Moreover, in several European profiles the vegetation changes are registered for this period. From 3-5 cold climate oscillations were recorded in profiles of Ireland (Ghilardi and O'Conell, 2013), Austria (Kofler et al., 2005) and Romania (Feurdean et al., 2008; Grindean et al., 2015) (Fig. 1). These oscillations were expressed usually as changes in shares and concentration of pollen of thermophilic taxa. The fluctuations in cited records were observed in areas particularly vulnerable to climate change. From this it follows that choice of research area is very important in studies on climate changes.

Good example of this is our research, where study area is located in the transition zone between oceanic and continental climate in north-eastern Poland. It is the best place to study influence of climate changes, because the natural environment is particularly sensitive to climate changes and very quickly responds to them. Therefore, on this area, thermophilous tree species occur at their ecological tolerance limit so that their abundance, regeneration, and pollen production are constrained by climate.

Our multi-proxy data (pollen, diatoms, Cladocera, ^{14}C) from the sediments of Lake Suchar Wielki (8.9 ha, 9.6 m max depth, 54°01'41" N, 23°03'21" E) representing the period ca. 9200-5800 cal. BP have allowed the reconstruction of the influence of five Atlantic cold oscillations on terrestrial and aquatic environments, including the 8.2 ka event. These events were registered as a temporal increase in *Pinus* and/or *Betula* representation and transient decrease in *Corylus* proportion – concentration and pollen percentage values. Pollen data were mostly confirmed by results of Cladocera and diatom analyses, suggesting different intensity of theses climate oscillations. The most pronounced cold climatic anomaly in our study was dated to 8600-7900 ka and lasted about 7 centuries. It is equated with the 8.2 ka event (Bond et al., 1997). Such a long duration of this oscillation is recorded quite rare in the literature. However, the climate proxy records of this oscillation in Europe and the world confirm that the duration of this event in different regions amounted from 400 to 600 years (Rohling and Pälike 2005), This allows for very accurate tracing changes in vegetation and aquatic communities at this time precisely showing the heterogeneous nature of this cooling.

References

Bond, G., Showers, W., Cheseby, M., Lotti, R., Almasi, P., de Menocal, P., Priore, P., Cullen, H., Hajdas, I., Bonani, G.,1997. A pervasive millenial-scale cycle in North Atlantic Holocene and glacial climates. Science 278, 1257–1266.

Feurdean, A., Klotz, S., Mosbrugger, V., Wohlfarth, B., 2008. Pollen-based quantitative reconstructions of Holocene climate variability in NW Romania. Paleogeography, Paleoclimatology, Paleoecology 260, 494–504.

Fiłoc, M., Kupryjanowicz, M., Rzodkiewicz, M., Suchora, M., 2016. (Accepted Manuscript) Response of terrestrial and lake environments in NE Poland to Preboreal cold oscillations (PBO). http://dx.doi.org/10.1016/j.quaint.2016.02.052.

Ghilardi, B., O'Conell, M., 2013. Early Holocene vegetation and climate dynamics with particular reference to the 8.2 ka event: pollen and macrofossil evidence from a small lake in western Ireland. Vegetation History and Archaeobotany 22, 99–113.

Grindean, R., Feurdean, A., Hurdu, B., Fărcaş, S., Tanţău, I., 2015. Lateglacial/Holocene transition to mid-Holocene: Vegetation responses to climate changes in the Apuseni Mountains (NW Romania). Quaternary International 388, 76–86.

Nesje, A., 2009. Latest Pleistocene and Holocene alpine glacier fluctuations in Scandinavia. Quaternary Science Reviews 28, 2119–2136.

O'Brien, S. R., Mayewski, P. A, Meeker, L. D., Meese, D. A., Twickler, M. S., Whitlow, S. I., 1995. Complexity of Holocene climate as reconstructed from a Greenland ice core. Science 270, 1962–1964.

Rohling, E.J., Pälike, H., 2005. Centennial-scale climate cooling with a sudden cold around 8200 years ago. Nature 434, 975-979.

Palaeoecological assessment of prehistoric and historic human impact in the high elevation areas of the Northern Carpathians, Romania

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The Carpathian Mountains of northern Romania are classed as outstanding ecosystems for their species endemism and habitat diversity (UNEP, 2007). However, despite their protected status, these mountains are presently threatened by both direct human impacts and climate warming affecting medium to long-term ecosystem stability and the resilience of natural habitats (Pauli et al., 2012). Such threats are likely to result in a dramatic loss of biodiversity and habitat change (Knorn et al., 2012).

This paper presents a high resolution, multi-proxy palaeoenvironmental reconstruction (pollen, dung fungal spores, micro and macro-charcoal, mineral magnetic properties and geochemistry) in three sedimentary sequences located at different elevations across the Northern Carpathians (Romania) over the Late Holocene (i.e. the last 4000 years). We aim to: i) determine what aspects of prehistoric and historic human activity (e.g. burning, clearing, grazing) have shaped the landscapes of today, and ii) use this information to facilitate their environmental management and conservation strategies to maintain the ecological and economic sustainability of extant habitats in the currently changing environment.

Our preliminary results suggest that the most impacted landscapes were located above 1600 m a.s.l. As such, vegetation above the timberline (the limit of the closed forest) appears to have undergone the most marked structural and compositional changes, characterised by: i) increases in landscape openness after ca. 3000 cal yr BP, and particularly over the last two centuries; ii) increasing human disturbance after 3000 cal yr BP, with two significant episodes between 2100 and 1000 cal yr BP, and over the last two centuries. Conversely, the conifer belt underwent prominent disturbances only during the last 1200 years. Our results further suggest that humans have actively contributed to the lowering of the timberline and treeline. On the other hand, low-intensity land-use practices on mountain pastures appear to be beneficial for mountain grasslands resulting in the formation of rich mountain grassland communities.

Fire was identified as a significant driver of vegetation change particularly above timberline, mainly due to its use as a tool to enlarge and maintain subalpine grassland areas used for grazing. Increased anthropogenic pressure is reflected in a series of erosion increases around ca. 1400-900 cal yr BP and over the last two centuries.

Our reconstruction offers a greater understanding of the legacy of land use management for vegetation and habitat change and helps to improve our predictive capacity of future environmental changes in the Carpathian Mountains. We found that fire activity was connected with landscape openness and grassland extent, and possibly contributed to the formation of rich subalpine grasslands in these sensitive, marginal environments. Based on our findings, we suggest that an effective strategy to maintain grassland openness and likely diversity is to promote moderate intensity grazing and burning.

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References

Knorn, J., Kuemmerle, T., Radeloff, V. C., Szabo, A., Mindrescu, M., Keeton, W. S., ... & Hostert, P. (2012). Forest restitution and protected area effectiveness in post-socialist Romania. Biological Conservation, 146(1), 204-212.

Pauli, H., Gottfried, M., Dullinger, S., Abdaladze, O., Akhalkatsi, M., Alonso, J. L. B., ... & Grabherr, G. (2012). Recent plant diversity changes on Europe's mountain summits. Science, 336 (6079), 353-355.

UNEP, 2007. Annual Report. United Nations Environment Programme, http://www.unep.org/PDF/AnnualReport/2007/AnnualReport2007_en_web.pdf, accessed 27.02.2016

Fire as a driver of ecosystem dynamics in Central and Eastern Europe throughout the Lateglacial and Holocene

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Fire drives significant changes in ecosystem structure, diversity and function, and affects species evolution and biomass dynamics. To understand the ecology of terrestrial ecosystems it is crucial to understand the role of fire in the earth system. Through fire, humans have also greatly impacted on global land cover and climate for millennia and significantly altered wildfire dynamics (frequency and severity). Fire activity has increased over recent decades in many parts of the world and it is anticipated to intensify in a future warmer and drier climate and abundant biomass accumulation.

Sedimentary microscopic charcoal (particles smaller than 150 microns) has been used to describe multi-decadal to millennial scale biomass burning at regional scales, whereas macroscopic charcoal (particles larger than 150 microns) analysis is increasingly used to investigate past biomass burning at a local scale. Typically, previous studies of fire activity have focused on single microscopic charcoal records with a poorly defined source area. With the creation of the Global Charcoal Database (GCD thereafter) and the continually increasing number of charcoal records (mainly micro-charcoal), several regional, continental, and global syntheses of trends in biomass burning and associated drivers of change have become possible. These studies have highlighted that the distribution of charcoal records is relatively sparse and that filling the gaps is urgently needed to better understand the spatial complexity of patterns and processes responsible for trends in fire regime (Marlon et al., 2015). Central Eastern Europe is among the regions sparsely covered in terms of charcoal records.

We seek to contribute to the closing of this gap by collecting and unifying published medium to high-resolution micro and macro-charcoal records from CE Europe spanning the Lateglacial throughout the Holocene, thereby providing the palaeo-community with a comprehensive synthesis. These charcoal records will be evaluated in combination with other proxy-based and modelled data sets of past climate, vegetation, land cover and land use, and will facilitate a critical examination of various hypotheses regarding patterns, drivers and consequences of biomass burning over multiple spatial and temporal scales.

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References

Marlon, J.R., Kelly, R., Daniau, A.L., Vannière, B., Power, M.J., Bartlein, P., Higuera, P., Blarquez, O., Brewer, S., Brücher, T. and Feurdean, A., 2015. Reconstructions of biomass burning from sediment charcoal records to improve data-model comparisons. Biogeosciences Discussions, 12(22), pp.18571-18623.

Bat guano $\delta^{13}C$ and $\delta^{15}N$ values as climate proxy

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Geochemical studies of cave guano using stable isotopes can provide paleoecological and paleoclimate (mainly precipitation) records. Cave guano $\delta^{13}C$ values reflect the dietary preferences of bats that are largely controlled by local vegetation dynamics, which in turn depend on local climatic conditions.

The aim of the present study is to demonstrate the usefulness of stable carbon and nitrogen isotopes in bat guano as proxies for paleoclimate changes. We show a 2500-year record of environmental change in Romania using $\delta^{13}C$, $\delta^{15}N$, and (C:N) derived from precisely ^{14}C-dated bat guano cores recovered from Gaura cu Musca (GM), Zidită (ZC), and Magurici (MC) caves.

$\delta^{13}C$ values in guano at the Medieval Warm Period (MWP) - Little Ice Age (LIA) transition changed markedly only in the GM record. In the other two caves the carbon isotopic values indicate a steady onset of LIA at around AD 1200 but without significant climatic changes before ~ AD 1450 and abruptly ending between ca. AD1870 and 1900. The beginning of the 20th century is characterized by an average of $\delta^{13}C$ value of –25.2‰ up to ca. AD 1965 (which indicate a moderate change toward warmer period). More rapid changes in $\delta^{13}C$ values are recorded after AD 1970. These rapid changes by 0.5 to 1.5‰ were recorded within a few years. In this general picture, these indicate swings between several cold and warm events.

$\delta^{15}N$ values of guano can be utilized as an integrator of past states of the local nitrogen cycle. A $\delta^{15}N$ record from a 1.5-m core of bat guano deposit from Zidită Cave provides a record of climatic and anthropogenic influence on the regional nitrogen pool. The $\delta^{15}N$ values of guano has decreased from 12.5‰ to 7‰ since AD 1950, suggesting the N-cycle has been trending towards a more conservative state in response to lower water availability.

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Rock glacier lakes – a distinct lake subtype: a case study at Hridsko Jezero, (Bogičevica Mountain, Montenegro)

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This article presents a new concept on the genesis of a distinct subtype of glacial lakes. Hridsko jezero is one of the few lakes in the mountain Bogićevica in southeast Montenegro (part of Prokletije massif, along the borders with Kosovo and Albania). Situated at 1970 m a.s.l., the lake is suggested to fill depressions of a giant relict rock glacier, developed on the NW slopes of the peaks Hridski krš (2358 m a.s.l.) and Bogićevički krš (2374 m a.s.l.). Such a theory should be accepted as a reconsideration of the older views on lake's origin, which postulated that this was a glacial lake in a staircase cirque, formed after a several stadium retreat of Wurmian glaciers on Prokletije. Only very few lakes of such genesis exist in the mountains of the Balkan Peninsula. The article discusses on the main stages of rock glacier lake formation.

Late Pleistocene vegetational history and ecosystem variability in the karst areas of Ukraine, based on palaeontological studies of cave deposits

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Biotic response to Late Pleistocene climate changes has been studied in four sections of clastic cave deposits in two areas of Ukraine: in the western Podillya-Bukovynian gypsum karst region and the southern Mountain-Crimean carbonate karst region (Fig.1). New data have been obtained in the Bukovynka and Emine-Bair-Khosar caves, previously studied (Vremir et al., 2000, 2005; Ridush, 2009, 2014; Ridush et al., 2013; Gerasimenko et al., 2010, 2014, 2015), whereas deposits at the Kryshtaleva and Tovtry caves are studied palynologically for the first time. A lithological study, including grain-size analysis, has been also applied at all sites, and its palaeoenvironmental interpretations correspond well to those derived from pollen and palaeofaunal data.

The oldest deposits represent the Last Interglacial, as evidenced from the pollen succession and pollen percentages of broadleaf taxa that exceed those of the present. Telocratic and mesocratic phases of an interglacial (Quercetum mixtum and Carpinetum, respectively) are clearly expressed. In both areas, a special characteristic of the vegetation is the occurrence of *Fagus*, whereas in the western area (the Tovtry Cave), it is also the abundance in Ericaceae, and the admixture of *Picea* and *Pinus cembra* at the beginning of the interglacial. In the mountain meadow-steppe of Crimea, petrophytic vegetation included *Scorzonera* and *Ephedra,* whose abundance increased strongly during the Last Glacial. In the interglacial cave deposits, bones of *Cervus elaphus* dominate in Crimea, though remains of open-area animals (*Bison priscus, Bos primigenius* etc) also occur, whereas bones of forest dormice (*Dryomys nitendula*) are found in the western Tovtry Cave.

In deposits of all the caves, alternation of the Last Glacial interstadials and stadials is clearly marked,respectively, by the appearance and disappearance of pollen of broadleaf trees. Their refugia evidently existed on the Crimean mountain slopes and in the canyon-like valleys of the River Dniester and its tributaries. Pollen of broadleaf trees are also found in coprolites of troglophile carnivores. During the interstadials of the Early Glacial and in the interval between 48,500±2,000 and >42,000±1,200 BP, the western karst area was covered by mixed forest, whereas only patches of woods existed at the edge of the mountain meadow-steppe in Crimea. Polypodiaceae ferns grew extensively here. During the later interstadials (around 41,300±1,300/1,100 and between 33,100±400 and 27,700±250 BP), the extent of arboreal vegetation was much smaller in both areas (forest-steppe in the west and mesophytic steppe in the upper part of the Crimean Mountains). In the west, during the interstadial of 41,000 BP, there lived both steppe (*Equus ferus latipes, Bison priscus, Megalocerus giganteus)* and forest *(Sus scrofa, Vulpes vulpes)* large mammals, as well as cave inhabitans (*Crocuta spelaea, Ursus ingressus*). During the Early Glacial and Middle Pleniglacial stadials, tundra-forest-steppe (with an abundance of arcto-boreal forms of club-mosses and *Botrychium boreale*) existed in the west, whereas Poaceae-Cyperaceae associations and extensive patches of *Ephedra* formed the highest vegetation belt of the Crimean Mountains. There, during the

Middle Pleniglacial, the forest animals were *Cervus elaphus, Felis sylvestris, Martes sp., Sicista cf. betulina* and *Apodemus sylvaticus*, whereas the steppe animals included *Equus ferus latipes, Equus hidruntinus*, *Bison priscus, Bos primigenius, Saiga tatarica, Vulpes corsac*, *Mustella eversmanii*, *Marmota bobac*, *Microtus arvalis*, *Spermophilus sp.*, and inhabitans of periglacial landscapes: *Mammuthus primigenius, Coelodonta antiquitatis, Alopex,* and *Microtus oeconomus.* Optimal phases of spread of broadleaf vegetation during the Last Interglacial and the interstadials were characterized by the accumulation of clay particles in the clastic cave deposits, whereas the stadial deposit are marked by an increase in large silt particles.

The Late Pleniglacial deposits are represented only in the western karst area (the Kryshtaleva Cave), where they are characterized by the lowest pollen percentages of trees and the highest percentages of cryophytes including *Betula* sect. Nanae et Fruticosae. A treeless periglacial tundra-steppe occupied the area. Poaceae and Cyperaceae prevailed in the vegetation cover, together with arcto-boreal plants (*Lycopodium dubium, Diphazium alpinum, Botrychium boreale*), though Asteraceae, Lamiaceae and *Ephedra* were also rather significant. Bones of *Rangifer tarandus, Alopex, Dicrostonyx torquatus*, and *Lagopus lagopus* are evidenty related to these (Late Pleniglcail) sediments as they are overlain by dated Late Glacial deposits. Large silt particles in the latter are half those occurring in the Late Pleniglacial sediments. This might indicate frequent dust storms and loess deposition on the surface during the Pleniglacial.

Fig. 1 Site location.

Late Glacial deposits in the caves Kryshtaleva, Bukovynka and Emine-Bair-Khosar have yielded ^{14}C-dates 12,240±70, 12,050±60, 11,890±60, 11,710±60, 10,720±60, 10,490±70 BP. Their common characteristic in both areas is the increase in arboreal pollen, as compared to the Pleniglacial. During the Bölling-Alleröd, boreal trees (particularly pine) dominated on the left bank of the Dniester River valley, whereas on its right bank (closer to the Carpathians), a few broad-leaved trees appeared (*Ulmus* and *Corylus*), as well as in the highest forest belt of the Crimean Mountains (*Acer* and *Fagus*). During the Young Dryas, on the left bank of the Dniester, mesophytic steppe existed and a few cryophytes re-appeared (*Betula* sect. Nanae et Fruticosae), whereas the right bank of the Dniester was occupied by boreal forest-steppe. Meadow-steppe dominated at the high levels of the Crimean Mountains, but a few broadleaf trees continued to grow. The proportion of clay particles in the Young Dryas deposits is less than that in Late Glacial interstadial sediments. At the beginning of the Late Glacial, *Ursus*

arctos appeared in the western area, but *Rangifer tarandus* was still present. In the Crimean Mountains, the diversity of large mammals decreased due the disappearance of the periglacial elements. The forest animals included *Cervus elaphus, Ursus arctos, Felis* sp. and *Apodemus cf. flavicollis*. Steppe species dominated during the Young Dryas: *Saiga tatarica, Bison priscus, Vulpes corsac, Lepus europaeus, Mustella eversmanii, Cricetus cricetus, Microtus arvalis, Eolagurus luteus*, and *Lagurus lagurus*. The faunal assemblage, as well as the pollen data, indicate a drier climate than nowadays.

Thus, this multidisciplinary study in two karst areas proves that clastic cave deposits record the global climatic signal and show regional ecosystem variability.

What can long-term data contribute to the "Land-sharing versus Land Sparing" debate?

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Global environmental challenges can only be addressed by multifaceted approaches that integrate biodiversity conservation with sustainability targets. While only 12% of the land surface is in protected areas, 40% is used for food production; the latter areas are therefore critical in managing environmental change in the Anthropocene. Proponents of land-sparing suggest that food production should be concentrated into as small an area as possible, using intensive methods, thereby freeing up land for biodiversity conservation. Land-sharing suggests that wildlife friendly farming is better for both biodiversity and sustainability. By looking at long-term trends in the management of agricultural systems, we can assess the role of traditionally managed cultural landscapes in biodiversity conservation, and their potential contribution to sustainability and managing global change.

Rock glaciers in the Bulgarian high mountains

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Despite the fact that the term rock glacier was first used in the Bulgarian scientific literature in the middle of the 20-th century these periglacial landforms of the high Bulgarian mountains have long remained unexplored. It was only recently that the results from new studies were published and relict rock glaciers were ascertained and mapped in many parts of the Rila and Pirin mountains.

