Synchronicity between IRD events in Northern Atlantic and grain size variations of the Serbian loess during the last million years

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Loess covers huge parts of the continents, especially in the middle latitudes of the Northern Hemisphere. However, except in the case of formation of the Chinese Loess Plateau, which is linked with the East Asian Monsoon, we do not know the potential relationship between loess formation and responsible air circulation type(s) in any other region. Comparison between Serbian and Chinese loess-paleosol sequences magnetic and grain size records provide general similarities especially in the case of magnetic records matching. This transcontinental correlation reveals also that there are significant similarities between the magnetic records of northern Serbia and the central Chinese loess plateau. The general multi-millennial variations of presented magnetic proxies are almost identical in these distant major loess regions. This correspondence appears to be also similar with the globally integrated marine records, potentially suggesting accordance in soil formation processes on Eurasian scale. However, median grain size and other parameters of textural variations indicate significant differences in variations of median grain size between Serbian and Chinese loess records. These textural differences point that Serbian loess is formed as a consequence of completely different air circulation than in the case of Chinese loess plateau.

Robust evidence of grain size variations recorded in the Serbian loess indicates significant synchronicity with the appearance of Ice Rafted Debris (IRD) events identified from deep sea cores in the North Atlantic during the last one million years. Additionally, higher contribution of coarse grains, the thickness of loess layers, sedimentation rates and increase of U-ration is observed in Serbian loess-paleosol sequences is associated with a more pronounced decrease of sea surface temperatures in the Western than in Eastern Mediterranean. These differences in the sea surface temperatures in the Western and Eastern Mediterranean illustrate more polar front fluctuations between the Pyrenees and Alps influencing the more frequent cyclone genesis in Genova gulf, as an important regional climatic anomaly. Modern regional synoptical atmospheric circulation patterns as well as studies in the North Atlantic area support our hypothesis that the observed grain size variations reflect the long-term migration, seasonal duration and permanency of the polar front on a multi glacial-interglacial scale.

Grassy systems of CE Europe: changes and drivers during the Holocene

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Human use of land has been transforming the land cover in Europe for millennia. Lowlands dominated by open ecosystems i.e., woodlands, forest-steppe, and grasslands (after that, grassy ecosystems), were central to the human story providing environments for hunter-gathers, husbanding livestock, and crops because they were easy to hunt, forage, graze and clear and cultivate. Yet, despite humans having a long-sustained interaction with open ecosystems, these cannot be defined as sole legacies of humans nor described as deforested or wastelands. This work examines the palaeoecological records (pollen and pollen-based quantitative vegetation reconstructions, charcoal, coprophilous spores) and archaeological evidence from SE Europe, focusing on Romania. It discusses how climate change, fire, herbivores, and humans have shaped grassy ecosystems for millennia We need more palaeoecological records from grassy systems to understand better the fundamental ecological controls that derive forest–grassland coexistence. This could give us points of leverage that are important for the conservation and restoration of the grassy systems for biodiversity and climate change adaptation.

It's virtually fieldwork: exploring the role of digital visualisation tools (DVTs) beyond the COVID-19 pandemic

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The COVID-19 pandemic shut down field-based activities across the Environment sector leading to a rapid, unplanned shift to digital alternatives. Subsequently, while much fieldwork has been resumed, some methods of visualising fieldwork activities have remained. They can support inclusion and accessibility in Environmental Education, moreover, in-person fieldwork is still not possible everywhere and Virtual Field Trips (VFTs) continue to play an important role e.g., in Ukraine where war has impacted the learning environment.

We have assessed the continued use of VFTs to evaluate students' learning experiences through virtual fieldwork in this key aspect of Environmental Science. The attitudes of students to virtual, rather than in-person fieldwork, have changed since 2020. Students tended to favour the in-person experience of fieldwork but also recognised the inclusive potential of the use of DVTs. Responses also indicated the benefits of pre and post field trip support via VFTs in augmenting students' learning experiences.