Rock glaciers are positive landforms representing a body of unsorted, angular debris in the form of a tongue at the valley floor or lobe at the slope base. They have characteristic morphology expressed in the steep slopes and the system of ridges and furrows on their upper surface. Because of their characteristic appearance rock glaciers can be successfully identified and mapped using remotely-sensed imagery. For identification and mapping of the relict rock glaciers in Rila and Pirin Mountains aerial and satellite imagery with very high spatial resolution have been used.

Rock glaciers in Rila Mountain. Back in 1959, M. Glovnya was the first Bulgarian geomorphologist to use the term rock glacier to refer to a small landform north of the Musala peak. However, in his later studies of the periglacial landforms in Rila Mountain this term was not used. Some recent publications have mentioned the existence of rock glaciers without providing details.

In this study 27 rock glaciers are identified and mapped using remote sensing methods and then verified on the field. Based on the observations of their morphology and significant vegetation cover it can be argued with a high confidence that these rock glaciers are exclusively relict forms.

The overall area of the rock glaciers in Rila Mountain is estimated to 153.5 ha. The largest one is situated in the northwestern part of the mountain in the foot of the Mechit peak (2568 m a.s.l). Its length is 865 m and the area is 20.6 ha. The root zone is at 2350 m a.s.l and the front is at 2140 m a.s.l. The highest is the rock glacier situated north of the Musala peak (2925 m a.s.l). Its altitude is between 2600 and 2690 m. In a regional perspective, rock glaciers are distributed rather evenly between the three highest parts of the Rila Mountain. Only in the lowest part – Southwestern Rila there is no rock glaciers.

Rock glaciers in Pirin Mountain. The existence of rock glaciers in Pirin Mountain have only recently been documented even though its altitude and environment are very similar to that of the Rila Mountain. Using the same remote sensing and field verification methods a total of 55 rock glaciers were identified and mapped. Probably all of them are relict too. The total area of the rock glaciers in Pirin Mountain is almost three times greater than that of the rock glaciers in Rila Mountain. The largest rock glacier in the mountain is situated on the western slope, at the foot of Kuklite peak (2686 m a.s.l). The altitude of the rock glacier is between 2180 m and 2350 m a.s.l. Its length is 1100 m and the area is 30.5 ha. In Pirin Mountain there are four rock glaciers with area over 20 ha all of which are greater than the largest Rila Mountain rock glacier. Unlike Rila Mountain, significant part of Northern Pirin Mountain is build of carbonate rocks. There were no rock glaciers identified in this part of the mountain.

It appears that the specific drainage conditions in these karst areas do not favor the formation of rock glaciers.

The debate on the origin of the rock glaciers in Bulgaria is still opened. The fact that they are present only in the two highest Bulgarian mountains where there are undoubted evidence for alpine glaciation during the Pleistocene, but are lacking in Stara Planina, Osogovo and other high mountains, suggests that they might be formed mainly by transformation from ice glaciers to rock glaciers. Most likely, this happened at the beginning of the Holocene. Later on, with the rise of the global temperatures, the interstitial ice melted and they became relict rock glaciers. It is possible also that a few rock glaciers formed in periglacial conditions without interaction with alpine glaciers. It could be assumed that some of the highest located rock glaciers had an active phase during the Little Ice Age.

Are Deltas Human Constructs?

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Productive and biologically diverse, deltaic lowlands attracted humans since prehistory and may have spurred the emergence of the first urban civilizations. Deltas continued to be an important nexus for economic development across the world and are currently home for over half a billion people. But recently, under the double whammy of sea level rise and inland sediment capture behind dams, they have become the most threatened coastal landscape.

Large dams are relatively recent phenomena, but human alteration of landscapes has been ongoing ever since the advent and expansion of agriculture. Combining field data and modeling, I discuss how human activities have significantly influenced the formation of the deltas including the Danube and Ebro deltas in Europe and the Indus, Krishna, and Godavari deltas in Asia and Mississippi in North America. Can rates of growth of these deltas be attributed to climate change, land-use impacts, or both?

Understanding the historic morphologic change in deltas has become increasingly important as sea levels rise and sediment loads feeding deltas continue to be sequestered behind dams in the hinterland. Traditionally deltas have been densely populated while providing disproportionately high ecosystem services and resources to society. In regions that have been affected by humans, deltas can serve as a regional record of climate and land-use changes across large watersheds.

If human activities are in some degree responsible for the development of the world's deltas, this would provide an important context for understanding how humankind will manage these resources over the coming centuries, particularly as climate changes and humans continue to alter these landforms.

Reconstructed and simulated temperature asymmetry between continents in both hemispheres over the last centuries

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Available proxy-based temperature reconstructions covering the past millennium display contrasted evolutions between the continents. The difference is particularly large between the two hemispheres. When driven by realistic natural and anthropogenic forcings, climate models tend to simulate a more spatially homogenous temperature response. This is associated with a relatively good agreement between model results and reconstructions in the Northern Hemisphere but a low consistency in the Southern Hemisphere. Here, simulations with data assimilations are performed to analyse the causes of this apparent disagreement. It shows that, when the uncertainties are taken into account, states of the climate system compatible with the forcing estimates, the reconstructions and the model physics can be obtained over the past millennium, except for the twentieth century in Antarctica where the simulated warming is always much larger than in the reconstructions. Such states consistent with all sources of information can be achieved even if the uncertainties of the reconstructions are underestimated. Although, well within the range of the proxy-based reconstructions, the temperatures obtained after data assimilation display more similar developments between the hemispheres than in those reconstructions. Ensuring the compatibility does not require to systematically reduce the model response to the forcing or to strongly enhance the model internal variability. From those results, there is thus no reason to suspect that the model is strongly biased in one aspect or another. The constraint imposed by the data assimilation is too low to unambiguously identify the origin of each feature displayed in the reconstructions but, as expected, changes in atmospheric circulation likely played a role in many of them. Furthermore, ocean heat uptake and release as well as oceanic heat transport are key elements to understand the delayed response of the Southern Hemisphere compared to the northern one during some transitions from warmer to colder states or from colder to warmer ones. The last millennium is thus an interesting test period to better understand and quantify the associated mechanisms.

Processes and controlling factors of lacustrine sedimentary dynamics over the last ~6000 years in Lake Ighiel, Apuseni Mts, Romania

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Lake sediments act as high-resolution archives of past climate and environments, able to record natural and anthropogenic driven changes, and their effects on the ecosystem. Here we discuss a new lacustrine record from Lake Ighiel (924 m a.s.l.), located in Apuseni Mountains, in an attempt to reconstruct the lacustrine dynamics over the last 6000 years and identify the main processes, which controlled the depositional system during specific phases of lake evolution. Based on ^{210}Pb and ^{14}C dating, X-ray fluorescence scanning (μ-XRF) measurements, long-core sedimentary logging and environmental magnetic proxies (susceptibility, natural and induced remanences) we discuss the following points: *i)* the characteristics of main lacustrine sedimentation phases; *ii)* the amplitude and interplay of processes controlling the depositional environment through time; *iii)* contribution of hydroclimatic forcing in explaining changes in the nature of lacustrine deposition.

The 553 cm long composite profile of lake Ighiel was divided in four main sedimentation phases based on macro- and microscopic description (composition, structure, color), layer thickness and frequency and geochemical behavior of selected elements. The age-depth model revealed that sediments started accumulating in the basin ~6000 years ago. The first phase of lacustrine depositional environment covers the interval ~6000-4000 cal yr B.P., the Middle to Late Holocene transition, and is characterized by the highest clastic input and lowest lacustrine productivity of the entire profile. The presence of sand-sized clastic layers coupled with information derived from environmental magnetic proxies suggests that at the inception of lacustrine sedimentation, intense erosional processes affected the catchment area. Our finding is supported by other regional (Feurdean et al., 2013, Magyari et al., 2009) and extra-regional (Magny et al., 2006) studies which document the interval between 6000-5,500 cal yr B.P. as a period dominated by cold and wet conditions, that likely favored water retention in the basin and intense slope activity.

During the second phase of lake sedimentation covering the interval ~4000-2500 cal yr B.P., the sediment changed from massive to partly laminated, and the detrital fluxes decreased while productivity increased; these sediment characteristics point to a decline of erosional activity. The third sedimentation phase, 2500-1000 cal yr BP, is dominated by alternating stable and unstable conditions where the clastic input is decreasing, productivity is increasing and there was a tendency towards high oxygen conditions in the water column. The increased frequency of thin organic layers, composed mainly of aquatic plants, could be interpreted as reflecting seasonal and rapid variations in lake levels, most likely due to enhanced evaporation during warm seasons. This interpretation is supported by the

synchronicity with the Roman Warm Period, when climatic conditions in the region were warmer and drier than previously.

The last sedimentation phase, lasting from 1000 to -60 cal yr B.P. shows increasing detrital fluxes, oscillating lake productivity, reducing oxygenation conditions, and high carbonate contents; the last 300 years are marked by a strikingly oscillating trend in almost all proxies. This centennial instability is probably showing the intensification of human activities over the more recent past through landscape exploitation.

The statistical analysis (PCA) applied on the entire dataset helped better disentangle the processes responsible for the different sedimentation phases identified. Moreover, the changes observed in our proxies appear synchronous with regional hydro-climatic indexes, such as precipitation and total solar iradiation, pointing to a causal link between lake dynamics and natural climate variability. Superimposed on the natural climate forcing, changes observed in lake evolution also reflect the contribution of anthropogenic factors, starting with the Bronze Age and extending towards present times.

Acknowledgements

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References

Feurdean et al., 2013

Magyari et al., 2009

Magny et al., 2006

Towards multi-proxy based millennial time scales in Late Pleistocene Danubian Loess-Palaeosol Sequences

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Late Pleistocene palaeoclimatic records for south-eastern Europe rely largely on loess-palaeosol sequences (LPSS). The general spatial scarcity and often limited temporal range of other sedimentary archives assign the LPSS of the region a key role even in millennial scale temporal reconstructions of the Late Pleistocene terrestrial environmental dynamics. In Eurasia, aeolian dust sediments (loess) are widespread in continental mid-latitudes. The Eurasian loess-belt has its western end in the Middle Danube (Carpathian) and the Lower Danube Basin. Similar to the Chinese Loess Plateau (CLP) and to the steppe areas of Central Asia one can find true loess plateaus in this area dating back more than one million years and comprising a semi-continuous record of the Quaternary palaeoclimate (Marković et al. 2011, 2015).

Loess forms from aeolian dust and consists predominantly of common silicates and a varying amount of detrital carbonate; it reflects the average geochemical composition of the upper continental crust (cf. Muhs 2013). After deposition the aeolian silt undergoes a special diagenetic process called "loessification" which comprises initial silicate weathering, partial carbonate dissolution and re-precipitation as well as the neo-formation of clay minerals. It also controls the complex geochemical dynamic of Iron (Fe) which in turn is responsible for the colour and magnetic properties of the loess. No sharp limit can be drawn between "loessification" and soil formation as long as the detrital carbonate is not completely dissolved and subsequently intense silicate weathering starts. When more humid conditions predominate, synsedimentary pedogenesis prevails and (embryonic) soil horizons are formed which are rapidly buried by fresh dust as soon as the climate returns to drier conditions. These buried soil horizons are referred to as palaeosols and developed during the humid and warm interglacial phases of the Pleistocene as mature soils, when aeolian silt deposition – as generally assumed – dramatically decreased or even ceased in most parts of western Eurasia. Loess deposits with intercalated palaeosols represent the most widespread terrestrial archives of Quaternary climatic fluctuations in Eurasia (Hosek et al. 2015, Marković et al. 2015).

The LPSS of the Lower Danube and the Carpathian Basin allow inter-regional and trans-regional correlation and, even more importantly, the analysis of temporal and spatial trends in Pleistocene palaeoclimate, even on hemispheric scales (Buggle et al. 2013; Marković et al. 2015). However, the general temporal resolution of the LPSS seems mostly limited to (sub)deca-millennial (orbital) scales enabling the correlation of their well documented

palaeoclimate record to the marine isotope stages (MIS) and thus to the course of the global or northern hemisphere ice volume with time (cf. Basarin et al. 2014).

Magnetic susceptibility (χ, χ_{fd}) and grain size (GS) became fundamental palaeoclimate proxies in loess research. They are highly sensitive proxies for the environmental conditions during loess accumulation (cf. Buggle et al. 2014; Muhs 2013). χ reflects the neo-formation of magnetic minerals in the course of silicate weathering and depends largely on the temporal variation of soil humidity and thus the temporal course of palaeoclimate, given that the parent dust from which the loess was formed is mineralogically homogenous. GS, however, reflects the aeolian conditions during dust transport and deposition as well as post-depositional processes like pedogenesis. Recent studies on GS trends across the CLP reveal Late Pleistocene palaeoclimatic fluctuations on millennial scale which correlate to the Dansgaard-Oeschger (D-O) events known from the Greenland Ice Cores (GIC) (Yang & Ding 2014). Such millennial scale variations were up to date not observed in Late Pleistocene Danubian LPSS.

In order to investigate the potential of Danubian loess in recording millennial palaeoclimate variability, Late Pleistocene LPSS from the southern Carpathian Basin (Titel-Plateau) and the eastern Lower Danube Basin (Dobrogea) were sampled in high resolution (5 to 2 cm spacing). A chronological frame is provided by luminescence dating, tephra-chronology and the correlation of palaeoclimatic proxy parameters to marine and ice core records. Here, we focus on the environmental records of the past 60 kyrs, an interval of extreme palaeoclimatic dynamics during which anatomically modern humans dispersed into Central and Western Europe.

The down-section temporal variability of χ, χfd and GS as palaeoclimatic proxy parameters reveals detailed information on the environmental dynamics. Based on these records we can draw the following conclusions:

- Estimated accumulation rates in both regions are relatively homogeneous over the past 60 kyrs.
- In the studied sections, millennial scale variations are present probably reflecting Dansgaard-Oeschger (D-O) cyclicity.

There are a lot of similarities between the environmental records of the Vojvodina and the Dobrogea and also between these records and those from the Chinese Loess Plateau, but also fundamental differences.

References

Basarin et al. 2014. Time-scale and astronomical forcing of Serbian loess-palaeosol sequences. Global and Planetary Change 122, 89–106.

Buggle et al., 2013. The progressive evolution of a continental climate in southeast-central European lowlands during the Middle Pleistocene recorded in loess paleosol sequences. Geology 41(7), 771–774.

Buggle et al., 2014. Iron mineralogical proxies and Quaternary climate change in SE-European loess–paleosol sequences. Catena 117, 4–22.

Hošek et al., 2015. An integrated rock-magnetic and geochemical approach to loess/paleosol sequences from Bohemia and Moravia (Czech Republic): implications for the Upper Pleistocene paleoenvironment in central Europe. Palaeogeography, Palaeoclimatology, Palaeoecology 418, 344–358.

Marković et al., 2011. The last million years recorded at the Stari Slankamen loess-palaeosol sequence: revised chronostratigraphy and long term environmental trends. Quaternary Science Reviews 9/1, 1142–1154.

Marković et al., 2015. Danube loess stratigraphy - Towards a pan-European loess stratigraphic model. Earth-Science Reviews 148, 228–258.

Muhs, 2013. The geologic records of dust in the Quaternary. Aeolian Research 9, 3–48.

Yang & Ding, Z., 2014. A 249 kyr stack of eight loess grain size records from northern China documenting millennial-scale climate variability. Geochemistry, Geophysics, Geosystems 15, 798–814.

Changes in the precipitation variability in Romania and its relation to the circulation weather types

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Many studies link the observed changes in local climate to the variations in the atmospheric circulation. A tested method of describing atmospheric circulation is by employing the weather or circulations types. This paper presents an objective classification of the atmospheric circulation affecting Romania, between 1951 and 2010, and its relation to the significant changes in the amount of precipitation after 1980.

A successful approach is the automatic classification based on Lamb's subjective scheme (1950). Originally used by Jenkinson and Collison (1977) for the British Isles, this method was also employed for other regions in Europe by Goodess and Jones (2002), Trigo and DaCamara (2000), Ramos et al. (2010) in Iberian Peninsula; Chen (2000) for the Scandinavian Peninsula; Holobaca (2010) for Romania.

The grid-point data used for the identification of the large-scale circulation patterns are obtained from NCEP/NCAR Reanalyses (Kalnay et al., 1996). These data are available at a resolution of 2.5° by 2.5° latitude/longitude at the four synoptic hours (00, 06, 12 and 18) on a daily basis, since 1 January 1948. Using these data, we calculated the WT variables and LWTs for each day from 1950 onwards producing an analysis for 12 UTC. This method allowed us to define 27 types of CWTs for Romania – two with high vorticity (cyclonic (C), anticyclonic (A)), eight pure directional types, 16 hybrid types and one with light indeterminate flow corresponding to Lamb's unclassified type (U). We chose to objectively define the thresholds for the light indeterminate flow class (U) by using the 0.15 percentile of the F and |Z| ranges.The 27 CWTs were regrouped in 11 basic ones in order to obtain a practical analysis scheme.

We used Barry and Perry's 1973 method in order to decompose the climatic differences between two periods into different parts that are caused by frequency and within the same type changes of circulation. The synoptic characteristics and the frequency of the ten basic circulation weather types are discussed, as well as the amount of precipitation associated with each type. It is shown that the dry types (A, S, SE), although being the most frequent classes, have a rather small contribution to the precipitation amount while the wet types (C, N, NE) have a very important contribution to the annual amount of precipitation. Also, the climatic differences between the two periods were quantified.

References

Barry RG, Perry AH. 1973. Synoptic Climatology. Methuen, London.

Chen D. 2000.A monthly circulation climatology for Sweden and its application to a winter temperature case study.Int. J. Climatol. 20: 1067–1076.

Goodess CM, Jones PD. 2002. Links between circulation and changes in the characteristics of Iberian rainfall. Int. J. Climatol., 22: 1593–1615. doi:10.1002/joc.810.

Holobâcă IH. 2010. Studiulsecetelor din Transilvania. PresaUniversitarăClujană: Cluj-Napoca.

Jenkinson AF, Collison FP. 1977. An initial climatology of gales over the North Sea. Synoptic Climatology Branch Memorandum, 62, Meteorological Office: London.

KalnayE, KanamitsuM, KistlerR, Collins W, DeavenD, GandinL, Iredell M, SahaS, White G, WoollenJ, Zhu Y, LeetmaaA, Reynolds R, ChelliahM, EbisuzakiW, Higgins W, JanowiakJ, Mo KC, RopelewskiC, Wang J, JenneR, and Joseph D. 1996. The NCEP/NCAR 40-Year Reanalysis Project.Bulletin of the American Meteorological Society.77:3, 437-471.

Lamb HH. 1950. Types and spells of weather around the year in the British Isles. Quarterly Journal of the Royal Meteorological Society76: 393–438.

Ramos AM, Lorenzo MN, Gimeno L. 2010. Compatibility between modes of low-frequency variability and circulation types: a case study of the northwest Iberian Peninsula. J. Geophys. Res. Atmos. 115:D02113. doi:10.1029/2009JD012194.

Trigo RM, DaCamara CC.2000.Circulation weather types and their influence on the precipitation regime in Portugal.Int. J. Climatol., 20: 1559–1581. doi:10.1002/1097-0088(20001115)20:13<1559::AID-JOC555>3.0.CO;2-5.

Chronology and inorganic geochemistry of four sediment sequences from the Retezat Mts, South Carpathians (Romania)

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In the frame of PROLONG (*Providing long environmental records of Late Quaternary climatic oscillations in the Retezat Mountains*) project lake sediment records were studied to reconstruct climate changes in the Southern Carpathians. During 2007 and 2008 summer long sediment cores were obtained from four glacial lakes (Lia, Bukura, Gales and Brazi) in the Retezat Mts (Southern Carpathians, Romania). Here we report the chronology and inorganic geochemistry from these lakes.

The chronologies were build based on radiocarbon dating. Preferably terrestrial plant macrofossils were selected for dating, while in several cases aquatic animal remains (Cladoceran eggs), bulk sediment or different size fractions of wet sieved sediment samples were dated. Samples were measured with EnvironMICADAS AMS and its gas ion source in the Hertelendi Laboratory of Environmental Studies (Debrecen, Hungary). Age-depth models were developed using both Bayesian modelling with the BACON software and smooth spline curve fitting with the CLAM software. Bayesian models were used to identify outlier ^{14}C dates. As smooth spline models follow better the frequent deposition time changes of the lake sediments were used to model sediment accumulation age-depth relations.