We also facilitated the student co-creation of VFTs using a range of accessible technologies. Student groups collected 360-degree images and video, and drone-based photo and videography (they also used their own smart phones) hosting their work on an online educational platform. Student co-creation was positively received and increased engagement but had some surprising results in terms of attitudes to technology.

Our findings indicate that DVTs can enhance the accessibility of fieldwork, the student learning experience and engagement. They can also foster additional skill development. Furthermore, in providing a digital legacy, VFTs can also play a role in the 'value for money' and sustainability of this important element of Environmental Education. Our research suggests there remains a role for DVTs beyond COVID-19 that can make use of a growing set of digital tools. However, more investment is required to better understand the pedagogy of this developing area of environmental education research.

Vegetational and climatic changes in Ukraine during the last interglacial

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In Ukraine, pollen studies of the most complete palaeosol sequences of the last interglacial, located in palaeodepressions, have demonstrated that these palaeoarchives are quite comparable in the levels of palynological information, which they yield, to lake and peat deposits. Trends in vegetational development during the last interglacial, well-established in western and central Europe, are traced in Ukraine but its regional particulars, dependent on palaeoclimate changes, are also recognised. The results of pollen studies presented here have been obtained from the forest belt in the north of Ukraine (the Muzychi and Stari Bezradychi sites), the forest-steppe in its central and western parts (the Vyazivok, Yaseny, Lypova Gully, Tovtry and Neporotove sites), the steppe of central and eastern Ukraine (the Sazhavka, Kryva Luka, Novorayske and Dokuchaivsk sites), from the Carpathian Mountains and Transcarpathia (the Sadzhavka and Sokyrnytsya sites). and from the Crimean Mountains (the Kabazi II and Emine-Bair-Khosar sites). The assignment of these pollen successions to the last interglacial is confirmed by chronostratigraphy and pedostratigraphy. Some sites discussed herein have been in part described (Gerasimenko, 2005, 2006; Gerasimenko et al., 2019). Schematic maps for vegetational types during the different phases of the last interglacaial are drawn on the basis of the summary of the data on Ukraine by different authors.

The spread of *Picea* forest at the very beginning of the last interglacial is the particular feature of this period‘s vegetational succession in the forest belt on eastern Europe (Grichuk, 1989; Yelovicheva, 2013). The appearance of spruce before the other boreal trees is explained by the fact that the surface root systems of this tree enabled its growth when permafrost remnants persisted close to the ground surface. At the border of forest and forest-steppe belts of Ukraine and in the eastern foreland of the Carpathian Mountains, wooded patches consisted almost completely of spruce. Incipient podzolic soils developed here. Further south and in Transcarpathia, spruce formed a significant admixture in the forest composition, but it disappeared in the area of the present-day steppe belt. The humid boreal climate of the northern regions of Ukraine became more arid to the south, but still was rather wet (the steppe had more woodland than nowadays). The next phase, of *Pinus-Betula* forests, had a cooler and drier climate, as indicated by the presence of arcto-boreal species of birch in the NE of Ukraine (Bolikhovskaya, 1995) and in the Carpathians, and by the shift of the northern boundary of the former steppe belt further to the north. During the next phase, of *Betula-Pinus*, a small admixture of oak, elm and hazel in the tree stands had already appeared all over the forest and forest-steppe belts. In the East-Carpathian foreland, spruce and fir also blended in the woodland. These facts, as well as the spread of the forest-belt further to the south, indicate an early increase in warmth and humidity in Ukraine during the pre-temperate stage of the last interglacial.

The early-temperate stage of the interglacial started with the rather rapid spread of broad-leaved forests (mainly oak and elm, with an admixture of *Tilia cordata*) which occupied the entire area of the modern forest-steppe. The same woodlands also occurred within the steppe plains, indicating higher precipitation than seen nowadays. The share of pine in the forests was larger in northern Ukraine because of the dominance of sandy soils there. In the eastern foreland of the Carpathians and in the Dniester valley, hornbeam (*Carpinus betulus*) had already appeared during this phase, as well as such indicators of moisture as *Hedera*, *Viscum* and *Humulus* (Komar et al., 2015). The characteristic feature of the Transcarpathian Lowland during the last interglacial is the spread of *Fagus,* which had appeared there almost simultaneously with *Quercus*. Beech patches occurred also in the Bukovyna area, on the eastern side of the Carpathians. In the western regions, the presence of highly mesophilic plants during

the mesocratic phase of the interglacial was evidently dependent on the increase in precipitation under the impact of the Carpathian Mountains. Nevertheless, few *Carpinus betulus* and *Tilia platyphyllos* still occurred in the woodlands of the eastern margins of Ukraine (Bolikhovskaya, 1995). This fact could be explained by the survival of refugia of broad-leaved species within the dissected Russian Upland, which was not covered by a glacial ice tongue during Dnipro (Saalian) times. Albic Luvisols and Luvisols were the dominant soil types in the plains of Ukraine. In the Crimean Mountains, oak woodland occupied even the high parts of the mountain slopes, where beech and hornbeam grow nowadays. Evidently, under the very warm climate of that time, the balance of evaporation and precipitation did not benefit the growth of highly mesophilic trees. Pollen grains of *Juglans regia* found at sites in the Carpathian foothills and the low ridges of the Crimean Mountains might indicate that refugia of this thermophilic species survived there during the penultimate glaciation.

During the *Corylus* phase of the last interglacial, reduction in wooded areas and the spread of mesophytic grass-herbal associations on plateaux characterised the forest-steppe and steppe belts of Ukraine. The aridification of the climate, reflected in the advance of herbal vegetation, is also confirmed by fact that forest pedogenic processes were replaced by humus accumulation, which is revealed at the corresponding levels within the last interglacial pedocomplexes. Dense hazel thickets existed only in relief depressions and river valleys, and they were particularly abundant in the Dniester River valley. In the forest belts, the peak of *Corylus* was frequently followed by a noticeable increase in *Tilia cordata.* In Transcarpathia, the acme of *Corylus* coincided with an extensive spread of *Carpinus betulus* (the latter usually typifies the late-temperate phase of the last interglacial). This fact and the continuous growth of *Fagus* in this area indicate that if even the decrease in precipitation did occur here, it was not significant enough to cause vegetational changes. The same is true for the northern forest belt of Ukraine, where the spread of alder took place at the end of the *Corylus* phase.

The expansion of hornbeam during the second half of the interglacial was extensive even in the forest-steppe of the eastern part of Ukraine, where this tree does not grow nowadays. Then Quercetum mixtum forest had been replaced here by Quercetum carpinetum, whereas in the northern forest belt of Ukraine, woodland made up entirely of hornbeam surrounded the lakes and peat bogs. In the northern and western parts of Ukraine, *Tilia platyphyllos* spread together with *Carpinus.* The forest belts moved southwards within the area of the present-day forest-steppe, and the larger part of the modern steppe belt had a forest-steppe landscape, with patches of woodland on plateaux. Grey forest soils and leached chernozems spread in this area. Hornbeam was present as an admixture in woodlands even in the eastern Donetsk Upland, and was absent only in the steppe of the Black Sea Lowland. The steppe vegetation was mesophytic and consisted mainly of forbs and grasses. Hornbeam significantly dominated over beach and oak in Transcarpathia. The interglacial vegetation of the eastern foothills of the Carpathian Mountains and the areas adjacent to the Dniester River valley indicates the existence there of the optimal combination of warmth and humidity for the diversity of arboreal taxa. Forests, dominated by hornbeam, included here highly mesophilic species: *Fagus sylvatica, Hedera helix, Viscum album*, *Humulus lupulus,* rarely - *Taxus baccata,* and, in the Carpathians, *Abies alba* and *Picea abies* (Gurtovaya, 1983; Bezusko et al., 2011; Komar et al., 2015). According to these authors, the forests also included the warmth-loving species, which do not belong to the modern flora composition in the area: *Juglans regia, Corylus colurna, Osmunda cinnamomea,* and *Ilex aquifolium*. *Juglans regia* and *Cornus mas* grew in the lower ridges of the Crimean Mountains, but the precipitation was not sufficient here for the spread of highly mesophilic species. Nevertheless, the share of *Carpinus* was much larger than in the modern hornbeam-oak forests of the area. Thus, in the entire area of Ukraine, the climate of that time was much wetter than nowadays.