Major and trace elements were analysed on bulk sediment samples. Sediment organic matter was determined by loss-on-ignition method. Total element concentrations were measured using an Inductive Couple Plasma Optical Emission Spectrometer (ICP-OES) and Microwave Plasma Atomic Emission Spectrometer (MP-AES). Concentration of major elements was calculated in oxide forms (Al_2O_3, SiO_2, TiO_2, CaO, MgO, K_2O, Na_2O, Fe_2O_3, MnO and SO_3). Multivariate statistical analyses (PCA, LDA) and cluster analysis were performed on geochemical records.

Sediments represent the Lateglacial and Early Holocene period. Sediment accumulation in the early- and mid-Holocene largely depended on slope stability, vegetation cover in case of the high altitude deep lakes, while the lower altitude shallow lakes showed fast sediment accumulation. Sediments deposited during the cold and warm period showed significantly different chemical compositions. We infer that sediment major element geochemistry of these mountain lakes mainly reflect changes in the terrestrial ecosystems and show distinct responses to major climatic oscillations within the Holocene.

Arctic Holocene paleoclimate synthesis - a PAGES endorsed project

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The Arctic Holocene Transitions project is an international community-based effort to systematically review available evidence of the spatial and temporal pattern of climatic changes across the Arctic during the Holocene. In 2014, regional and proxy experts released a major compilation of published proxy climate time series from Arctic (north of 58° latitude) lake sediment, marine sediment, glacier ice, and other sources (Climate of the Past 10:1605). Regional teams then compared the dataset with other available paleoenvironmental evidence to reveal the most prominent trends represented by a large variety of paleo evidence.

The results are presented in three new major synthesis papers, one for each Arctic region: (1) western North America, (2) eastern North America (including Greenland), and (3) North Atlantic and Fennoscandia. In addition, the dataset has been analyzed to extract the timing and magnitude of the mid-Holocene Neoglacial transition, and to compare with climate-model simulations. The results have clarified the primary millennial-scale trends in Arctic Holocene climate and have highlighted proxy biases and future research priorities.

Inter-annual fluctuations in the internal climate variability of the Eastern Carpathians foreland

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Introduction

Studies of the multicentennial climate dynamics over the European mountainous regions point to the primary external solar and atmosphere-ocean forcing included in the global climate models (Camenisch et al., 2016). The climate variability model during the period of instrumental records is resolved into several different in duration periods reflected in the regional climate models in response to the boundary forcings (Deque et al., 2007; Birsan et al., 2014). Still, the appropriate inclusion of internal climate variability remains the complicated task in the climate change models and projections (Maraun et al., 2015).The acknowledged methods of trend analysis enabled to detect phases of decrease/increase in Europe that are significant mostly for the thermal regime. The issue of representation of internal short-term fluctuations in the climate trends requires further exploration and unification. The analysis of such periods on the example of the forelands of Eastern Carpathians may provide information for the onset of the climate change phases in response to local features of climate transformation.

Materials and Methods

The Carpathian mountainous region is distinguished for controversial manifestations of variability in the last two centuries. Here, certain climate indices (precipitation, wind, extreme values) show insignificant trends complicating to detect the cycle features of temporal distribution. Still, all the regions of the Eastern Carpathians differ in the short-term fluctuations. In particular, the Ukrainian Precarpathian region of foothills serves the contrast area triggering convergence of airflows over the Ukrainian Carpathians and the Volyn-Podolian height. The conditions are manifested in the increased values of wind and precipitation extremes, as well as the range of thermally-generated weather events. In summation, the set of atypical inter-annual fluctuations occur. To discover such temporal and spatial peculiarities the methods of differential integral curves, trend detection and time-varying probability distribution are applied. The short-term periods up to 10 years within the time of instrumental records were analysed for the region using data of Nowy Sacz, Rzeszow, and Jaslo (1881-2015) in Poland; Kolomyia (1876-2013), Chernivtsi (1881-2013), and Ivano-Frankivsk (1951-2013) in Ukraine; Radauti and Suceava (1961-2015) in Romania.

Results and discussion

Inter-annual fluctuations (3-8 years) are detected to be apparent in the region between multidecadal phases of the 50-60 year duration. Preliminary results of integral curves, trend analysis, and probability distribution show the highest reoccurrence of such periods in the

end of 19th, in the middle of 20th and on the beginning of the 21 century. The phenomena may indicate the interstate shifts distinctive for extraordinary increase or inhibition of fluctuations of the annual, seasonal, and monthly climate parametres for several years in a row. The most apparent fluctuations are noticed in the dynamics of precipitation, temperature, and wind indices, as well as their extreme manifestations (Fig. 1).

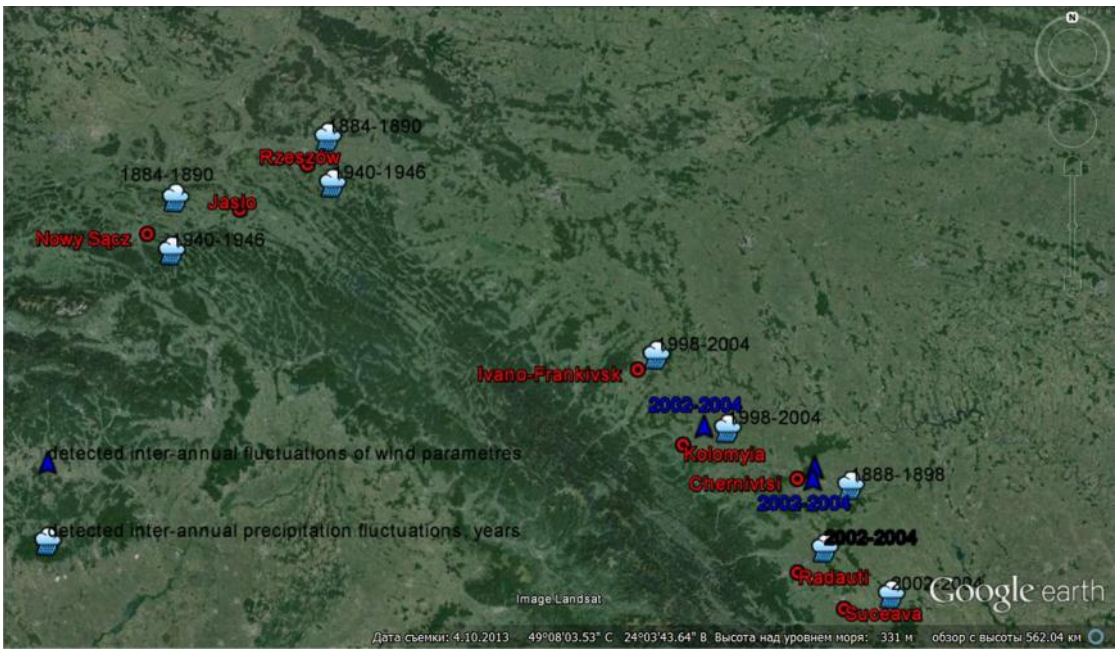

Fig. 1 Short-term climate fluctuations in the foreland of Eastern Carpathians.

The precipitation trend over the last century in the region is observed to be insignificantly positive in the first half of the 20th century and negative – since the 60-s of the 20th century. The application of difference integral curves in the study of long-term precipitation variability enabled to distinguish the cycles of short-term periodicity. They are periods with diminished or extreme fluctuations. In particular, the period of 1883-1890 was significant for extreme precipitation in the Polish sites and Chernivtsi (Twardosz et al., 2015). Within the last 60-year period of synoptic background, the 7-8 year fluctuations are apparent for the foreland area represented by the weather stations of Chernivtsi, Kolomyia, and Ivano-Frankivsk. In comparison, in the end of the 19th century - on the beginning of the 20th century, the 2-3-year cycles within the 50-year cycle were distinguished. The 7-8-year cycles of precipitation regime became apparent after 1981. In the 21th century fluctuations with shorter periodicity can be determined in the region too (2003-2004).The latter period corresponds to the atypical annual wind roses of speeds and frequency for most of the sites. These are the years of high temperature ranges and extreme precipitation fluctuations. Other fluctuations of annual and seasonal wind directions and extreme speeds with insignificant range were detected in the 1945-1950 years for the Ukrainian part. The phenomena coincide with the diminished annual precipitation and temperature fluctuations and in all the parts of the region. The quantitative parametres of short-term changes are achieved.

The revealed inter-annual fluctuations seem to reflect the internal climate variability that is specific for the foreland region. They point to the interstate temporal oscillations of climate system related to the boundary belt of the distinct nature environments. The findings may be indicative of the rebuilding of regional circulations and contribute to the identification of centennial climate dynamics of the Eastern Carpathian region.

References

Camenisch, C., Keller, K. M., Salvisberg, M., Amann, B., Bauch, M., Blumer, S., Brázdil, R., Brönnimann, S., Büntgen, U., Campbell, B. M. S., Fernández-Donado, L., Fleitmann, D., Glaser, R., González-Rouco, F., Grosjean, M., Hoffmann, R. C., Huhtamaa, H., Joos, F., Kiss, A., Kotyza, O., Lehner, F., Luterbacher, J., Maughan, N., Neukom, R., Novy, T., Pribyl, K., Raible, C. C., Riemann, D., Schuh, M., Slavin, P., Werner, J. P., and Wetter, O., 2016. The early Spörer Minimum – a period of extraordinary climate and socio-economic changes in Western and Central Europe, *Clim. Past Discuss*. doi:10.5194/cp-2016-7, in review.

Deque M., Rowell DP., Luethi D., Giorgi F., Christensen JH., Rockel B., Jacob D., Kjellstroem E., de Castro M., van den Hurk BJJM., 2007. An intercomparison of regional climate simulations for Europe: assessing uncertainties in model projections. *Climatic Change, 1*, doi:10.1007/s10584-006-9228-x.

Maraun, D., M. Widmann, J. M. Gutiérrez, S. Kotlarski, R. E. Chandler, E. Hertig, J.Wibig, R. Huth, Wilcke R. A. I., 2015. VALUE: A framework to validate downscaling approaches for climate change studies, *Earth's Future, 3*, doi:10.1002/2014EF000259.

Twardosz R., Cebulska M., Walanus A., 2015. Anomalously heavy monthly and seasonal precipitation in the Polish Carpathian Mountains and their foreland during the years 1881–2010. *Theoretical and Applied Climatology*. doi: 10.1007/s00704-015-1570-3

Radiocarbon dated late-glacial Scots pine (*Pinus sylvestris* L.) chronology from Central Poland

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Dendrochronologically dated wood of subfossil trunks of trees presents the basic material used at construction of the calibration curve. In the last years numerous studies have been aimed at construction of chronologies covering the late-glacial period (Kaiser et al. 2012).

At present, Koźmin (Dzieduszyńska et al. 2014) and Kwiatków (Kolska Basin, Central Poland) proved to be very perspective sites, in which wood from the end of Allerød and Younger Dryas was recognized. A level of organic deposits with so-called 'fossil forest' was encountered within the late-Vistulian terrace of the low valley of the Warta river.

In Kwiatków over 300 pieces of wood were documented. Abundant trunks and short stumps of trees have been very well preserved in a series of organic sediments, up to 0.5 m in thickness. Felled trunks are up to 4 m in length and up to 20 cm in diameter. In straight majority the pieces analysed represented narrow-ringed wood. At most of the samples examined the average increment width was below 1 mm. Only about 20% samples exhibited somewhat wider growth rings (above 1 mm in average), and in a few cases values of the average growths amounted to 2 mm or more. Most probably these last pieces came from redeposited trunks, which had grown in more favourable conditions. Dendrochronological analysis of over 250 samples complying to the requirements of the method allowed, at the present stage of the research, to construct a chronology spanning almost 300 years. It was absolutely dated with the wiggle-matching technique, on the basis of 6 samples of selected annual growth rings, dated relatively with the dendrochronological method. The chronology covers the period 11800-11500 (±45) cal BC.

Before the measurements of radiocarbon ages for whole sequence, the authors investigated several methods of chemical pretreatment. The different methods of production of holo-cellulose and alpha-cellulose were tested in three laboratories in order to find the most stable, repeatable and reliable one (Nemec et al., 2010). The prepared samples were analysed using chromatography and measurements of delta 13C were done for them. Moreover selected samples were checked using measurements of radiocarbon by the high precision AMS technique.

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References

Dzieduszyńska, D., Kittel, P., Petera-Zganiacz, J., Brooks, SJ., Korzeń, K., Krąpiec, M., Pawłowski, D., Płaza, DK., Płóciennik, M., Stachowicz-Rybka, R., Twardy, J., 2014. Environmental influence on forest development and decline in the Warta River valley (Central Poland) during the Late Weichselian. Quaternary International 324, 99-114.

Kaiser, KF., Friedrich, M., Miramont, C., Kromer, B., Sgier, M., Schaub, M., Boeren, I., Remmele, S., Talamo, S., Guibal, F., Sivan, O., 2012. Challenging process to make the Lateglacial tree-ring chronologies from Europe absolute – an inventory. Quaternary Science Reviews 36, 78-90.

Nemec, M., Wacker, L., Hajdas, I., Gaggeler, H., 2010. Alternative methods for cellulose preparation for AMS measurement. Radiocarbon 52(2-3), 1358-1370.

Community- and population-level response of marine plankton to stress exposure: learning from the past

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The effects of stress exposure in marine plankton are difficult to assess directly, because it is hard to replicate realistic conditions in laboratory experiments and because the physiological changes and adaptations in response to stress exposure occur over times scales that cannot be covered by direct observations. A viable alternative is provided by studies of marine microfossils. Census counts of microfossil assemblages allow reconstructions of community-level changes, whilst biometric studies provide information on the reaction of populations to different levels of stress. An important prerequisite for such studies is the identification of suitable natural experiments in the geological past, where a well-constrained plankton population was exposed to stress in a situation where it could not respond simply by shifting ranges. An ideal example for such situation is provided by the periodic salinity crises affecting the Red Sea during glacial sea level lowstands. The salinization of the basin during sea level fall has created a unique strong stressor acting with increasing strength up to the level where it drives local extinctions of plankton species. Using planktonic foraminifera as a model, we reconstructed both the community response of the entire group as well as the population-level response of two selected species to the same salinity crisis. These co-registered records allow us to investigate how stress thresholds are linked between community-assembly processes and population processes, assess the reaction norm of selection-relevant parameters and how these are coordinated among members of the same plankton community.

Refining the Quaternary Geomagnetic Instability Time Scale: The Laschamp Excursion Dated from a Speleothem Record

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Short-lived events such as geomagnetic excursions are global events that are used for dating purposes across scientific disciplines. A critical ingredient for characterizing such geomagnetic instabilities are tightly constrained age models that enable high-resolution magnetostratigraphies. The focus of this study is a speleothem geomagnetic record of the Laschamp excursion, which was the first geomagnetic excursion recognized and described in the paleomagnetic record, and remains the most studied event of its kind. The geological significance of the Laschamp lies chiefly in the fact that it constitutes a global geochronologic marker about 40,000 years ago. The Laschamp excursion occurred around the time of the demise of *Homo neanderthalensis*, in conjunction with high-amplitude, rapid climatic oscillations leading into the Last Glacial Maximum, and coeval with a major supervolcano eruption in the Mediterranean. Thus, precise determination of the timing and duration of the Laschamp would help in elucidating major scientific questions situated at the intersection of geology, paleoclimatology, and anthropology. A geomagnetic record from a stalagmite collected in Crevice Cave, Missouri has been dated using a combination of high-precision ^{230}Th ages and annual layer counting using confocal microscopy. The maximum duration for the Laschamp excursion spans the interval 42,250–39,700 years BP, with an age of 41,100 ± 350 years BP for the main phase of the excursion, during which the virtual geomagnetic pole was situated at the southernmost latitude in the record. This chronology provides the first robust bracketing for the Laschamp excursion, and improves on previous age determinations based on ^{40}Ar/^{39}Ar dating of lava flows, and orbitally-tuned sedimentary and ice-core records. A rigorous documentation of timing, duration, and frequency of excursions can be invaluable for constraining the chronology of certain periods of the Quaternary. Well-constrained age models are critical for characterizing geomagnetic instabilities, and are key in developing high-resolution geomagnetic time series. One such effort is the development of the Quaternary Geomagnetic Instability Time Scale (GITS). Geomagnetic excursions are concentrated within two ~200 ka time periods (722–528 ka BP and 211–17 ka BP) within the Brunhes polarity chron, each containing half a dozen excursions, which are in the dating range of the ^{234}U/^{230}Th method. The younger Brunhes excursions would particularly benefit from precise pinpointing by taking advantage of this method, which under ideal circumstances yields 2σ uncertainties as low as ± 0.1 ka at 130 ka BP, and ± 0.3 ka at 200 ka BP.

Climate change and human occupation in the hyperarid core of the Atacama Desert

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Significant changes in available moisture have occurred in the hyperarid Atacama Desert throughout the late Quaternary. Paleorecords show that areas in the adjacent high Andes and western Altiplano have experienced significant increases in rainfall, likely the result of intensified summer systems associated with the South American Summer Monsoon, tropical Pacific sea-surface temperature gradients and the mean position of the Intertropical Convergence Zone. These past "pluvials" generated increased runoff, elevated groundwater tables throughout the region, and had far-reaching impacts from the Andes to the Pacific coast. Four different examples from our recent research show how such changes in climate bear on cultural evolution in the Atacama. First, there is now abundant evidence for an early colonization of even the Atacama's hyperarid core between 12-13 ka (thousands of calibrated 14C years BP). These sites have extraordinary well-preserved evidence for how this region was settled and the hydrological and ecological resources available. Second, increased groundwater supplies and abundant marine resources along the coast of northern Chile likely augmented Chinchorro hunter-gatherer populations to the extent that this may help explain their advanced technology and artificial mummification techniques. Third, increases in groundwater associated with minor pluvials during the late Holocene at 2.5-2.1 and 1.2-0.7 ka are coeval with major population expansion and development of "hydraulic societies". Finally, a recent long-term trend in aridity may explain the demise of Aymara populations in the precordillera of northernmost Chile. By using population size as a primary response to environmental change, we have developed a conceptual model that shows how these past social changes can be related to climate change.

Landscapes and Paleolandscapes in south-eastern Europe during Late Quaternary and their relevance for human habitats and dispersal

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Pleistocene landscape dynamics affect climatic and environmental conditions, and may have had a major impact on modern human habitats. In this contribution, reconstructions of modern and late Pleistocene environments based on landscape evolution models are presented and discussed following a series of transects from the Pannonian Basin to the Black Sea. These transects include geomorphological features and landscapes like loess plateaus, dune fields, alluvial plains, the Carpathian Mountains, and their foothills. To enhance our understanding of anatomically modern human (AMH) habitats, transects of paleo-landscapes from the Carpathian Basin to the Black Sea coast are investigated, focussing on a time-interval of ca. 30,000-40,000 years ago and the last glacial maximum. These transects include important landscape features, such as the ones mentioned above, and their geoarchives. These geoarchives serve as important proxies for ongoing research investigations. We understand such a transect as data visualization over a wider region, following a west-east direction and a (paleo)climatic gradient. As data visualization, the presented landscape model must extrapolate on existing data, and is therefore partly artistic by its nature.

In the West, the Pannonian Basin and its landscape mosaic (loess, alluvial plains, terraces, dune fields) is visualized, followed towards East by the Danube gorges cutting through the Carpathian Mountains, including the foothills west and east of Iron Gates. East of the Carpathians, in the Lower Danube area, the alluvial plains and terraces of the Danube and its tributaries are currently the dominating features on the landscape. However, north and south of the Lower Danube plain, the Carpathian and Balkan mountain ranges present a different environment, which is of major importance for better understanding more recent environmental changes and related landscape evolution. During the last glaciation, this dependence may have been even more important, especially through strong seasonality of rainfall and therefore of glacial meltwater runoff, that had an impact on discharge rates of main river systems in the region.