The characteristic feature of the last interglacial vegetational succession in Ukraine was the limited spread of *Abies,* by which is differed from earlier interglacials. Fir grew only in the eastern foreland of the Carpathian Mountains and, to lesser degree, in the Transcarpathia at the end of the late-temperate

phase of the interglacial (together with hornbeam) and at the beginning of its post-temperate stage (together with spruce). By contrast, the spread of *Picea* at the beginning of the post-temperate stage was rather extensive. At present, *Abies* grows only in the middle altitudinal belt of the Carpathian Mountains, *Picea* in the higher altitudinal belt, and the latter is also a constituent of the mixed forest in the plains of the north-western part of Ukraine. In the *Picea* phase of the post-temperate stage of the last interglacial, birch-pine-spruce forest covered the entire area of the modern belt of mixed forests, reaching its northeastern edges. Spruce constituted a significant portion of the birch-pine woodlands of the forest-steppe, which area coincided with that of the present day. A few spruce occurred in the valley forests of the rivers Dnipro and Donets, even within the northern area of the modern steppe belt. Thus, it grew more than 400 km southwards from the southern limits of its modern habitat. Hornbeam, oak and lime first formed an admixture in these forests, but they disappeared rather soon. The maximal spread of *Picea* took place in the area adjacent to the Carpathian Mountains. *Calluna vulgaris* grew rather abundantly here. In the Transcarpathian Lowland, spruce dominated in the mixed forest, which also included beech and, to a lesser extent, hornbeam. Broad-leaved trees became much fewer at the end of the *Picea* phase. The impoverishment in broad-leaved trees in the forest's composition also occurred in the eastern foreland of the Carpathians, where spruce woodlands first included an admixture of *Abies alba, Fagus sylvatica, Carpinus betulus*, and *Corylus avellana*. The extensive spread of *Picea abies* indicates a cooling of the humid climate, as well as the disappearance of broad-leaved trees and the establishment of a boreal forest. The upper part of E horizon of the grey forest soils, frequently with features of gleying, was formed during the *Picea* phase, indicating development of podsolization processes under a humid climate.

Spruce did not grow in the Crimean Mountains, and the cooling after the phase of maximal spread of hornbeam was reflected in the spread of birch, alder and the lower altitude of the beech forest belt - it earlier occupied the higher parts of the mountain slopes. The steppe plains of southern Ukraine were covered by grassland instead of the forb associations of the preceding phase. Humus accumulation developed in chernozem-like soils. Pine, birch and alder formed groves in riverine situations. Precipitation was not sufficient here for mesophytic plants to grow. The environments of the northern and southern parts of Ukraine were rather contrasting at this time, despite the gradual lateral replacement of grey forest soils by chernozems that has been observed in the studied areas.

During the final *Pinus* phase of the last interglacial, the boundaries of forest, forest-steppe and steppe belts were located close to those of modern times, but the vegetational composition of these zones significantly differed from today. Within the present-day zone of mixed forest (broad-leaved trees and pine), light tree stands were formed by pine and birch only (rarely with few hazel and spruce). A ground cover from herbs, grasses and ferns was well-developed, supporting formation of the AE genetic horizons of the soils. Broad-leaved trees also disappeared from the forest-steppe belt and from the valley groves in the steppe belt. The share of xeric herbs increased in the steppe vegetation. The lower ridges of the Crimean Mountains were covered by pine forest with a small admixture of oak, hornbeam, elm and hazel, - the trees, which form the woodland on these mountain slopes nowadays. Birch in the forests increased, a boreal tree which at present occurs very rarely and at the highest parts of the Crimean Mountains. Humus accumulation developed in the mountain soils here during the *Pinus* phase. A short episode of warming is revealed by an increase in *Quercus* and *Carpinus* at the very end of the last interglacial succession in Crimea. In the eastern foothills of the Carpathians, spruce blended with birch and pine in the woodlands in this final phase. A few *Abies alba*, *Pinus cembra*, *Frangula alnus* occurred, but there also appeared (though in small numbers) arcto-boreal species: *Betula humilis, B. nana, Botrychium lunaria* and *Selaginella selaginoides*, which do not grow in the area nowadays (Gurtovaya, 1983; Bezusko et al., 2011). In Transcarpathia, spruce also combined with pine in the forests of this phase, but no cryophytic plants spread. In the entire area of Ukraine, the climate was

colder and drier than nowadays. Trees of a temperate climate remained noticeable only in the lower ridges of the Crimean Mountains.

Vegetational patterns demonstrate that during all the phases of the interglacial the climate became less humid from the north to the south, but the increase in continentality from west to the east in the plain area of Ukraine was less than nowadays. The majority of the interglacial phases had a more humid climate than the modern one, when the southern borders of forest and forest-steppe belts shifted southwards. In the area of the modern forest-steppe and steppe belts, the 'pine' phases of the pre-temperate and post-temperate stages had a drier climate than nowadays, and the *Corylus* phase had a more arid but not a cooler climate than at present. The study of the last interglacial vegetational patterns is important for understanding and protection of present-day biodiversity, whereas the studies of succession in climatic changes during the last interglacial enables its comparison with the elapsed part of the modern interglacial and predicting future changes which would occur under the impact of natural factors.

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400-year multi-parameter reconstruction of Carpathian temperatures from tree rings

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Keywords: paleoclimatological reconstruction, multi-parameter analysis, high-resolution imaging, non-climatic biases, tree-rings, Carpathians

Despite numerous proxy-based climate reconstructions and relatively long instrumental records throughout Europe, reliable information about past climate is still lacking in some regions, particularly eastern parts of the continent. This issue is linked to limitations in data quality and large uncertainties in existing records. The REPLICATE project aims to fill this spatial paleoclimatic and data quality gap by applying a tree-ring multi-parameter approach to reconstruct climate using Norway spruce (*Picea abies*) samples. We are developing a set of temperature reconstructions across the Carpathian Mountain arc that will advance our understanding of recent climatic variability in this region. Therefore, annually resolved, robust, high-quality summer temperature reconstructions covering the past 300-400 years are developed for four locations across the Carpathians from chronologies of tree-ring width (RW) corrected for disturbance, blue intensity (BI) and color bias-free surface intensity (SI) from scanned and microscope-based high-resolution images, and traditional and surface-based quantitative wood anatomy (QWA/sQWA). Carpathian preliminary temperature reconstructions using RW and BI have up to 56% of their variability explained by April – September temperatures. Whereas BI responds strongly to this broader seasonal window, the RW response is also significant but generally weaker and mostly restricted to a narrower (June-July) season. We expect that the combination of parameters may strengthen the climate signal considerably, providing records with reduced uncertainty. Also, due to the different degrees of continentality among the four regions, we will explore the Carpathians as a whole and each sub-region individually. These reconstructions will provide improved spatial information on the transition from the LIA to the modern, warm period, which is important for tuning and downscaling climate models by constraining their performance and improving predictions of future climate scenarios.

Pleistocene to Holocene evolution of Bahluieț Valley at Costești (Iași County, Romania) – an interplay between fluvial and hillslope processes

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Keywords: Lateglacial, Holocene, terraces, channel incision, floodplain, landslides, MIS1, MIS2

Bahluieț Valley at Costești Village (Moldavian Plateau, Romania) is an archaeosite and geosite of unique relevance for the geomorphological evolution of Moldavian Plateau in the Upper Pleistocene and the Holocene (Niculiță și Mărgărint, 2018; Niculiță, 2022). The Bahluieț valley sides are affected by generations of landslides, some of which are fossil. The landslided material accumulated in the floodplain that represents the fossil landslide was covered by alluvial deposits. The post-LGM incision dettached the coverlet of fluvial deposits as a terrace and exposed the fossil landslide in the bank of the active floodplain.