We compiled such a transect as data visualisation over a wider region, following a west-east direction, likely along a former (paleo)climatic gradient. With the data visualisation algorithm employed, the landscape evolution model extrapolates on existing information and brings forward novel insights, being therefore rather innovative in nature. Moreover, results from ongoing sedimentological and paleoclimatic research on several important sites in the Pannonian Basin and the Lower Danube area are presented. In addition, an upland-lowland environmental model highlighting the most important paleoclimatic and habitational

constraints for successful peopling of this region by anatomically modern humans (AMH) during Late Pleistocene (i.a. water availability, food availability, biodiversity, raw material availability) are further proposed. We suggest the foothills of the mountain ranges and terraces of Danube tributaries having been preferential habitats for AMH at the time of their arrival and dispersing throughout south-eastern Europe.

A first record of mass wasting events in peat records from the Romanian Carpathians throughout the late Holocene

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Mass wasting events, including landslides, avalanches and flooding related to heavy rains can have a major impact on the local environment. Due to their association to extreme precipitation and glacial retreat, their occurrence is likely to increase as the climate changes in the future. As such, understanding their causation, and predicting their future impact is of paramount importance. To make such predictions, understanding of the relationship between the climate and the mass-wasting event is key. For this to happen, we must use historical records of mass wasting and climate to tie the two together. As a result, a reliable, quick and easy method for determining these events in the sedimentological record must be developed.

Here we present the first Holocene record based on this proxy from a peat archive from a raised mountain bog in the Romanian Carpathians, nested at the foot of an avalanche-prone glacial cirque. Utilising a multi-proxy approach, including a novel geochemical proxy (Rb/Sr), Loss On Ignition (LOI), grain size measurements and the vegetation record as reconstructed via pollen assemblages, we have created a record of such mass wasting events for the last 3500 years.

Part of our work discusses the ratio of elements Rubidium against Strontium (Rb/Sr) that has been suggested as one indicator of mass wasting events, particularly based on lake sediment research in glaciated terrain. Our work was initially developed upon the behaviour of the two elements during weathering, considering that Rb commonly substitutes for K in mineral lattices and Sr commonly for Ca, due to similar ionic radii. Minerals containing K are much more resistant than Ca-bearing ones, and so there is enrichment in weathering products of Ca, and therefore Sr. As a result, Sr should be enriched in weathered material, resulting in a lowering of the Rb/Sr ratio. This assumption has been proven as reliable in similar research involving aeolian deposits and lake sediments.

Our geochemical assessments are based on complete digestion of samples, and analysis via ICP-OES, rather than based only on core scanning. Initial results look promising, with the peat core below the active layer (acrotelm) and above the minerogenically-influenced zone producing strong correlation to the estimates of the minerogenic input over the bog based on combustion techniques. Coupled to the more traditional LOI results, we have identified a number of periods of intensified local mass wasting, and we explore the potential for tying these periods of increased activity to changes in the local, or regional palaeoenviroment.

Base metal pollution as a result of historical ore smelting in the Romanian Carpathians throughout the Holocene

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In Europe the characteristics, distribution and effects of recent pollution are well known, with monitoring observations existing at a continental scale. However, estimates of long-term pollution are restricted to central-western Europe, the British Isles and Scandinavia. In Eastern Europe in particular, the lack of such estimates has led to incomplete understanding of regional differences. When coupled to the insufficient knowledge of past emission sources and isotopic signatures of various ores, it is clear there are gaps in our knowledge of the history of pollution in this area. As a result, the causal relationships between humans and the environment are insufficiently explored, particularly within the Carpathian region - one with significant mineral wealth and a long history of human presence.

Here we present initial results from a multi-proxy study into the geochemical history of an ombrotrophic peat bog located in the Southern Carpathians, Romania. Peat bogs have long been used as an archive for environmental and climatic imprints, with research using climate indicators from bogs burgeoning in recent decades, and a range of proxies for past hydrological change have been developed. The potential for utilising the geochemistry of archives such as peat bogs to resolve the input of metals from the atmosphere has long been known, and has been used to distinguish the background levels from the anthropogenic imprint. We present elemental concentrations for a number of the base metals associated with metal mining, smelting and subsequent pollution. These data (base metal concentrations) display one of the first such study in the region and indicate a pollution history hitherto largely unremarked in the records from Western Europe, with peaks in metal production over time periods during which production was thought to be low. Alongside the geochemical results, an initial pollen record is presented, indicating timing and extent of deforestation in the region.

The development of gravitational caves versus periods of mass movement intensification during the humid phases of the Late Glacial and the Holocene: study of dated speleothems and slope deposits (Polish Outer Carpathians)

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Mass movements have been one of the most efficient processes controlling the morphogenesis of the Outer (Flysch) Carpathians. Dated by ^{14}C method 180 landslides and related processes in the Polish Carpathians enabling to reconstruct mass movement chronology, confirm the thesis formulated by Starkel (1966), that the periods of acceleration of gravitational processes during the Late Glacial and the Holocene were connected with the stages of climatic humidity growths (Alexandrowicz, 1996; Margielewski, 2006; Starkel et al., 2013). Gravitational slope failures have often generated formation of non-karst caves. In the Polish part of the Outer Carpathians ca. 1400 caves, mainly of gravitational origin, have been explored up till now (Klassek, Mleczek, 2015). Part of these caves formed in the initial stage of landslide development, some ones formed during subsequent stages of landslide evolution (Margielewski, Urban, 2003; Lenart et al., 2013). Radiocarbon datings of speleothems allow us to reconstruct the stages of cave development and related mass movements. Pollen analysis of speleothems confirms these datings (Urban et al., 2015).

The oldest dated speleothems were formed in the Late Pleniglacial (Jaskinia Słowiańska-Drwali cave, Beskid Niski Mts.). The composition of carbon stable isotopes in these speleothems indicates their formation due to repeated water freezing or evaporation. The first stage of common speleothem formation (recorded in two caves of the Beskid Śląski Mts. and two caves of the Beskid Niski Mts.) fell on the short climate warmings of the Bølling and Allerød as well as at the beginning of the Holocene. The intensive water circulation in those periods was related to the permafrost deterioration. The stages of cave opening are correlated with the intensification of mass movements (Starkel et al., 2013), during the periods of an increase in precipitation in the close of the Boreal Phase and at the beginning of the Atlantic Phase as well as during the Middle Atlantic Phase - climatic optimum of the Holocene (ca 7.5-7.2 ka cal BP). Climate coolings and increases in humidity at the turn of the Atlantic-Subboreal Phases, as well as at the turn of the Subboreal-Subatlantic Phases are recorded by the beginning of speleothem formation or change from concentric to deconcentric growth of speleothem rings. All periods of speleothem formation (or their de-concentric growth) are correlated with phases of the intensification of slope failures (landslides), as well as with palaeoenvironmental changes recorded in peat bogs situated close to the caves (Margielewski, 2006; Urban et al., 2015).

References

Alexandrowicz S.W., 1996. Stages of increased mass movements in the Carpathians during the Holocene. Kwartalnik AGH, Geologia 22(3), 223-262.

Klassek G., Mleczek T. 2015. Exploration and investigation of the caves in the Polish Flysch Carpathians (September 2014-August 2015). In: Kicińska D., Stefaniak K., Szynkiewicz A. (Eds.), Mater. 49. Symp. Speleol.. Sekcja Speleol. PTP im. Kopernika, Kraków: 90-95..

Lenart J., Panek T., Dusek R., 2014. Genesis, types and evolution of crevice-type caves in the flysch belt of the Western Carpathians (Czech Republic). Geomorphology 204, 459-476.

Margielewski W., 2006. Records of the Late Glacial-Holocene palaeoenvironmental changes in landslide forms and deposits of the Beskid Makowski and Beskid Wyspowy Mts. Area (Polish Outer Carpathians). Folia Quaternaria 76, pp. 149.

Margielewski W., Urban J., 2003. Crevice-type caves as initial forms of rock landslide development in the Flysch Carpathians. Geomorphology 54, 325-338.

Starkel L., 1966. The palaeogeography of Mid- and Eastern Europe during the last cold stage and West European comparison. Philosophical Transaction of the Royal Society, London B 280, 351-371.

Starkel, L., Michczyńska, D., Krąpiec, M., Margielewski, W., Nalepka, D., Pazdur, A., 2013. Holocene chrono- climatostratigraphy of Polish territory. Geochronometria 40(1), 1-21.

Urban J., Margielewski W., Hercman H., Žák K, Zernitska V., Pawlak J., Schejbal-Chwastek M., 2015. Dating speleothems in sandstone caves - methodological aspects and practical interpretation, Polish Outer Carpathians case study. Zeitschrift für Geomorphologie 59, Suppl. 1, 183-208.

The Late Glacial and Early Holocene palaeoenvironmental changes recorded in landslide peat bog (landslide fen) deposits in the northern parts of the Polish Outer Carpathians (Southern Poland)

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In the northern part of the Polish Outer Carpathians, the Beskid Makowski Mts., four landslides formed during the Late Glacial have been identified so far. The landslide peat bogs formed within landslide depressions represent specific type of minerogenic mires filled down by organic-minerogenic deposit. Within the depositional sequences of these peats, palaeoenvironmental changes of the Late Glacial and the Holocene are recorded. The oldest of the studied fens started to form in the Oldest Dryas, the younger ones – in the Bolling (two peat bogs), Older Dryas and the Younger Dryas (Margielewski, 2003; Margielewski, 2006). In the sediments of the four landslide fens of the thickness varying from 4.5 m to 1.5 m, several logs were cored using the Instorf sampler. The laboratory study of the logs, reaching the deepest parts of the fens, included: palynological analysis, peat analysis (microscopic examination of organic deposits), grain-size (aerometric) analysis and content of minerogenic material (loss on ignition) analysis for 2.5 cm long intervals. Over 50 radiocarbon datings made in the studied logs (7-14 ones for each log), enable to date the horizons of lithological and pollen changes .

The loss on ignition curves show large variability of mineral inserts and illuvial horizons in peat deposits, which were formed owing to supply of minerogenic material to the peat bogs related to slope wash during the phases of an increase in precipitation (climate humidity growth). In the Late Glacial sequences of logs, mineral horizons were affected by periodic climate warmings resulting in the permafrost deterioration during the Bølling and the Allerød (see Starkel et al., 2013). However, the Allerod is bipartite in part of analyzed logs: the lower sections of Allerod (AL-1) sequences are usually represented by peat deposition, whereas in the upper parts of the logs (AL-2) numerous minerogenic (clay, silty clay) inserts confirm the climate humidity growth. In the Late Glacial sequence sections pollen of thermophilous trees, such as *Corylu*s, *Tilia*, *Quercus*, *Carpinus*, as well as (typical for Subboreal Phase of the Holocene) *Abies alba* and *Fagus sylvatica* occur, which is probably caused by long transport from remote refugees.

During the termination of the Younger Dryas climate cooling, the gradual increase in the delivery of allochthonous material to peat bog is commonly observed. This process is finished by the deposition of clay and silty clay horizon. The lack of the depositional sequences of the upper Preboreal and the whole Atlantic Phase in the majority of logs is caused by the erosional removal of sediments during the climate humidity growth at the beginning of the Subboreal (Margielewski, 2003, 2006).

References

Margielewski W., (Ed.). 2003. Late Glacial-Holocene palaeoenvironmental changes in the Western Carpathians: case studies of landslide forms and deposits. Folia Quaternaria 74, pp. 96.

Margielewski W., 2006. Records of the Late Glacial-Holocene palaeoenvironmental changes in landslide forms and deposits of the Beskid Makowski and Beskid Wyspowy Mts. Area (Polish Outer Carpathians). Folia Quaternaria 76, pp. 149.

Starkel, L., Michczyńska, D., Krąpiec, M., Margielewski, W., Nalepka, D., Pazdur, A., 2013. Holocene chrono- climatostratigraphy of Polish territory. Geochronometria 40(1), 1-21.

The Crvenka loess-paleosol sequence (Vojvodina, Northern Serbia)- a record of continuous domination of the Late Pleistocene grasslands

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In this study we present a comparison of two independent paleo-environmental evidences: novel n-alkane biomarkers and traditional land snails assemblages, associated with widely used proxy records such as the low field magnetic susceptibility, grain size and various isotopic and geochemical indices. These paleo-environmental proxy records provide evidence for the continued predominance of the different grassland vegetation types during the entire Late Pleistocene. The results presented in this study highlight the spatial differences in the environmental conditions during the Late Pleistocene across the European loess belt. Contrary to other European loess provinces characterized by high diversity of the Late Pleistocene environments (ranging from tundra-like to deciduous forest habitats), our investigations indicate a continued dominance of grassland-dominated ecosystems in the southeastern Carpathian Basin. This uninterrupted presence of Late Pleistocene grassland zone in the southeastern part of the Carpathian Basin may have played an important role in the preservation of exceptional biodiversity of the Balkan region, as well as in the migration of anatomically modern humans into Europe.

Using high resolution LIDAR DEM to reconstruct historical network of lakes and wetlands in the Northern part of the Moldavian Plateau, NE Romania

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Keywords: abandoned dams, Lidar DEM, historic lakes map

A particular environmental feature of the northern part of Moldavian Plateau (NE Romania) is the large number of anthropic lakes along river courses. Even more, due to climatic, hydrological, hydrogeological and geomorphological settings and human activities (dominated by an extensive agriculture) this characteristic was mentioned and mapped in writen records and cartographic representations in many historical stages of the humanization of this region. The need for watter supply have forced the inhabitants to build dams of various sizes along the entire river network. Over the time, many dams were abandoned, while others have been relocated with a impresive dynamic at historical time scale.

Until nowadays, the spatial distribution of these historical generations of lakes was available only for certain periods (the case of historical maps) being characterized by numerous localization uncertainties and incompleteness.

Analizing recent high resolution Lidar DEM images, we have perform an accurate inventory of abandoned dams. Using *„generating contour"* function of Global Mapper v.15.0 package, we have recnstruct an approximately spatial extension of corresponding lakes. Some of them have been recognized on old maps (topographic map form 1894, 1940, 1960, 1984), while many others have been identified and mapped for the first time in this work. Alongside this new cartographic representations and the posibilities to asses the dynamic this environmantal factor, this historical inventory of old dams represent a usefull database of lacustrine deposits of the studied region.

Reflection of climatic changes during Interpleniglacial in geoecosystems of Southern Poland

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The central part of Europe during the last cold stage was occupied by permafrost and twice invaded by the Scandinavian ice sheet, but about 70% of time was taken by transitional phases of continuous fluctuations of permafrost, which are reflected especially in type and thickness of slope, fluvial and aeolian deposits.

Two very distinct changes took place: one during the relatively rapid aridisation of climate around 30-25 ka BP (with the ice sheet transgression, expansion of continuous permafrost and the start of loess deposition) and second rapid warmings at 14.8 and 11.7 ka with expansion of forest and change of the hydrological regime. The greatest transformations in the relief of slopes and river valleys (denudation of slopes, thick alluvial fills) took place not in coolest phases with stable permafrost but during Interpleniglacial. The authors exemplified number of sites in Southern Poland documenting frequent fluctuations of temperature and permafrost from that 30 ka long period. Calibrated dates of dated episodes correlate well with ^{18}O NGRIP curve from Greenland with frequent warmings (more than 4 officially named). These rapid warmings are reflected in higher rate of aggradation in valley floors and thick colluvia, both combined with the retreat of permafrost. The authors also suggest to turn more attention to spatial diversity of sediments and forms depending on type of substratum, local relief and topoclimate as well as short episodes of higher intensity of processes, which some try to explain as products of longer phases. In palaegeographical reconstructions, we simplify too much the picture of changes both in space and in time. Therefore the comparison with ^{18}O NGRIP curve is so valuable for establishing so valuable chronology of events even for distant area like Central-Eastern Europe.

Palaeoenvironmental changes of Orawa-Nowy Targ Basin in the Late Glacial and Holocene recorded in sediments of Grel raised bog

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The Grel raised peat bog is located in the Ludźmierz village vicinity in the Orawa-Nowy Targ Basin. This raised bog, has heavily degraded peat dome covered with numerous post excavation pits which are the results of peat extraction for local purposes. Peat bog is overgrown with birch and pine forests and typical vegetation for raised bog. First palynological study of the peat depositional sequence was performed by Koperowa (1962). The beginning of the peat bog formation was then attributed to the Oldest Dryas. Consequently the Grel is the oldest peat bog in the peatland of the Orawa-Nowy Targ Basin.

Several corings were made at the deepest part of the peat bog basin (GPS N49°28.733', E19° 59,293', 601 m asl) because, as a sample compared to the 1960's study, there was a significant compaction of peat and drastic reduction in thickness of peat bog (from the initial ca 8 m in the 1960's, to about ca 4 m today), which is the result of a significant drainage and desiccation.

Two cored logs, were examined by means of loss on ignition (Heiri et al., 2001) and palynological, as well as geochemical, and (mineral material) areometric analyses. The type of peat was determined based on macroscopic analysis. There were performed over 20 radiocarbon datings with using AMS and conventional techniques and an age-depth model was prepared using P_Sequence model in OxCal programme (Bronk Ramsey 2006) and IntCal13 calibration curve (Reimer et al. 2013).

Palynological analysis showed that the mineral sediments underlaying peat bog represent the overbank deposits of the Czarny Dunajec River, characteristic for river marshes (possibly of a crevasse character) accumulated during the Oldest Dryas. Only part of the Late Glacial and Holocene climatic changes are clearly marked within the peat bog sequence. The Late Glacial sequence is dominated by mineral deposit (mainly sandy silty clay) with thin organic inserts. The beginning of the accumulation of minerogenic, fen-type peat underlying sphagnum and eriophorum ombrogenic peat (predominating in the sequence) is ascribed to the upper Allerød. Mineral inserts (illuvial horizons) in the ombrogenic peat indicating increases in humidity of the climate (related to periodic floods of the nearby Czarny Dunajec River), were associated with the decline of the Younger Dryas (permafrost degradation), as well as the upper part of the Preboreal Phase and the Boreal Phase of the Holocene. Human impact is very slightly marked in the deposits. Pollen grains of cereals, weeds and other anthropogenic indicators occur only in the top of the sequence (uppermost 30 cm of the log),

which may indicate the removal of the upper, Subatlantic part of the sequence of sediment owing to as the peat extraction.

Acknowledgements

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References

Bronk Ramsey C, 2006. OxCal program v 4.0 [software and documentation]. http://c14.arch.ox.ac.uk/oxcal/hlp_contents.html

Heiri O, Lotter AF, Lemcke G, 2001. Loss on ignition as a method for estimating organic and carbonate content in sediments: reproducibility and comparability of results. Journal of Paleolimnology 25, 101-110.

Koperowa W, 1962. The history of the Late-Glacial and Holocene vegetation in Nowy Targ Basin. Acta Palaeobotanica 2(3): 3-57.

Reimer PJ, Bard E, Bayliss A, Beck JW, Blackwell PG, Bronk Ramsey C, Buck CE, Cheng H, Edwards RL, Friedrich M, Grootes PM, Guilderson TP, Haflidason H, Hajdas I, Hatte C, Heaton TJ, Hoffmann DL, Hogg AG, Hughen KA, Kaiser KF, Kromer B, Manning SW, Niu M, Reimer RW, Richards DA, Scott EM, Southon JR, Staff RA, Turney CSM, van der Plicht J, 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0-50,000 years cal BP. Radiocarbon 55(4): 1869-1887.

Radiocarbon dated malacological records of two Late Pleistocene loess-paleosol sequences from SW-Hungary: paleoecological inferences

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The two loess-paleosol sequences of Villánykövesd and Máza preserved expressive paleoecological information of the Late Pleistocene environmental conditions of SW-Hungary. For malacological examinations sampling of 12 cm intervals were used and homogenous amounts of sediment (cca. 5 kg) were collected. During the malacological examinations more than 27,000 specimens were identified. Adjusting their environmental and climatic demands the paleoclimate and paleoenvironment of the last 80,000 years could be reconstructed.

The results of the malacological investigations of Villánykövesd sequence indicated 5 malacological zones (MZs) by the snail species' dominance relations. All of the 5 MZs referred mild climatic conditions with only one cooling phase. The mild climatic conditions were reconstructed by the high dominance of thermophilous species, especially the *Pupilla triplicata*. This warmth loving, xerophilous and open vegetation dweller species is present in the entire sequence, which indicates a refuge area of *P. triplicata* around Villánykövesd.

At Máza sequence 9 MZs could be allocated with mainly significant dominance of cold resistant species, indicating cooler climatic conditions than Villánykövesd. The reason of the high ratio of cold resistant species and the high number of MZs could be the geographic exposition of Máza sequence. Máza sequence is located in a bench between higher and lower reliefs on the northern pediment area of Mecsek Mountains. This indicates the presence of a fluctuation area of the snail species in the area of Máza sequence.

The Late Pleistocene sequences possess different climatic and environmental conditions during same timeframe, so it can be said that the previously reconstructed mosaic-like environmental patters in the Carpathian Basin even here provable.

Petrographic comparison of four recent stalagmites from Baradla Cave Hungary - implications for the paleoclimate interpretation

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Baradla Cave is a world heritage site situated in the northeastern part of Hungary. The cave itself formed supposedly from the Pliocene in Mesozoic marine carbonates and today has a total length of 25 km. The climate of the area is continental most of the precipitation arrives during early-summer, however, the main infiltration period is from November to April when precipitation exceeds evapotranspiration. According to recent monitoring data, temperature in the cave varies around 9.8°C throughout the year while the pCO_2 of the cave air follows a seasonal cycle. The CO_2 mixing ratio is highest (~4200 ppm) during the summer and lowest during in winter (~1600 ppm).

The Nehéz-út ("NU") and the Vaskapu ("VK") branches are situated about 300 m away from each other and at a distance of about 1 km from the entrance of the cave. Four small, actively forming stalagmites were retrieved from here in 2014 (Fig. 1.). The aim of our study was to analyse their microfabric to improve our understanding how they can be used as proxies for environmental reconstruction.

Carbonate material for radiocarbon analysis was drilled out as 6-7 sampling lines from all four stalagmites parallel with the lamination. Petrographic thin sections were prepared and photographed under polarizing light and fluorescent blue light microscopes using 2x magnification. Lamina counting was performed along the growth axis of all stalagmites to check if the number of laminae is in agreement with the radiocarbon ages. Assuming the lamina couplets were forming annually, all radiocarbon sample lines were associated with a number of years according to the number of laminae they sampled. This way plotting the time-ranges of the radiocarbon samples derived from lamina counting against the atmospheric ^{14}C bomb peak the continuous growth and annual lamination of the stalagmites could be proved (Demény et al., 2016). The thickness of laminae was also measured in each stalagmite to compare it with the change in microfabric and isotopic composition and to check if it could be used as an independent proxy.

Using a petrographic microscope, two different types of fabrics were identified based on the samples' extinction under crossed polars: a mosaic and a columnar fabric (Frisia, 2015). The latter includes two other subtypes: columnar open fabric has high intercrystalline porosity, while the other columnar fabric is more compact. Lamina couplets in the open columnar fabric consists a thin, porous lamina, often covered by a thin detrital coating and a thicker lamina of dense calcite. In the open columnar fabric porous, inclusion-rich laminae are thicker. Comparing the average thickness of lamination we found that open columnar fabric

has wider lamina couplets. Mosaic fabric was common in the very bottom of the stalagmites with no lamination and without any fluorescence.

Two of the stalagmites (NU-1 and VK-2) consist of only open columnar fabric with parts of mosaic fabric by the clay surface they grew on, one stalagmite consist of both columnar fabrics (NU-2) while the other stalagmite (VK-1) had a reasonably denser fabric with frequent and thick detrital coatings in its laminae of columnar calcite. In the latter several uneven surfaces were also identified which questioned the continuous growth of this stalagmite.

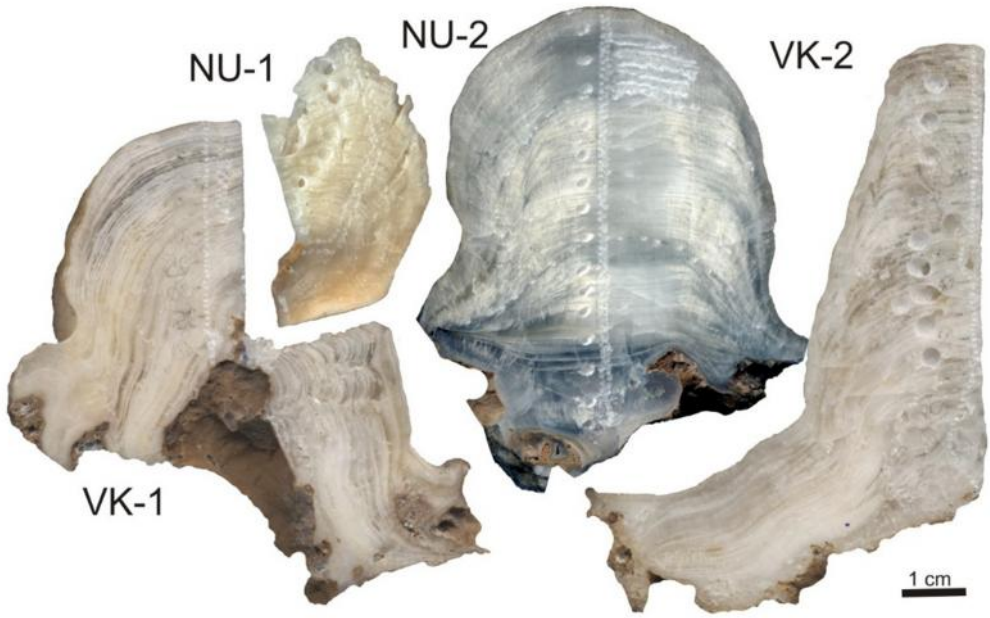

Fig. 1 Cut, polished and scanned surfaces of the four stalagmites collected from Nehéz-út (NU1, NU-2) and Vaskapu (VK-1, VK-2), Baradla Cave.

We compared the growth rates of the four stalagmites (Fig.2) based on the lamina counting and thickness measurements and also on the location of the atmospheric ^{14}C bomb peak. Stalagmites with more porous fabric (NU-1 and VK-2) showed higher growth rates compared to the denser ones (NU-2 and VK-1). Considering this, a uniform sampling size (0.5 mm diameter) and distance (1 mm) for $\delta^{18}O$ and $\delta^{13}C$ analysis can result in data series with very different temporal resolution. To mitigate this sampling bias all stable isotope analysis drill spots on the stalagmite surfaces were cross-checked with the thin-sections and given lamina dates. This way their geochemical information could be plotted on a common timescale.

Comparing the four $\delta^{18}O$ and $\delta^{13}C$ data series we found that stalagmites with similar fabric (the more porous NU-1 with VK-2 and the denser NU-2 with VK-1) had much more similarities in their stable isotopic composition than the ones with different fabrics. In the next step, all $\delta^{18}O$ and $\delta^{13}C$ data were cross-plotted. Samples drilled from similar fabrics formed partially overlapping groups. The most distinct group was formed by the samples drilled from mosaic fabric; where $\delta^{18}O$ values were always between -10 and -11 ‰, while $\delta^{13}C$ values showed a greater variation between -7 and -9 ‰.

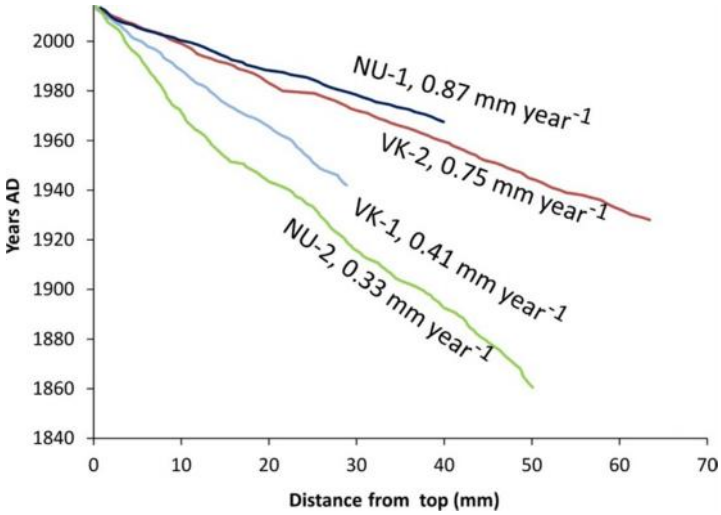

Fig. 2 Different growth rates of the four stalagmites based on lamina counting, Nehéz-út (NU1, NU-2) and Vaskapu (VK-1, VK-2).

These results are quite contrasting regarding that all stalagmites were collected from the same branch of the cave. The "NU" and "VK" coded collection sites were in a hundred metres distance from each other, however fabrics and growth rates were very distinct even at the same sampling site. These results call the attention that very different seepage pathways and reservoirs can feed nearby dripping points in the same cave, resulting in stalagmites with contrasting fabrics and geochemical features forming on the same site.

Acknowledgements

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References

Demény, A., Czuppon, G., Kern, Z., Leél-Őssy, S., Németh, A., Szabó, M., Tóth, M., Wu, C., Shen, C., Molnár, M., Németh, T., Németh, P., Óvári, M. (2016) Recrystallization-induced oxygen isotope changes in inclusion-hosted water of speleothems - Paleoclimatological implications. Quaternary International doi:10.1016/j.quaint.2015.11.137

Frisia, S. (2015) Microstratigraphic logging of calcite fabrics in speleothems as tool for palaeoclimate studies. International Journal of Speleology 44:1-16.

Pleistocene landslides in the Moldavian Plateau, Eastern Romania

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The Moldavian Plateau is a landslide prone region located in North-Eastern and Eastern Romania, the general morphostructural setting of this area consisting of a monocline with cuesta landforms. In the study area, the landslides are characterized by a strong temporal and spatial clustering, being influenced by the morphostructural setting and by the stratified layered rocks. The majority of the hillslopes affected by landslides are characterized by the presence of large old, relict landslides whose morphological signature is degraded by erosion and by younger landslides, the majority of them generating the retreat of the scarps in a retrogressive manner. In this paper we study the topological relations between several large landslides and archaeological sites for three selected settlements in the Moldavian Plateau, situated on ridges and hillslopes. Landslides and archaeological sites were mapped using high resolution LiDAR DEMs and extensive field validation activities were performed for stratigraphic and morphologic recognition of the landslides, deposits, and its relation with archaeologic sites.

Costești - Cier site is located in the Bahluieț floodplain on a relict landslide deposit that comes from failures of both sides of the valley, which possibly blocked the Bahluieț River. Nowadays is eroded by river, the morphology being of a terrace remnant. The oldest levels of population of the site is Cucuteni A. The landslide deposit is covered by a loamy deposit, which is a floodplain deposit, overlayed by a paleosoil, and the archaeological remains. Such a sequence not only is evidence that the landslide is older than the settlement, but older than the loam deposition event, which in turn occurred before the formation of a ~30 cm thick soil.

Cucuteni - Cetățuia site is located at the edge of the Laiu plateau, on a promontory cut by a gully, and is bounded on north, east and south sides by deep-seated landslide scarps. The main inhabitation of the settlement is attributed to Cucuteni A. This settlement is related to the Băiceni - Dâmbul Morii settlement, located downstream, at the base of the hillslope, on the relict landslide deposits, between Recea and Morii rivers. The site was populated in the Cucuteni A and AB phases.

The Truşeşti - Ţugueta is located on a plateau on top of a hill, on a loess layer of ~10 m thickness overlying the Bessarabian clays. The main very old landslide scarps appeared and evolved trough retrogressive before 6550 BP (pre-settlement), but after the loess deposition (LGM to Lateglacial).

Using the relations between archaeologic sites, landslides and site stratigraphy we argue the Pleistocene age of these landslides located in the lowland of Eastern Carpathians.

Tracing the influence of Mediterranean climate on Southeast Europe during the past 350,000 years

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Although global patterns of past climate change are relatively well established at the scale of orbital forcing, local responses in various regions are still not understood. Loess-paleosol sequences (LPS) are valuable archives of past environmental changes in Southeast Europe. However, most LPSs seem to be limited in their sensitivity to paleoclimate due to an overall imprint of enhanced dryness in the region during loess sedimentation. Here we present the results from the Stalać section in the Central Balkans, one of the first high-resolution multiproxy LPS records spanning the past ~350,000 years in Southeast Europe. Stalać LPS developed under stronger Mediterranean influence than most of the LPSs studied so far in Southeastern Europe. The results show a different climate evolution of the Central Balkans compared to the more northern environments in the Carpathian Basin. The Mediterranean influence strongly prevailed from Marine Isotope Stages (MIS) 10 to 6. However, a general trend of progressively weaker Mediterranean climate influence can be observed over the entire Southeastern Europe. An abrupt shift in general climate conditions over the interior of the Balkans to more continental conditions from MIS 5 is evident, possibly connected to a Greenland ice-sheet retreat. The different conditions over the Balkans during the last glacial can be inferred from the absence of a stronger glacier expansion over the region in this period. The absence of large glaciers probably enables stronger penetration of Mediterranean moist air from the south-west into the interior of the Balkans, causing higher humidity and precipitation during the last glacial compared to previous glaciations. This may explain why the Balkan Peninsula was a Quaternary floristic refugium, showing that the sharp and narrow climatic boundary between the Balkans and surrounding areas sustained to protect the Balkan Peninsula from the adverse climatic conditions in the North. Especially the observed enhanced humidity during the last glacial explains the importance of the Balkan Peninsula as a unique European biodiversity hotspot. Generally mild last glacial conditions by glacial standards and harsh conditions during the Heinrich event 4 combined with a sudden climatic change after the Campanian Ignimbrite - Y5 ashfall may be related to the anatomically modern human dispersal trough the Balkans and Europe.

A 1500 year aeolian history as recorded in a peat bog from northern Romania: dust fluxes and deposition control in comparison with Western Europe

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Dust consists of small particles that reached the atmosphere from various sources (arid or semi-arid regions) via aeolian processes. Dust plays an important role in climate systems due to the changes it can induce in the radiative properties of the atmosphere; reflecting or absorbing solar radiation, or, indirectly, by affecting cloud formation and precipitation patterns. Dust transport and deposition can vary over time and space, and it is controlled mainly by climatic characteristics (e.g., precipitation, wind speed, the movement of air masses) (Fig. 1). However, in Europe past variability in dust fluxes has been reported mainly from western regions of the continent.

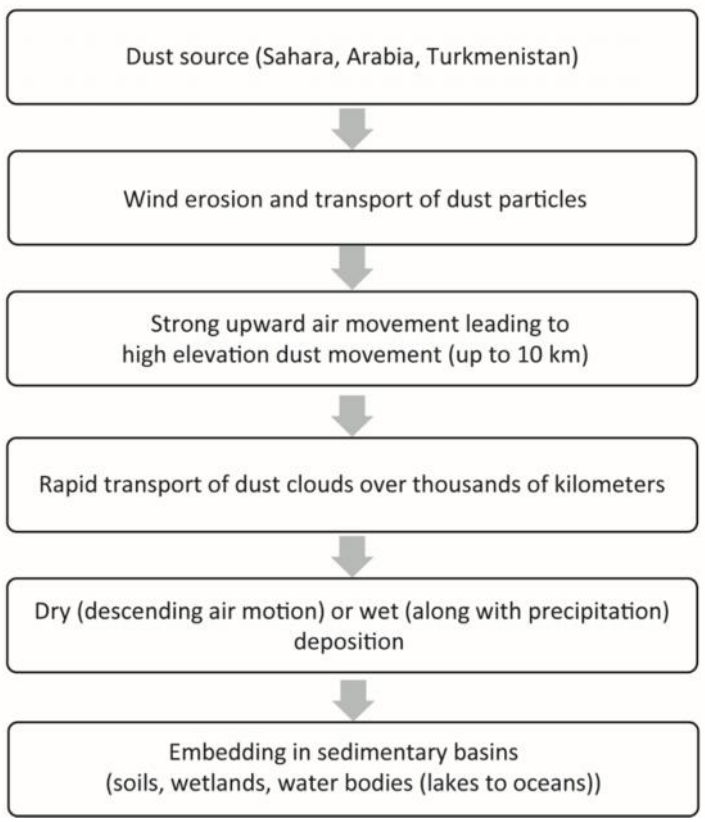

Fig. 1 Simplified scheme of dust transport and sedimentation.

Here, we have used a multi-proxy approach including physical (loss-on-ignition and two methods of particle size analysis), geochemical (XRF elemental data and carbon isotopic composition $\delta^{13}C$), biological (testate amoeba, pollen) and dating measurements (AMS ^{14}C, ^{210}Pb) to investigate an ombrogenous peat bog in the Carpathian Mountains of northern Romania. Our aims were to: i) determine dust fluxes over an extended Period (the last 1500 years); ii) examine the conditions that have influenced dust deposition in this area and whether these factors have changed over time; and iii) compare our data with studies elsewhere in continental Europe placing our Carpathian millennial dust history into a wider regional context.

Our results from show that during the Medieval Climatic Anomaly (MCO) (1050 – 750 years BP) the dust flux was high at time when the bog's testate amoeba and $\delta^{13}C$ indicate a wetter climate in this region. At the same time the minerogenic content, median size of particles and the maximum grain size diameter show high values indicating higher wind speeds. During the Little Ice Age (LIA) (650 - 150 years BP), dust fluxes declined, whereas climate conditions changed to a dry. Minerogenic content of the peat is low during this period, with a diminished median and maximum grain size, suggesting a fall and the fining of inputs during this period. From the end of the LIA to 1950 AD we recorded an increasing trend in dust flux associated with wetter climatic conditions. Subsequently, dust fluxes peaked over the last 60 years when climate conditions were warm and dry. As the same time the arboreal / non-arboreal pollen ratio indicates substantial deforestation in the wider region although not locally.

In Central-Western Europe (Poland and Switzerland) in the MCO dust fluxes were low in contrast to the LIA when they increased (De Vleeschouwer et al., 2009; Le Roux et al., 2012). Our record of dust fluxes from the MCO and LIA in the Carpathian Mountains are therefore contrary to those recorded elsewhere (and further west) in central Europe.

References

De Vleeschouwer, F., Piotrowska, N., Sikorski, J., Pawlyta, J., Cheburkin, A., Le Roux, G., Lamentowicz M., Fagel N., Mauquoy, D. (2009). Multiproxy evidence of `Little Ice Age' palaeoenvironmental changes in a peat bog from northern Poland. *The Holocene*, *19*(4), 625–637.

Le Roux, G., Fagel, N., De Vleeschouwe, F., Krachler, M., Debaille, V., Stille, P., Mattelli, N., Van der Knaap, W. O., Van Leeuwen, J. F. N., and Shotyk, W. (2012).Volcano- and climate-driven changes in atmospheric dust sources and fluxes since the Late Glacial in Central Europe, Geology, 40, 335–338.

Adjustment of the river channel due to block ramps introduction: Porębianka mountain creek, Polish Carpathians

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The paper includes a description of 25-five interlocked boulder block ramps with increased roughness located on Porębianka creek and presents an analysis how those low head hydraulic structures fit to a natural river system: riffle-pool. These block ramps with increased roughness structures might be called "close to the nature", and in hydraulics engineering they are replacing traditional drop hydraulic structures. One of the main advantages of block ramps is that they are supposed to be placed in a natural sequence distances which follows pools and riffles pattern along a river, also block ramps allows free movement of fish upstream and downstream without necessity of fish pass construction.