At the current stage of geomorphological research, the Late Pleistocene age of the fossil landslides is well constrained by the ages of the terrace, without the possibility of saying the precise moment of the trigger, but only the upper limits: 15 to 46 ky BP (Niculita, 2021). These limits imply that multiple events generated the deposit of fossil landslides (Niculita, 2021). This is also supported by the non-continuous outcrops from the banks of the active channel. The fossil landslides are rock slides, while the

retrogressive reactivations that followed the initial landslides are various types of rotational and translational slides.

The retrogressive reactivation of the landslide continued during the Holocene, generating a complex landslide affecting the entire hillside, a general pattern of slope evolution in the Moldavian Plateau (Niculita et al., 2016, 2019; Niculita, 2020).

The fluvial incision in the floodplain and in the deposit of fossil landslides is Holocene, with an increased rate in recent centuries (Niculita, 2021). Additional OSL dating of the terrace deposits indicates a major period of the incision after the Neolithic period (Niculita, 2021), Cucuteni-Trypillia culture pottery being found in the deposits associated with this incision.

The incision is also characterized by the presence of incised meanders, with several cut fossil meanders. The sedimentology of the terrace deposits is different from the deposits from the floodplain upstream and downstream of the Costeşti area. The deposits of the downstream floodplain are younger than 4 ka BP. It would also be interesting to date the deposits of the upstream floodplain, in order to reveal the geomorphological evolution of the area upstream of the slide that barred the valley (with the possibility of the existence of a lacustrine deposit). To date, no organic remains have been identified for radiocarbon dating, which would be the most accurate. Even the outcrop of these deposits does not exceed 3 m, so drilling, possibly geophysics, may be needed to estimate the depth of the deposits.

The terrace deposit in the area of the fossil landslide is mainly clay and silt with pockets of sand. The major floodplain type can be associated with a confined bed, fine texture, and high energy (sensu Nanson and Croke, 1992), due to the rough topography of the bed of the landslide body.

In some parts, the structure is consistent with lateral accretion, while in some parts it is consistent with flood basins, again influenced by the layer of landslided material. This situation is very well observed in the opening of the Costeşti-Cier geoarcheosite, where the two lateral accretion zones are identified, influenced by the large slope of the Hărmanesti oolite deposits and by the presence of the fossil beds that determined both the deposition as well as the individualization of the meander island. Lateral accretion deposits are inclined and have fine and coarse textures, deposited lamellarly. Between these two areas of lateral accretion are flood basin deposits that are fine and nearly horizontal.

In the other areas where these deposits surface on the banks of Bahluieţ active floodplain it is noted that: the lateral accumulation deposits have a different direction of the structure, while for the flood basins the horizontal lamination is still visible. In general, the deposits have a columnar structure, which is marked by cracks, these being post-depositional, and very often individualized by tree roots. Fine sediments (clays and silts), highly compacted, often with disordered or even convoluted layering/lamination, with Miocene shells or spherical pebbles, sandstone slabs and sand pockets have various orientations of layering. I believe these deposits are the result of lateral accretion, and often also contain material eroded and deposited from adjacent slopes. Sandstone/oolite slabs can be used as a criterion for differentiating deposits and sedimentary unit boundaries. Thus, when they accompany sedimentation unit boundaries, they have a parallel direction to them and can present accumulations with diverse granulometry. When present within sedimentary units they vary in direction and may occur singly or in concentrations indicating fall as boulders from adjacent slopes.

The confined nature of the active channel and the major floodplain could explain the different orientations of the lateral accretion stratifications, a situation similar to present-day sedimentation in the confined space of the present-day channel (but showing narrowings and widenings). The difference is given by the greater constraint in the present period, compared to the fossil post-landslide period, when the constraint was limited to the disordered topography of the slide mass (hence the multitude of cut-off meanders).

In some parts, there are even situations where it is difficult to separate the possible landslides from the depositional structure, especially if no sandstone or oolite outcrops are present, but only mudstones that can be altered or disturbed.