The analysis of geomorphological justification for cascades of block ramps in the river system has been done on the basis of inspection of orthophotos. These maps have been used for 1999, 2003 and 2009 from [http://miip.geomalopolska.pl/imap/] and for 2015 for [https://www.google.com/maps]. Maps from 1999 show the Porębianka riverbed before the construction of block ramps with increased roughness. In maps from 2003 one can see 9 located in the lower section of the stream (structures 1 - 9). Moreover, in those maps one can see the boulder ramps 17 and 18 which were under construction that time. Next map from 2009, shows the riverbed and 18 rapids (structures 1 - 18). The last map shows all already built hydraulic structures (structures 1 – 25). Based on all orthophotos from the years 1999 - 2015, one can notice the width of the water table and the river bed, as well as the surface of the gravel bars. The analysis shows that during the period of ramp construction, the distance between only 1 pair of ramps corresponded to the range of 5-7 channel widths.

Also along the paper we determined variability braided parameters and their changes along 16 years of existing of block ramp cascades, which values indicate a tendency to reduce braiding of Porebianka. Finally we determined the changes of width of the water table and river bed and river gravel bars area and so called active riverbed along the period of observations.

Rock glaciers evolution in Late Glacial and Holocene inferred from the new palaeoclimatic data

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Overview

Rock glaciers are landforms made of mountain permafrost creeping under the effect of gravity and characterized by a particular topography of ridges and furrows ended with a steep front. By decoding their present morphology and understanding their altitudinal distribution, a variety of aspects of the past climatic conditions can be inferred because inactive and relict rock glaciers are located in warmer climates in comparison to their necessary morphogenetic conditions (Frauenfelder and Kääb 2000). Most of the rock glaciers from SC are of small dimensions (0.05km2), they have a faded morphology and are covered in different proportions with soil and vegetation indicating their inactive or relict state, characteristic to the marginal permafrost conditions of Southern Carpathians. That is because most of the rock glaciers are located in positive mean multiannual air temperatures. Several field studies performed in the last decade indicate that permafrost is present in rock glaciers above 1950 m a.s.l. in the highest massifs of SC, with a relatively more widespread distribution in the granitic massifs (Vespremeanu-Stroe et al., 2012; Onaca et al., 2013; Popescu et al., 2015; Onaca et al., 2015).

New palaeoclimatic information

Several recent palaeoclimatic studies brought valuable information regarding the climate oscillations during the Late Glacial and Holocene in the region of the Romanian Carpathians. They were based on speleothems (e.g. Tămaş et al., 2005) and glacial lake sediments analysis (e.g. Magyari et al., 2012, Toth et al., 2015). Other studies investigated in detail the glacial traces (especially moraines) and inferred the timing and extent of SC glaciers from the Last Glacial Maximum to the Holocene (Reuther et al., 2007; Urdea and Reuther, 2009; Kuhlemann et al., 2013; Gheorghiu et al., 2015; Ruszkiczay-Rüdiger et al., 2016). All these information can be used for a better understanding of the glacial-permafrost interactions and rock glaciers genesis at the end of the last glaciation and also of the periods of activity of rock glaciers from different altitudinal floors.

Approach and analysis

We computed the contemporary mean annual air temperature (MAAT) at the mean elevation of each rock glacier, the annual potential incoming solar radiation and the offset necessary (ΔMAAT) for each rock glacier to be active. The necessary period for each rock glacier development was than estimated using the length, surface, morphology characteristics and using a mean creep rate.

Rock glaciers vegetation cover and Pinus mugo growth ring analysis on three rock glaciers from Retezat Massif are also presented and discussed in relation to the possibility of the past and present rock glaciers activity. In the same time, the results are discussed in the context with the recent studies on rock glaciers activity (Vespremeanu-Stroe et al., 2012; Necşoiu et al., 2016) and with other in situ measured data (Popescu and Vespremeanu-Stroe, unpublished data).

Preliminary results and discussion

The low altitude SC rock glaciers are located in MAAT conditions well above 0°C and would need a ΔMAAT of at least 3-4 °C to be active. According to Kääb et al. (2007) rock glaciers from the Alps are active between +0.5 and -8°C and those with MAAT between 0 and -1…-2 °C are often climatically destabilized and fast moving landforms. They formed after the local glacial retreat probably in Oldest Dryas and were active for a short period of time, from a few hundred years to at most one thousand years. That could explain the smaller surfaces and faded morphology of low altitude rock glaciers besides their lower debris supply from the secondary mountain ridges. In turn, high altitude rock glaciers, above 2000 m present near 0°C MAAT, some of them close to -1 °C, but they seem rather inactive. The only notable exceptions could be Judele rock glaciers and the upper sectors of Valea Rea and Galeşu rock glaciers from Retezat Massif. These high altitude rock glaciers are better developed in surfaces and lengths indicating a prolonged activity period of more than one thousand years and a more consistent debris supply. In the same time they should have experienced more intense creep processes that could counterweight their younger ages, probably Younger Dryas or early Holocene. Whether glaciers were widespread in SC during the Younger Dryas or not is still a debated issue (Gheorghiu et al., 2015; Ruszkiczay-Rüdiger et al., 2016). If glaciers were largely absent in the Younger Dryas in SC it is probable that the most high altitude rock glaciers from SC were born in that period and were active only until the beginning of the Holocene, no more than the 8.2 ka cold event. They should have maintained their status until the present after they became inactive and relict and they could not have been reactivated in the Holocene cold phases. When permafrost favorable conditions emerge after a warm phase new protalus lobes cover the relict rock glacier body and become new rock glaciers. However, this evolutionary model seems not suitable for the most shaded and cold rock glaciers like Judele which looks active in the present with very small creep rates though (Popescu and Vespremeanu-Stroe, unpublished data). Even more surprisingly, a new study (Necşoiu et al., 2016) indicate that a medium altitude rock glacier like Pietrele from Retezat Massif was still active in the last 46 years and also in the last 7 years in spite of its vegetated ridges. Its creep rates are currently below 1 cm/year. If the movement is caused by permafrost creep it would imply that SC granitic rock glaciers above 2000 m with fragmentary patches of permafrost in their bodies were active during the entire Holocene and the vegetation cover was possible because of their low creep rates.

The Pinus mugo shrubs installed almost simultaneous across the rock glacier areas between 1950 m and 2150 m a.s.l. beginning with the year of 1830 CE (Valea Rea) indicated a reduction in rock glaciers speed after the end of the Little Ice Age. We conclude that more in situ topographical and dendrological (growth ring) data and on a longer time scale are needed in order to validate the actual rock glacier dynamic state. Some absolute age dating methods could also be applied on rock glaciers boulders in the attempt to infer their ages.

Coordinated global change research – the ICSU perspective

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Bottom-up collaboration between scientists across borders is expanding, as shown by authorship analyses. It is also fruitful, since publications with authors from several countries have, on the average, higher impact than single-country papers. Coordinated international collaboration is needed to address complex problems in a strategic and interdisciplinary fashion. The International Council for Science (ICSU) organized the International Geophysical Year in 1957, which fostered research in global environmental change from the geosciences perspective. The scope of research interest soon expanded, first into other "hard" natural sciences, then into biological and ecological sciences, and finally into social sciences. To coordinate international research, ICSU with partners set up four interdisciplinary programs, with the focus first on climate (WCRP), then on the geosphere-biosphere (IGBP), ecology and biodiversity (Diversitas), and finally the the human dimension (IHDP). These programs produced most of the science reviewed by the IPCC in its assessments and advice to policymakers.

However, an expert review of the four programs indicated that they did not strategically address urgent issues important for society related to global change, that there were gaps and overlaps, and that a coordination structure set up by the programs themselves (ESSP) had failed. Therefore, ICSU decided to fuse the programs into a new research framework, Future Earth, launched in 2014 (WCRP decided to remain independent under WMO). The International Social Sciences Council (ISSC), UNEP, UNESCO, UNU, and the Belmont Group (formed by the major funding agencies) joined as partners. The guiding principles of the new program are true interdisciplinarity (including the social sciences and humanities), production of knowledge that society needs for action to meet the challenges of global change, and co-design and co-production of knowledge with end-users. As the old programs are closed, most of their Core Projects have joined Future Earth, with the expectation that they would adopt similar principles.

Future Earth is still struggling with getting organized and raising funds. However, a strategic research agenda has been adopted and eight major challenges identified, including food and water, biodiversity and ecosystem services, urbanization, sustainable consumption and production, and human health. These will be the themes of new collaborative research structures called Knowledge-Action-Networks (KANs), which will invite interested research groups and programs world-wide to participate. After several decades of experience on planning and evaluating international research programs, ICSU has learned some lessons. Interdisciplinary research is essential but difficult to achieve without a determined effort, and there is still room for competent disciplinary work. All programs should have a sunset clause, in the case of Future Earth a ten-year life span followed by a review. Co-design is important for truly engaging with societal partners, but not relevant in all situations. Governance of research programs should be light and flexible, preferably managed by an International Program Office and guided by a Scientific Steering Committee. Early career scientists should be recruited, not only to perform research but also participate in planning.

New Middle Pleistocene records from the North-East foothills of Carpathian Mountains

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Two kinds of paleogeographic records from the Middle Pleistocene were recently first discovered in the Bukovinian foothills of the Carpathian Mountains, not far downstream from the confluence of the Prut and Cheremosh Rivers.

The area of investigation is associated with the lower Brusnytsia River, the right tributary of the Prut River (fig. 1). Due to the active tectonic uplift, wide spread of dispersal Neogenic and Quaternary sediments, and comparatively wet climate, the whole area of the Prut and Siret rivers' interfluve is strongly damaged by landslides. Therefore it is quit problematic to find undisturbed Quaternary river terrace sequences in the area. Generally, the territory is characterized by the lack of Quaternary records at all. Only few Late Paleolithic sites without geological sequence were known few kilometers downstream the Prut R. Moreover it was important to look for the evidence of the Middle Pleistocene there.

Table 1 Selection of Zeleniv

Depth, m	Sediments	Age
0.0 – 5.75	Grayish-yellow silt pack, platy partied, with ferritization along bedding surface, and with spots of gleying along plants' roots. Its upper part (1.0-1.5 m) modified by modern soil.	**dn**
5.75– 6.65	Fine, silty, yellow polymictic, obliquely layered sand.	**dn**
6.65 –8.0	Pack of sediments, containing interbedding of silt, sand, and gley interbeds, strongly affected by cryoturbations.	**dn**
8.0 – 8.7	Thin laminated interbedding of silt and gley-soil (from 1-3 mm up to 5 cm) layers, microfolded.	**zv**
8.7 – 9.0	Clayey paleosol with the similar laminated and microfolded structure, and with carboniferous and ferriferous layers at the foot.	**zv**
9.0 – 9.5	The light-yellow loess, sometimes with layers of purple. The last 10 cm are grayish, probably glayed.	**tl**

Some paleontological evidence of the Middle and Late Pleistocene bone-bearing deposits presence in the area we found in three local museums, in Zeleniv and Brusnytsia villages. There were remains of Proboscidea, belonging to few individuals of the *Mammuthus* line, represented mainly with teeth and not numerous limb bones. The determination of *Mammuthus* species was realised with the method elaborated by Foronova and Zudin (1986) and developed in the next publications (Foronova and Zudin, 1999, 2001; Foronova, 2001a,b, 2003, 2007). The method is based on values of enamel thickness, plate frequency and plate length of molars (M3). Three specimens (ZL-02, BR-01, BR-04) were determined to *Mammuthus trogonterii and M.* cf. *trogonterii chosaricus* (probably late subspecies of *M. trogonterii*), which refers to the early and middle parts of the Middle Pleistocene. Two

specimens (ZL-03, BR-02) belonged to the early form of *M. primigenius,* referred usually to the first part of Late Pleistocene, but probably appear at the end of the Middle Pleistocene. Two specimens more were determined as *M. primigenius* cf. *jatzkovi*, referred by Foronova (2001) to the middle part of Late Pleistocene, and only one tooth belonged to *M. primigenius primigenius,* living at the end of Late Pleistocene. Teeth and bones were partly collected by local people from the river bed of the Brusnytsia R., and partly were excavated from the loess outcrop in Zeleniv Village, at the early 1990th.

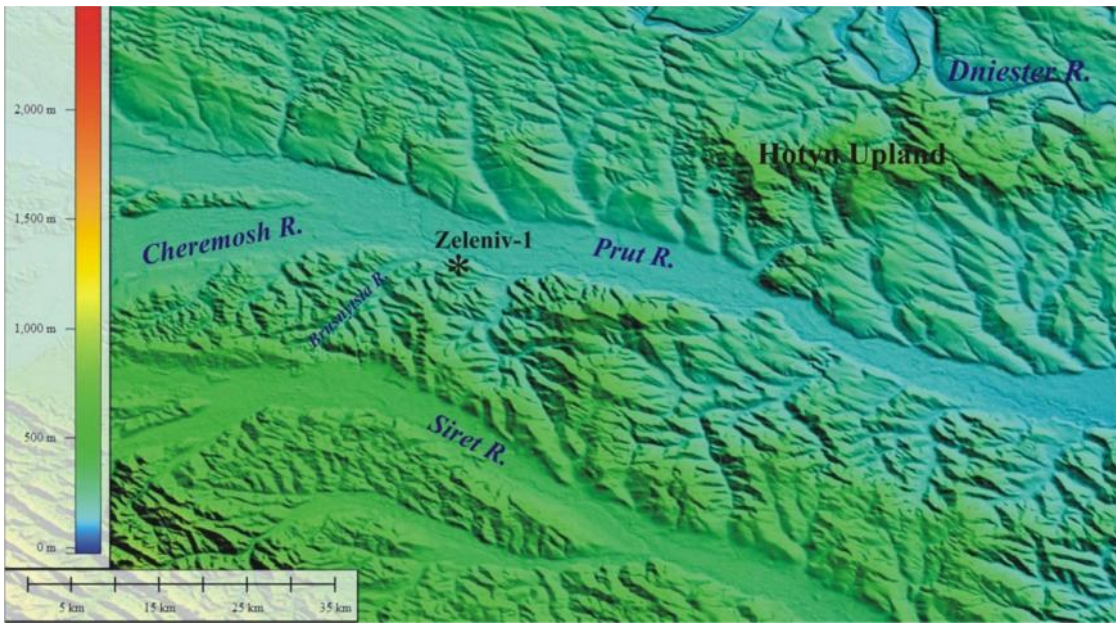

Fig. 1 Zeleniv-1 site location.

Fig. 2 Specimen BR-01, *Mammuthus* cf. *trogonterii chosaricus* from Zeleniv vicinities.

We studied preliminary this 10 m thick loess section (table 1). Its top is 30 m, and its basis is near 20 m above the Prut R. We suppose it represents the sequence of the VIth terrace of the

Lybny-Tiligul stage (Veklych, 1982) (correlates with Cromerian IV – Elster 2 (Lindner et al., 2004)).

The alluvial layer is suggested 2 m below but wasn't achieved yet. The geological age (geological stages after Veklych (1982), specified by Gerasimenko (2004)) of sediment units was estimated preliminary, on the base of paleopedological observations and the terrace position. It should be confirmed by the next complex study. Also, the search of the bone-bearing layers should be continued.

References

Foronova I.V., Zudin A.N., 1986. A new approach to the study of north Eurasian fossil elephants of the Archidiskodon-Mammuthus lineage. In: Arkhipov S.A. (ed.). Biostratigraphy and Paleoclimates of the Pleistocene in Siberia. Novosibirsk, p.6–31 (in Russian).

Foronova I.V., Zudin A.N., 1999. The structure of the lineage Archidiskodon – Mammuthus in Eurasia and peculiarities of its evolution. In: Haynes G., Klimovicz J., Reumer J.W.F. (eds.). Mammoths and the Mammoth Fauna. Deinsea, vol.6, p.103–118.

Foronova I.V., Zudin A.N., 2001. Discreteness of evolution and variability in mammoth lineage: method for group study. In: Cavarretta G., Gioia P., Mussi M. & Palombo M.R. (eds.). The World of Elephants. Rome, p.540–543.

Foronova I.V., 2001a. History of Quaternary proboscideans of the south of Western Siberia inferred from dental system analysis. In: Cavarretta G., Gioia P., Mussi M. & Palombo M.R. (eds.). The World of Elephants. Rome, p.109–114.

Foronova I.V., 2001b. Quaternary Mammals of the SouthEast of Western Siberia (Kuznetsk Basin): Phylogeny, Biostratigraphy, and Palaeoecology. Novosibirsk: Publishing House of Siberian Branch, Russian Academy of Sciences, 243 p. (in Russian).

Foronova I.V., 2003. History of mammoth lineage in the Southern part of Central Siberia. In: Third International Mammoth Conference, Dawson City and Whitehorse, Yukon. Occasional Papers in Earth Sciences, no.5, p. 35–36.

Foronova I.V., 2007. Thin-enamel dental specialization in mammoth evolution: an example of direction selection. Quaternary International 69–70 : 95–104.

Gerasimenko N.P., 2004. The development of zonal Quaternary landscapes in Ukraine. Kyiv, 41 p. (in Ukrainian).

Lindner L., Gozhik P., Marciniak B., Marks L., Yelovicheva Y., 2004. Main climatic changes in the Quaternary of Poland, Belarus and Ukraine. Geological Quarterly, 48 (2): 97–114.

Veklych M.F., 1982. Paleostages and stratotypes of soil formations of the Upper Cainozoic. Naukova Dumka, Kiev, 201 p. (in Russian).

Cave sediments and fossils as karst archives: the Urşilor and Muierilor caves, Romania

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During the last eight years an ongoing interdisciplinary research is being carried out at the Urşilor and Muierilor caves, Romania. This sedimentological, geomorphological and geochronological study aims at better understanding of the taphonomy of the MIS 3 fossil accumulations and their palaeoclimate context. The two sites contain complex types of fossil thanatocoenosis - in situ, secondary or mixt.

Numerous methods of investigation, typical for this type of multidisciplinary research were applied: AMS 14C direct dating on fossil bone (N = 42), U/Th dating of the relevant speleothems (N = 4), termoluminiscence for dating sediments (OSL; N=7), analysis of physical and chemical properties of cave sediments, rock magnetism, stable isotope analyses on the cave bear's bone collagen (δ15N and δ13C; N=125), taphonomic methods for assessing the bone assemblage's properties (MNI, NISP, ISD, long bone orientation etc.), high resolution osteometry, laser scanning of the cave bear' bioglyphs etc.

In Urşilor Cave, the obtained results on direct dating pointed to a continuous population by the cave bear fauna between ~45 and ~29 ka cal BP. The cave bear assemblage from the Excavation Chamber represents an in situ thanatocoenosis with high density of individuals (MNI = 109 individuals/9 m2), deposited between ca. 45 to 39.2 ky cal BP. Based on combined dating of speleothems and cave sediments, it appears that speleothem precipitation was not prevented during cold periods and sediment depositional events were more likely linked to warmer and wetter periods. The stable isotope analyses performed on the cave bear collagen indicated omnivorous habits for the analyzed individuals, similar to the Pestera cu Oase population. We performed a first palaeoichnological assessment of the site, with several bioglyphs being indirectly dated based on their assignment to skeletons or parts of cave bear skeleton.

In Muierilor Cave, the preliminary data show that the cave bear fauna dates back between ca. 48-28 ka cal BP, roughly coeval with Urşilor Cave. Long bones orientation was analyzed over ca. 9 m2 and indicates reworking processes of the fossil bones (secondary thanatocoenosis). The reworking appears to be linked to a climate event that generated successive floodings of cave passages by ~35 ka.

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Remotely Sensing the Ancient Interactions between Humans and the Environment during the Roman Period at Porolissum

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Introduction

This paper summarizes results from a landscape archaeology research project that explores the ways in which ancient Romans from the territory of Dacia Porolissensis (Romania) used and modified the environment around them. Based on LiDAR-derived data (Light Detection and Ranging) for accurate archaeological, geomorphological and vegetation feature detection, the most probable effects of past human land-use on the present landscape values are assessed. Knowledge of human disturbance periods, land-use history and their corresponding legacies is vital for evaluating habitat resilience and predicting future ecosystem services (Glenn et al. 1999; Foster 2003; Ritter 2011).