The flood basins, favored by the roughness of the landslide body, are usually higher than the lateral accretion deposits and frequently remained as meander islands. This situation has geomorphological logic because in these areas sedimentation occurred only during floods, and in adjacent areas with active bed erosion, constant degradation and deepening occurred.

It is clear from the above that there is a need for a continuation of dating and geophysical and archaeological surveys for the precise geomorphological evolution of the studied area. The present results, however, bring quite a lot of clarity and guide future study directions.

The finding that fairly rapid incision has occurred in recent centuries can be related to both the changes induced by the expansion of habitation in the medieval period and the climatic changes of this period. The identification of agents with which medieval and modern sedimentary deposits can be dated more precisely is an obvious need.

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Late Pleistocene mollusk fauna in terrace deposits of the Zeleniv section (Northern Bukovyna, Ukraine)

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Keywords: fauna of mollusks, Late Pleistocene, river terraces, Upper Prut valley.

1. Introduction

Cyclical climate changes in past at the regional and local scales are well recorded in the terrace deposits. Therefore, their study allows us to detail knowledge about the nature development in the region, to trace the cyclical changes in natural conditions during the deposits' formation, to find out their genesis, etc.

Unlike the Dniester valley, the age and dismemberment of the river terraces in the pre-Carpathian part of the Upper Prut remains studied insufficiently. There are still not many sections with strong and fully

dissected subaerial strata. It is mainly due to the poorly preserved terraces, which are strongly deformed by landslide processes, especially on the right bank of the Prut River. There is also practically no mention of sections of terraces with remains of large mammals' fauna and mollusks.

However, mollusk shells are the most common paleofaunal remains in the Quaternary sediments. They are present in almost all genetic types of sediments, are paleoecological indicators of the natural environment, and therefore allow us to restore the development of natural conditions, processes, and individual properties of paleolandscapes. The similarity of the landscape and ecological conditions of Pleistocene mollusk fauna to modern ones allows us to establish the natural conditions at different stages of the Pleistocene and trace the evolution of paleolandscapes. Since terrestrial mollusks (especially stenobiontic species) have limited opportunities for dispersion and are vulnerable to changes in natural conditions, they are one of the most representative groups of organisms for bioindication purposes and well reflect changes in natural conditions.

2. Investigated area

A section of the terrace of the Prut River was found near the confluence of the Brusnytsia River. The Prut River valley here is quite well-developed and terraced. A typical feature is its asymmetry - the right bank here is steep, and the left bank is gentle. Such a structure of the river valley can be traced almost throughout Pre-Carpathian. The primary topography of the right bank has been disturbed by landslides, so not all terrace levels can be traced here.

The studied 23-meter exposure is in a ravine, on the northeastern outskirts of the Zeleniv Village (Chernivetska Oblast), about 200 m upstream from the mouth of the ravine (right side). The relative altitude of the studied terrace surface above the incision of the Prut River is about 40 m; the roof of the channel alluvium is 21 m, and the terrace basement is 17 m. This site is unique for the region due to the well-preserved section of the terrace deposits and the paleontological remains found in them. A preliminary overview of the fauna on the site and its vicinities was presented at the symposium [Ridush et al., 2016]. More details about the geomorphological position of the object and current research results are covered in work [Ridush et al., 2021].

3. Methods

The sampling of subfossil shells was provided according to the methods described in the works by V. Bondarchuk [1933, 1937], I. Danilovskyi [1941], I. Melnychuk [1972], V Lozhek [1964], M. Kunitsia [1974, 2007], with the improvement by the authors: monolithic sampling considering microstratigraphy, facial variability of sediments and taphonomical conditions).

The taxa identification was carried out mainly by conchiological and conchiometric parameters of mollusk shells. Statistical processing was carried out according to the method of identification and calculation of shells' fragments according to V. Lozhek [1964], S.V. Aleksandrowich and V.P. Alexandrowich [2011].