Materials and methods

The study area covers 10 km^2 and encompasses the archaeological site from Moigrad-Porolissum (Sălaj County, Romania), which is part of the Roman Empire Frontier fortification system, also called the *Roman Empire Limes* (Figure 1a). LiDAR data were collected in March 2013 during the leaf-off season using a helicopter equipped with Riegl's LMS-Q560 laser scanner, flying at an altitude of 600 m. The raw LiDAR data were employed to create the very accurate and high resolution (0.5 m) Digital Terrain Model (DTM) and Digital Surface Model (DSM). Subsequently, the DTM was visualized by generating different topographical and geomorphological models. The Canopy Height Model (CHM), which revealed the 3D vegetation structure, was computed as a difference between the DSM and DTM. These LiDAR-derived models enabled the detection of both ancient human influences and their results in the present landscape characteristics.

Results and discussion

The visualization techniques of the LiDAR-derived DTM (Figure 1b and 1c) allowed the accurate mapping of previously unknown underground archaeological remains (Opreanu et al. 2014; Roman et al. 2016a manuscript) situated in forested steep terrain (Figure 2). These ancient structures, placed strategically within the landscape, are the vestiges of defense walls, ditches, forts, fortresses, watchtowers and tumuli. In addition, the present road network, water courses, some ancient roads, small anthropogenic depressions and caves (e.g. Figure 1d) were detected using these LiDAR derived-data (Roman et al. 2015; Roman et al. 2016b manuscript).

The analysis of 3D forest structure (CHM) revealed substantial differences in tree height between the trees growing upon underground ancient structures and the surrounding canopy (Roman et al. 2014). Currently, the forest vegetation is dominated by beech, hornbeam and oak species, (Roman et al. 2014), being considered similar to that found in this region during the Roman period (Nyárády et al. 1966; Raţiu 1966; Grindean et al. 2014).

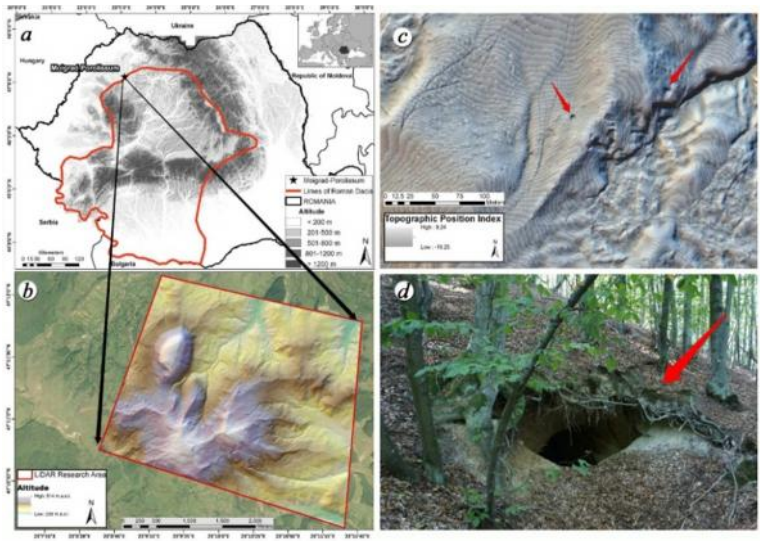

Fig. 1 (a) The frontiers of the ancient Roman Dacia and the study site; (b) The LiDAR-research area and derived terrain models: Hill-shade model displayed with a 60 % transparency on the DTM; (c) The topographical position index with the detected small anthropogenic depressions and caves (red arrows); (d) In-situ validation of a small depression – cave opening (red arrow).

The above mentioned interdisciplinary results support the understanding of ancient human activities and their impact on the environment during the Roman period at Porolissum (106-276 AD). We have identified the main interacting factors that shaped the natural landscape into a cultural one with many embedded legacies. The most important one is land cover, which was considerably different at that time. In contrast to the present forest dominance, it appears that in the areas of the Roman Empire Frontiers, like Porolissum, there was a deforested landscape with intense military and most probable agricultural activities. The defense walls and ditches, watchtowers, forts and fortifications, were built strategically on the local relief and formed an intricate system that had the role of early warning against barbarian attacks. Besides being mandatory for defensive purposes (visibility for communication between the watchtowers), the open landscape hypothesis is also supported by paleo-environmental studies and palynological analysis that indicate large-scale deforestation within this area (Rosch & Fischer 2000; Tanţău et al. 2003; Tanţău et al. 2006; Feurdean 2010; Tanţău et al. 2014). Oak, beech, and hornbeam show a decrease in the pollen spectra during a time span overlapping the Roman period (Grindean et al. 2014). Moreover, historical data sources also mention that deforestation around the military encampment was a basic strategic measure in the Roman provinces (Chew 2008; Ritter 2011). The buried remains of these ancient structures have caused anomalies in the soil matrix that translate nowadays into human generated tree height patterns (Figure 3a and 3b). These, along with the Roman earthworks (more than 7 km of turf defensive mounds build on the ridges) remain visible throughout the millennia.

Data regarding the historical landscapes are important since ancient forests are often used as a baseline for ecological restoration (Honnay et al. 2002). Nevertheless, their primary character is uncertain because the limited historical records available do not allow tracing a site's history for hundreds or thousands of years (Peterken 1996). LiDAR techniques can help landscape archeology go beyond this time barrier. Within the Porolissum site, the geomorphological and archaeological evidence combined with the vegetation data suggest a

deforestation land-use phase. There are just a few other ancient forest studies in France and Belgium that demonstrated the persistence of Roman land-use effects on both soil and vegetation characteristics for more than two millennia (Dupouey et al. 2002; Vanwalleghem et al. 2004).

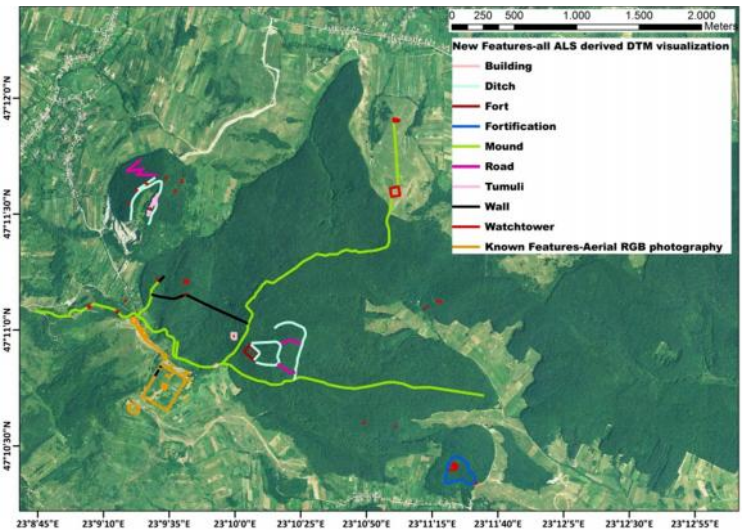

Fig. 2 The present forested cultural landscape with ancient underground defensive structures at Porolissum.

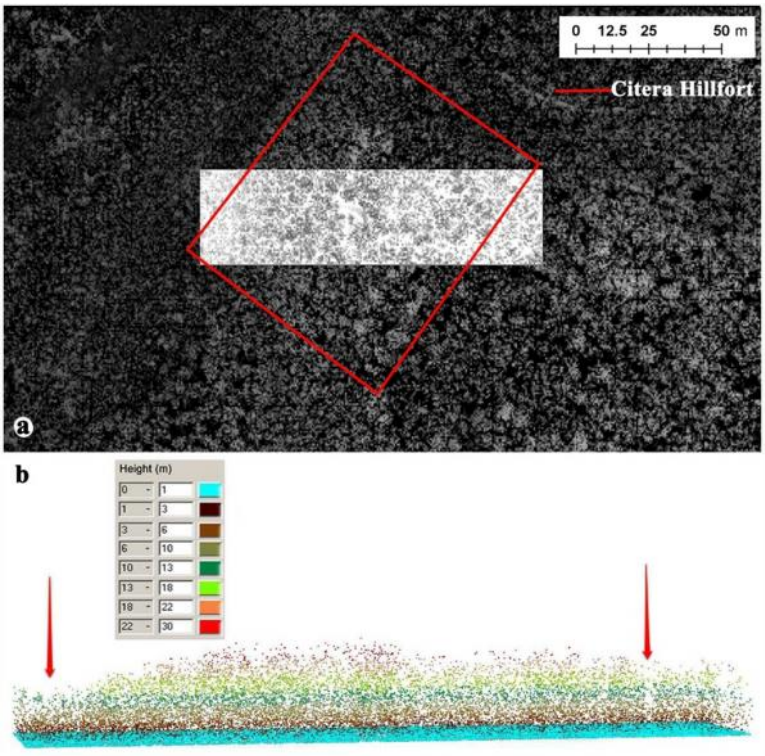

Fig. 3 (a) The DSM and the underground Citera Hill Fort remains (red lines) with a selection from the LiDAR-data point cloud (white rectangle); (b) Cross-section of the LiDAR point cloud displaying the 3D forest structure and tree height pattern (red arrows-low tree height above the ancient underground walls).

Conclusions

Vegetation analysis and mapping together with active and passive remote sensing provide a base for combining the knowledge of plant ecologists and archaeologists in order to achieve a thorough landscape analysis and understand the interacting processes that influence habitat quality. Since such buried legacies of ancient settlements, although widespread, are

easily overlooked mainly in forest habitats, they are of particular interest to conservationists and land managers as well as to scientists. These results emphasize the long term, irreversible effects of ancient human impact on the landscape, which is often cultural beneath its natural appearance. The detected trends should also raise awareness among scientists (e.g. biologists, soil scientists, geomorphologists) that research in historical sites requires a particular perspective. There are cases when habitats like ancient forests are not actually primary. In such circumstances, the seemingly intrinsic variations in vegetation, soil or relief are in fact the result of ancient human impacts on the environment. Consequently, the historical perspective and the awareness of land-use legacies may be facilitated by the remote sensing techniques, specifically when inferring the natural or cultural state of a landscape.

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References

Chew S.C. 2008. Ecological futures: what history can teach us. AltaMira Press, Plymouth, 170p.

Dupouey J.L., Dambrine E., Laffite J.D., Moares C. 2002. Irreversible impact of past land use on forest soils and biodiversity. Ecology, 83: 2978-2984.

Feurdean A. 2010. Forest conservation in a changing world: natural or cultural? Example from the Western Carpathians forests, Romania. Studia Universitatis Babes-Bolyai, Geologia 55(1): 45-48.

Foster D., Swanson F., Aber J., Burke I., Brokaw N., Tilman D., Knapp A. 2003. The importance of land-use legacies to ecology and conservation. BioScience, 53(1): 77-88.

Glenn M., Wilson P., Foster D., Allen A. 1999. Vegetation patterns in heterogeneous landscapes: The importance of history and environment. Journal of Vegetation Science, 10: 903-920.

Grindean R., Tanţău I., Fărcaş S., Panait A. 2014. Mid- to late-Holocene vegetation shifts in the NW Transylvanian lowlands (Romania). Studia Universitatis Babes-Bolyai, Geologia, 59(1): 29-37.

Honnay O., Bossuyt B., Verheyen K., Butaye J.,Jacquemyn H., Hermym. 2002. Ecological perspectives for the restoration of plant communities in European temperate forests. Biodiversity and Conservation,11: 213-242.

Nyárády A., Lupşa V., Boşcaiu N. 1966 Studiul geobotanic şi palinologic al mlaştinii de la izvorul râului Crişul Repede. Studii şi Cercetări Biologice Seria Botanică, 18(4): 331-339.

Opreanu C.H., Lăzărescu V.A., Roman A., Ursu T.M., Fărcaş S. 2014. New light on a Roman Fort based on a LiDAR survey in the forested landscape from Porolissvm. Ephemeris Napocensis, 24: 71-86.

Peterken G.F. 1996. Natural woodland.Cambridge University Press, Cambridge, 522p.

Raţiu F. 1966. Istoricul vegetaţiei. Flora şi vegetaţia rezervaţiei naturale „Defileul Crişului Repede". Contribuţii Botanice: 155-161.

Ritter E. 2011. Forests in landscapes. The myth of untouched wilderness. In Ritter E. (ed.), New Perspectives on People and Forests. Springer, pp. 11-28.

Roman A., Ursu T.M., Fărcaş S., Lăzărescu V.A., Opreanu C.H. 2014. Perspectives: remotely sensing the buried past of present vegetation. In Pfeifer N., Zlinszky A. (eds.), Proceedings of The International Workshop on Remote Sensing and GIS for Monitoring of Habitat Quality. Vienna University of Technology, Vienna, pp. 108-112.

Roman A., Ursu T.M., Lăzărescu V.A., Opreanu C.H., Fărcaş S. 2016a. Visualization techniques of ALS-derived DTM in forested steep terrain: A case study for the recovery of unknown underground archaeological remains. Manuscript.

Roman A., Ursu T.M., Fărcaş S., Lăzărescu V.A., Opreanu C.H. 2016b. An integrated airborne laser scanning approach to forest management and cultural heritage issues at the archaeological site from Porolissum Manuscript.

Roman A., Ursu, T.M., Fărcaş S., Lăzărescu V.A., Opreanu C.H. 2015. Using airborne LiDAR for detection and morphologic analysis of waterbodies obscured by the forest canopy. Transylvanian Review of Systematical and Ecological Research. The Wetlands Diversity 17(1): 1-14.

Rosch M., Fischer E. 2000. A radiocarbon dated Holocene pollen profile from the Banat Mountains (Southwestern Carpathians, Romania). Flora 195(3): 277-286.

Şuteu Ş., Teodoreanu E., Diaconeasa B. 1978. Prezentul şi trecutul vegetaţiei palustre din tăurile de la Hereclean (jud.Sălaj). Contribuţii Botanice: 265-268.

Tanţău I., Feurdean A., de Beaulieu J.L., Reille M., Fărcaş S. 2014. Vegetation sensitivity to climate changes and human impact in the harghita mountains (Eastern Romanian Carpathians) over the past 15 000 Years. Journal of Quaternary Science 29(2): 141-152.

Tanţău I., Reille M., de Beaulieu J.L., Fărcaş S. 2006. Late glacial and Holocene vegetation history in the southern part of Transylvania (Romania): Pollen analysis of two sequences from Avrig. Journal of Quaternary Science 21(1): 49-61.

Tanţău I., Reille M., de Beaulieu J.L., Fărcaş S., Goslar T., Paterne M. 2003. Vegetation history in the Eastern Romanian Carpathians: Pollen analysis of two sequences from the Mohoş Crater. Vegetation History and Archaeobotany 12(2): 11-25.

Vanwalleghemt., Poesen J., van den Eeckhaut M., Nachtergaele J., Deckers J. 2004. Reconstructing rainfall and land use conditions leading to the development of old gullies. The Holocene 15(3): 378-386.

Our way to Europe: Research for a better understanding of human dispersal

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The Collaborative Research Centre (CRC) 806, a big research project titled "Our way to Europe" organised by Universities of Cologne, Bonn and Aachen (Germany), aims in understanding the complex interplay between climate, the environment and the socio-cultural context influencing the spread of anatomically modern humans (AMH) from their source region in East Africa to one of their sinks: Central Europe. Localisation of individual research sites on the main pathways out of Africa, the methods used and first results will be presented with a special focus on the Balkans.

Non-marine Ostracoda in Sağlık plain, Kahramanmaraş, Turkey, since the Late Glacial to mid-Holocene

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We present the freshwater ostracod stratigraphy of former lake, in Sağlık plain, South Central Anatolia, Turkey, since the Last Late Glacial until the mid-Holocene. Podocopoid (non-marine) ostracods were identified in Sağlık II (SAĞ II) core whose the lowermost part goes back to 15500 years ago. Both smooth and noded forms of *Cyprideis torosa* (*Jones, 1850*), *Candona sp*. (*Baird, 1845*), *Ilyocypris sp.* (*Brady & Norman, 1889*), *Darwinula stevensoni* (*Brady & Robertson, 1870*), *Plesiocypridopsis newtoni* (*Brady & Robertson, 1870*), and *Prionocypris zenkeri* (*Chyzer&Toth, 1858*) were the observed species.

C. torosa, Candona sp., Darwinula stevensoni, Ilyocypris sp., and *Prionocypris zenkeri* were all observed in the lowermost half of the core during the Late Glacial. Observed *Candona sp*. valves and carapaces were mostly juveniles. Smooth and noded forms of *Cyprideis torosa* co-occurred during these time. The presence of both smooth and noded forms of *C. torosa* during lowermost half of the core may indicate changing salinity levels during this time. Both smooth and noded forms of *C. torosa* and more abundant *Prionocypris zenkeri* were mostly observed during zone I and zone 5, during the Younger and Older Dryas. *C. torosa* is almost absent during zone 4 during the Alleröd/Bolling.

Both forms of *C. torosa* disappear abruptly in the core sequence at the onset of the Holocene. High numbers of adult *Candona* sp. valves were only found at 600 cm depth, around 8558 years ago. They were mostly carapaces (77%). At the same depth juvenile carapaces of *Candona* sp. were present which could mean unfavourable conditions during this time. Almost absence of ostracods between 500th cm and 380th cm maybe indicative of severe drought. *Plesiocypridopsis newtoni* was recorded only in the uppermost. Zone 8, the uppermost part of the core, indicates shallow water environment.

Monsoon-driven paleoproductivity changes in the central Red Sea during MIS 4 - MIS 6

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The Red Sea is an elongated and desert-enclosed basin with very limited connections to the global ocean. As a consequence the effects of atmospheric forcing on its marine environment are amplified. Previous studies of planktonic microfossil assemblages suggested that paleoproductivity in the Red Sea was elevated during boreal winter insolation maxima[1], reflecting enhanced Indian NE monsoon-driven exchange with the Indian Ocean. However, the plankton-based reconstructions are overprinted by nuisance variables in the surface waters and cannot be applied to glacial times. To assess how Red Sea productivity changed on glacial-interglacial timescales and test the monsoon driver hypothesis, we generated an independent and continuous record of paleoproductivity based on the accumulation of benthic foraminifera.

Specifically, we investigated deep-sea benthic foraminifera assemblages (size fraction >63 μm) from piston core GEO TÜ KL09 (19°57.6'N, 38°8.3'E, 814 m water depth) from the central Red Sea across the MIS5 interglacial and its surrounding glacials (MIS 4 and 6). We found that the observed flux of benthic foraminifera allows robust reconstruction of organic matter delivery to the sea floor, even during glacial lowstands and associated hypersalinity in the basin. Contrary to previous hypothesis, our record reveals that productivity in the central Red Sea followed a semi-precessional cyclicity across MIS 5, with peak productivity occurring during summer low-latitude insolation maxima on both hemisphere. We suggest the pattern results from alternate enhancement of the Indian SW summer and Indian NE winter Monsoons over the Red Sea. The enhancement of each monsoon mode leads to elevated productivity at the studied site, but in each case for a different reason. This example provides a mechanistic explanation on how semi-precession can be a dominant forcing in the northermost part of the intertropical belt.

References

Trommer G., et al. Sensitivity of Red Sea circulation to sea level and insolation forcing during the last interglacial. Clim Past, 7, 941-955 (2011).

Paleolimnological record of the climate and pre-historic settlement from chalk karst region (Chełm Hills, SE Poland)

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The multi-proxy study (subfossil Cladocera and Ostracoda, palynology, sediment chemistry, stable isotopes) of the sedimentological record from three, closely situated, shallow lakes reveals multiple interactions between the lake esosystems and the main drivers of their mid- and late-Holocene development – climate changes and human actions within their vicinity. Such multi-proxy studies, built upon four complete cores obtained from three nearby situated sites, provide us with an unique advantage/opportunity to disentangle climate and human influence, as well as to trace in detail the ecosystem response. Starting from the Atlantic period, the favourable natural conditions of the Chełm Hills region (mainly rich, workable soils) attracted early settlement more than did nearby regions. This settlement grouped with close vicinity to natural water sources: lakes and small river valleys. Despite the rather low impact of the early settlement on the natural environment, its traces can be made visible from the pollen record of lake archives, as well as from eutrophication signals revealed by subfossil Cladocera and Ostracoda. In this study, three main settlement phases were noted. Herein, hemp retting practices were identified for all the lakes. This is put forward as the most profound factor in this lake ecosystem development (resulting, among other issues, in severe anoxia) and therefore, it was studied in detail as well as the issue of its further recovery.

Paleoclimatic and paleoenvironmental fluctuations inferred for the Middle and Late Pleniglacial transition and Late Pleniglacial (MIS3/MIS2 and MIS2) based on high-resolution (ca. 35 and 70 years) complex sedimentological and paleoecological data from the loess profile of Katymár brickyard (Hungary)

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The Katymár brickyard profile, found at the northernmost fringe of the Backa loess plateau, is one of the thickest and best developed last glacial loess sequences of Central Europe. In the present work high resolution (at 2 cm and 4 cm intervals representing ca. 35 and 70 years) magnetic susceptibility, grain-size, LOI, water-solution trace elements measurements and pollen, phytholithic, anthracological and malacological analyses were implemented on samples derived from the 11,5 m profile corresponding to a period between 35,000 and 13,000 cal BP years (from the terminal phase of MIS3 to the end of MIS2).

One aim was to correlate the findings with the ice core records of northern Greenland in order to establish a high-resolution "decadal" paleoclimatic - paleoecological record for the last climatic cycle, which could contribute to a better understanding of the process of regional landscape and paleoenvironmental evolution documented in other biotic and abiotic proxies so far. Our results revealed a strong variability of loess deposition and pedogenesis during the Middle and Upper Pleniglacial (MIS3/MIS2 and MIS 2).

Millennial time-scale climatic events that characterize the North Atlantic area during the last climatic cycle have been also clearly identified. The strong correspondence between the Greenland dust record and our magnetic susceptibility record up to 35-70 kys implies that magnetic susceptibility of the studied deposits was strongly controlled by dust accumulation in the area. From 35-70 kys onwards however temperature must have played a more prominent role seen in the opposite course of dust influx values at NGRIP and the recorded susceptibility, sedimentologic, geochemical values and paleoecological (antracological, pollen, phytolithic and mollusc) data at our site.

Optically stimulated luminescence dating techniques and multi-proxy analysis to quantify the timing of the last two major climatic transitions, as recorded by loess-palaeosol sequences

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The practice of tuning different climate proxies prevents the observation of regional response times of terrestrial archives to global changes. Thus, it is imperative to develop correlation protocols based on absolute chronologies. Loess-palaeosol (L/S) deposits are continental archives of Quaternary paleoclimates and loess is generally considered an ideal material for the application of luminescence dating.

The agreement previously obtained for 10-20 ka ages using different techniques has given us confidence in using the state of the art measurement protocols for young deposits, as confirmed by comparison with independent age control. Therefore, we propose detailed investigations of loess samples collected in close proximity to the transition to the recent soil, with the purpose of obtaining a temporal quantification of the ending of the Late Tardiglacial and the beginning of the Holocene (i.e. L1/S0 boundary).

We illustrate the application of such an integrated approach on the Mosorin loess-palaeosol site, in the Vojvodina region, Serbia. Optically stimulated luminescence dating method was performed by applying the single aliquot regenerative (SAR) protocol (Murray and Wintle, 2003) to 4-11 μm and 63-90 μm quartz grains extracted from the topmost part of the profile. For the sake of a consistency check and for minimizing the final error on the obtained ages, the post-IR $IRSL_{290}$ protocol (Buylaert el al., 2012) was applied to 4-11 μm polymineral grains extracted from the same samples. In order to constrain precisely the transition the multi-proxy approach included rock magnetic analysis, grain-size distribution colour indices (proxy for variations of mineral concentrations) of loess-palaeosol were determined as well. The sampling strategy included the collection of doublet samples for luminescence dating at 15 cm resolution while collection of samples for proxy analyses was at 5 cm apart, in total 13 samples being collected for luminescence dating from the topmost 1 m of the section. The OSL age results obtained on the two quartz extracts agree and are internally consistent, whereas the post-IR $IRSL_{290}$ ages highly overestimate the quartz data (the equivalent doses generally being 100% higher than the fine quartz equivalent doses), as it has been previously

shown at young ages (Buylaert et al., 2011; Schatz et al., 2012). If the maximum rate of change in the magnetic susceptibility record (Dong et al., 2015) is considered, this proxy locates the Pleistocene/Holocene transition at 30 cm. For this depth the luminescence age, (average of coarse and fine quartz ages determined on two samples) is 10.9 ± 0.8 ka, whereas data from the other proxies indicate an earlier transition, at about 45 cm depth (13.4 ± 0.9 ka).

Consequently, obtaining a comprehensive absolute dating of the timing of the most recent glacial/interglacial transition recorded in loess deposits requires a higher resolution for both luminescence as well as proxy analysis that should be ideally applied to soils of greater thickness.

For dating the Termination 2 as recorded in loess-paleosol deposits, we encounter the problem associated with luminescence dating of older loess deposits. A series of recent investigations carried out on quartz of different grain sizes extracted from Romanian and Serbian and loess (Timar-Gabor and Wintle, 2013, Timar-Gabor et al., 2015) yielded intriguing results. The optical ages obtained on coarse quartz (63-90 μm) were reported to be systematically higher than those on fine quartz (4-11 μm) for ages >~40 ka. While the cause of this chronological discrepancy is being hitherto not fully explained, our ongoing studies on loess from China and Israel prove that this is a general effect, potentially affecting deposits worldwide, and raising significant doubts on previously obtained chronologies.

We present explore our on-going studies that aim at unraveling the cause of the observed discrepancy and at the development of an innovative dating protocol that will improve the accuracy of luminescence dating with the ultimate goal of providing a temporal quantification of L1/S1/L2 boundaries.

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References

Buylaert J-P., Jain M., Murray A.S., Thomsen K.J., Thiel C., Sohbati R., 2012. A robust feldspar luminescence dating method for Middle and Late Pleistocene sediments. Boreas 41, 435-451.

Buylaert J-P., Jain M., Murray A.S., Thomsen K.J., Thiel C., Sohbati R., 2012. A robust feldspar luminescence dating method for Middle and Late Pleistocene sediments. Boreas 41, 435-451.

Dong Y., Wu N., Li F., Huang L., Wen W., 2015. Time-transgressive nature of the Magnetic susceptibility record across the Chinese Loess Plateau at the Pleistocene/Holocene transition. PLoSONE 10(7): e0133541. doi:10.1371/journal.pone.0133541.

Murray, A.S., Wintle, A.G., 2003. The single aliquot regenerative dose protocol: potential for improvements in reliability. Radiation Measurements 37, 377-381.

Schatz A.K, Buylaert J.-P., Murray A., Stevens T., Scholten T., 2012. Establishing a luminescence chronology for a palaeosol-loess profile at Tokaj (Hungary): A comparison of quartz OSL and polymineral IRSL signals. Quaternary Geochronology 10, 68-74.

Timar-Gabor, A., Wintle, A.G., 2013. On natural and laboratory generated dose response curves for quartz of different grain sizes from Romanian loess. Quaternary Geochronology 18, 34-40.

Timar-Gabor A., Constantin D., Markovic S. B., Jain, M., 2015. Extending the area of investigation of fine versus coarse quartz optical ages from the Lower Danube to the Carpathian Basin. Quaternary International, 388, 168-176.

Vegetation dynamics and plant species distribution under changing climates

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Quaternary climate variability strongly affected ecosystems and vegetation. Climatic oscillations became more moderate during the Holocene, and vegetation reorganizations in response to climate eventually shifted from the biome to the community level during the past 11500 years. Superimposed on climate variability, land use significantly altered European vegetation structure and composition during the mid and late Holocene. Anthropogenic alterations of vegetation during the past 8000 years included contractions and extensions of ranges and realized niches of species. Such paleo-ecological information can be used to infer measures to preserve future biodiversity and ecosystem services under global change conditions. The combination of paleoecological evidence with dynamic vegetation modeling allows investigating spatially explicit transient stages of past and future vegetation shifts under global change conditions. Specifically, dynamic modelling projections may be used to investigate open paleoecological questions or to plan paleo-validated climate-impact mitigation strategies at local to regional scales.

From the Neolithic to the Anthropocene: Humans and depositional processes in Iberian Mountain watersheds

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Large changes in the hydrological and biogeochemical cycles and surface processes dynamic have been documented in mountain watersheds during the last centuries, greatly affecting landscapes structure and surface processes. In Mediterranean regions, the summer drought and the variability in water availability are primary forcing controls for hydrological regimes, vegetation cover changes and depositional dynamics. Through changes in land uses, natural resources exploitation and an intense urbanization, humans have become significant agents shaping the mountain landscapes during the last millennia.

The mountain watersheds in the Iberian Peninsula showcase how humans have interacted with the landscape and contributed to change the depositional dynamics. Transformations from natural to rural and finally urban landscapes have left a strong signature in watersheds, slopes, rivers and lakes during the last millennia. Although first impacts could be traced to the Neolithic, fluvial and lacustrine environments were largely unaltered. Iberian and Roman imprint in the landscape resulted in the main first large-scale soil erosion and sediment accumulation phase and heavy metals atmospheric deposition, both documented with varied intensity all over the Iberian Peninsula. Fluvial deposits and lake sequences show large depositional transitions during the last millennia related to hydroclimate variability (e.g., mid Holocene transition, Iberian Roman – Humid period, Medieval Climate Anomaly, Little Ice Age) and to intense anthropogenic impact in the watersheds (Iberian- Roman, Middle Ages, the 19th-20th century). Most watersheds - even those located in remote areas and considered more "pristine" - have been transformed during previous centuries of intense land use and climate change. Intensification of soil erosion and sediment fluxes occurred both during more humid periods (stronger rainfall and higher frequency) and more arid periods (increased storminess, higher soil erodibility when vegetation cover was reduced). Synergetic effects between phases of increased human pressure and rapid climate change occurred during the onset and demise of the Little Ice Age and caused increased sediment fluxes in watersheds and changes in flood intensity and frequency.

Recent changes, both in the mountains and in the lowlands, have been even more dramatic. Climate and anthropogenic activities are responsible for some trends starting in the mid 1970s: diffuse contamination due to industrial development of intensive agriculture; recent eutrophication in aquatic systems in more touristic areas; lower sediment fluxes from watersheds where significant land abandonment occurred since the 1950s, changes in erosion patterns in slopes and channels in mountain rivers. Recent climate change has a global impact, already seen in flood and drought dynamics, with important implications in small-scale watersheds.

Anthropocene signatures in Iberian mountain depositional systems are varied, as the watersheds during the last centuries have witnessed phases with strong human impact (Medieval times, late 19th century and early 20th century) and periods with decreased human

activities (Little Ice Age, economic and social crises during Medieval times, rural exodus after mid 20th century). Past human activities have to be considered to understand current depositional systems and landscapes dynamics in the Mediterranean mountains with a long history of human activities. Climate variability, particularly in rainfall amount and seasonal distribution, has also played a determinant role. Synergies, resilience and hysteresis interactions have occurred in the past and should be expected in the near future. Evaluation of hazards and risks (floods and droughts, slope activity, landslides, soil erosion, sediment and geochemical fluxes) and adaptation strategies should include humans as active agents of change, not only as passive receptors.

Anthropogenic impact and environmental pollution over Southeastern Europe during the last 8000 years

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The exploitation of mineral resources, an essential driver of economic and technological development, also induces long lasting impacts on the global ecosystem. Aerosols such as volatilized elements and chemical aggregates released during mining, smelting and combustion are deposited further away onto peats or lake sediments. The geochemical study of such proxies coupled with isotopic tracing of pollution sources provides an indirect, albeit fundamental view on past anthropogenic impact and environmental pollution.

Here we present newly acquired high-resolution geochemical (major and trace elements) and lead isotopic data (^{206}Pb, ^{207}Pb, ^{208}Pb, ^{204}Pb,) on several peat records from the Carpathians that cover most of the Holocene, with a special focus over periods with enhanced human impact on the environment, such as the Early Metal Ages, the Antiquity, Medieval and the recent past. We distinguish signatures related to the natural cycling of elements from the anthropogenic contributions due to natural resource exploitation, mining, and smelting activities. Together with existing geological, archaeological, and archaeometric evidences, our results provide a comprehensive record on the long-term history of metal-use development in the Carpathian region. Through a comparison with records from other parts of Europe we document the existence of strong regional differences in the magnitude, temporal, as well as spatial shifts in our understanding of past emission sources. We therefore show that the existing picture of past pollution load and temporal variability at the European scale is incomplete because it is mainly based on western records without considering the long-term pollution inputs from southeastern Europe, a region with significant mineral endowment and long-lasting human impact on the environment driven by the early rise of agricultural and metal processing activities.

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Anthropic signature on the Danube Delta evolution and Danube mouths dynamics

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In natural conditions, the Mid- to Late-Holocene Danube delta evolution was driven by the complex interactions at the river mouths areas between fluvial sediment deposition, wave climate and longshore and coastal currents. The latest two have a high sediment transport capacity due to the acute wave angle attack (< 60˚) to the mean shoreline orientation, efficient for the river-borne sediment dispersal and coastal sediments reworking.

Recent studies on human pressure evolution on the Danube watershed highlight that forest clearances intensified during the Roman times, which after a long stagnation in Early Middle Age (which reclaimed the reforestation) have restarted since 12th and 15th centuries in the Upper, respectively Lower Danube watershed, leading to the rejuvenation of the denudation processes and the artificial increase of the river solid discharge. During these influences (last 2000 years) the delta surface area grew much faster, forming ca. 40% of the total Danube delta. Nevertheless, the human influence became critical during the second half of the 20th century when the hydrotechnical works from Danube watershed lead to a dramatic reduction of the solid discharge and changes in sedimentation rates along with the progradation and erosion pattern changes. Currently, the river mouths areas are confronted with a substantial increased influence of the marine controlling factors (waves and currents) which trigger their present morphodynamics change from river-dominated to wave-dominated delta morphology (Chilia) or from the assymetric wave-dominated to deflected lobes (Sfântu Gheorghe).

Advances in fire history research and their application for ecosystem management and conservation

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Paleoecology is a valuable tool for understanding the long-term ecosystem dynamics that underlie present environmental conditions. Fire is an important form of disturbance in most terrestrial ecosystems, and increased levels of biomass burning in many parts of the world have raised concerns about the role of fire in transforming vegetation composition, extent, and function in the future. Sedimentary charcoal records can help inform this discussion by providing fire-history information that spans a range of temporal and spatial scales. At a regional to continental scale, climate emerges as the strong driver of past biomass burning, with warmer periods being associated with higher fire activity. In many regions, humans have also significantly altered natural fire regimes through (1) igniting fires in places where fires were naturally rare, (2) lengthening the fire season through deliberate burning, (3) manipulating fuels through land-use activities, and (4) suppressing or eliminating natural fires. Human impacts are often greatest where fires are naturally infrequent. In New Zealand, for example, the arrival of people c. 700 years ago was associated with large-scale burning; deliberate fires destroyed about 40% of the native forests within decades and resulted in a fundamental transformation of many watersheds. In the European Alps, significant anthropogenic burning has occurred since the middle Holocene, and millennia of land use have altered both the vegetation and natural disturbance regimes. In contrast, in the US Rocky Mountains, past fire activity is largely driven by climate, and pre-European human influences are primarily local in scale. The implications of the past for the future will vary among these three regions: In the western U.S., increased temperatures will increase fire activity and likely shift ecosystems beyond the historical range of variability. In Europe, landscapes that have been long altered by people may be somewhat insensitive to climate-driven changes in fire occurrence. In New Zealand, future climate and land-use conditions will likely increase fire and help maintain current open landscapes at the expense of forest. In each example, knowledge of past fire variability can help guide appropriate management and conservation strategies.

Using ancient dung to reconstruct the transformation of prehistoric island ecosystems by invasive rats

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Rats have been dispersed with prehistoric humans to thousands of islands around the world, where they have had devastating effects on indigenous biotas and ecosystems. However, a complete understanding of the ecological consequences of rat invasions has remained elusive. This is because contemporary studies on rat impacts are based on ecosystems heavily modified during prehistoric times, and prehistoric evidence for direct rat predation is mostly circumstantial e.g., a short temporal overlap of bones of rats with extinct birds. In this talk I will show how ancient DNA and microfossil analyses of dated ancient rat dung found in rock crevices can directly reveal the impacts of the Pacific rat (*Rattus exulans*) on intact New Zealand ecosystems, from the start of their invasion when they were introduced with the first human settlers in the 13th century. Reconstructing past ecological interactions between an invasive rat and island biota helps to resolve questions about how invasive rats transform vulnerable island ecosystems, and to advance our thinking about the legacy of rat impacts on current ecosystem processes and function.

Three climatic cycles recorded in a loess-palaeosol sequence at Semlac (Romania) – implications for dust accumulation in the Carpathian Basin and the northern Hemisphere

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Semlac is regarded as a key section for the Carpathian Basin because of the good preservation of the fine silt. The site is situated at the Mureş River in its lower reaches (Banat region, western Romanian). The more than 10 m thick loess sequence includes four fossil sol-complexes developed in homogenous relatively fine silty loess and dates back to marine isotope stage (MIS) 10. This setting offers possibilities to a) improve the understanding of the type and composition of the lowland loess sequences in the Carpathian Basin for the last interglacial palaeosol complex and beyond, b) reconstruct the temporal evolution of the local loess-palaeosol successions and c) compare the loess of the region to loess-sequences in adjacent areas (Carpathian Basin, Lower Danube) and to dust proxy data in the northern hemisphere. A strikingly sinusoidal course of physical property data in depth and time point to relatively homogenous, quasi-continuous background sedimentation of dust, which are interpreted as resulting from long-range transport. This is in contrast to a commonly observed more glacial-interglacial pattern with sharp boundaries of paleosols.

An integrated age model based on correlation to reference records and luminescence dating is compiled. Applying this age model we compare climate proxy data from Semlac to both global data and to data from the very southeast of the Carpathian Basin (Vojvodina, Serbia).

The obtained results provide new insight into the dust accumulation regime in the eastern part of the Carpathian Basin and offer new palaeoenvironmental information for the region. Results from Semlac represent an important step towards establishing a catena from the thin loess-like sediments of the Banat foothills in the East towards the thicker and seemingly more complete loess sections of the southeastern and central Carpathian Basin.

Disentangling grain size data from soil formation proxies gives quantitative estimates for the contribution of original sediment and weathering (through soil formation) to the present clay fraction. Patterns of clay from direct sedimentation are dissimilar to grain size proxies from China, suggesting western and eastern Eurasian loess to have different mechanistic origins which may be caused by different palaeoclimatic circumstances.

Challenges of loess formation models for the Carpathian Basin

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The general pattern of loess-paleosol sequences for the last several glacial-interglacial cycles in South-eastern Europe is becoming more established through an increasing amount of available data. However, the paleoclimatic mechanisms leading to these patterns are much less understood, especially the deviations from northern hemisphere patterns. Here we use relatively simple models to determine the effect of insolation forcing and global climate, as represented by benthic $d^{18}O$ data, onto loess-paleosol sequences.

Multiple linear regression models are rather simple models which may be used for the estimation of factors influencing dust deposition resulting in loess-paleosol formation, including pedogenesis in loess. We demonstrate that such models consistently fail to reach a baseline as observed in proxy data for soil formation in loess. This is due to the lack of such baselines in input data, requiring more sophisticated models clipping input data at least at its base.

Applying regression models including an optimisation of fit adjusting base levels, estimates for the forcing mechanisms behind loess-paleosol sequence formation are discussed. Results from such models show clear discrepancies to proxy data, more in the timing of events than in magnitude and patterns, suggesting that models may be used for iterative time scale adjustment. Such approaches, however, should be treated with caution and need to be supported by fully independent age control to avoid circular reasoning. Here we present and discuss an updated time scale for a loess-paleosol sequence by iterative model adjustment.

Future work should focus on the effects of (a) time scale inaccuracy, (b) phase lags of input data, (c) comparison of several proxy data and (d) investigations and interpretations of residual from models.