4. Results

In general, the sediments in the section are represented by channel, floodplain, and subaerial strata. Faunal remains of large mammals, sometimes with traces of processing, are associated with the layer of the floodplain alluvium, represented by sands, sandy loams, and sometimes gleyic. The developed Upper Paleolithic flints and mollusk shells were also found. According to the biostratigraphical dating of the remains of mammoths, the layer corresponds to the end of the Vytachiv Stage (MIS 3) - the beginning of the Bug Stage (MIS2). The main part of the Bug Stage in the section is represented by rhythmic interlaying of sand, sandy, loam, and dusty layers and interlayers, often with signs of glaying, ferrugination, solifluction micro deformations [Ridush et al., 2016], cryodesiccation cracks. Sediments in the section lie at a slight angle.

Accordingly, younger sediments are wedged closer to the headwaters of the ravine. Therefore, sediment research and sampling were carried out in several geological clearings. A total of 32 main and additional samples were taken at the Zeleniv section.

The mollusk fauna of the beginning of the Bug Climatolithic is mainly represented by species of mesophytic meadows. The species composition is dominated by *Succinea oblonga* (Drap.). Few *Vallonia tenuilabris* (Al. Br.), *Pupilla sterri* (Voith), *Vertigo parcedentata* (Sandb.), as well as isolated finds of *Vallonia pulchella* (Müll.), *Helicodiscus singleyanus* Pilsbry, fragments of *Vallonia* sp., *Pupilla* sp., *Clausiliidae* and *Helicoidea* . In the ecological composition, the part of mesophiles is the highest (for the account of the eurythermic *Succinea oblonga* (Drap.). The part of species that prefer open biotopes is high. These are representatives of the genera Valloniidae, Pupillidae and the species *Vertigo parcedentata* (Sandb.). The presence of cryophilic species in the fauna (*Vallonia tenuilabris* (Al. Br.) and *Vertigo parcedentata* (Sandb.) testifies to intervals of significant cooling of the climate, which were characteristic of certain phases of the beginning of the Bug Stage.

In the sediments of the Bug Stage, a layer of the older pedosediment (Zl_{2a}) re-deposited by a mud-debris-flow, is present in the section, which is similar in characteristics to the Kaidaky paleosol (MIS5e). The species composition of mollusks from this layer is quite rich. Taxa representing open biotopes (*Pupilla muscorum* (L.)) and mesophytic meadows (*Succinea oblonga* (Drap.)) are dominant. High proportions of *Pupilla bigranata* (Rossmässler), *Vallonia tenuilabris* (Al. Br.), *Columella edentula* (Drap.). Such taxa as *Acicula polita* (Hartmann), *Pupilla bigranata* (Rossmässler), *Clausilia dubia* (Draparnaud), *Cl. pumila* C. Pfeiffer, and *Carpathica calophana* (Westerlund) in the sediments of the Zeleniv section are found only in this pedosediment. Most of them (except for *Pupilla bigranata*) are shade-loving species. So, at that time, in the studied part of the Upper Prut valley, forest landscapes were also common in addition to open meadows.

Shells of mollusks from the extremely cold chronointerval of the Bug Climatolithic (LGM, Zl_7) were found in only one of the six selected samples. They are represented by the taxa: *Succinea oblonga* (Drap.), *Vallonia excentrica* Sterki, *Trichia hispida* (L.) and *Pupilla* sp., but their number is too low for paleoecological reconstructions. At the same time, in the inner canyon part of the neighboring Middle Dniester valley, even in the LGM sediments, we find at least the eurybiont taxon *Succinea oblonga* (Drap.), characteristic of this region. According to the molluscan fauna and the sediments in the Zeleniv section, which here are represented by thin-layered, fissured loess, formed mainly under nival conditions, we established that during the coldest phases of the Bug Stage, in the Upper Prut valley, the landscapes were similar to periglacial semi-desert or desert. At the same time in the Middle Dniester valley, an extreme impoverishment of the mollusk species composition can be traced, but the region remains to be a refugium.

A detailed analysis of the of mollusks ecological assemblage at the site, based on samples selected considering the microstratigraphy and facial variability of sediments, allows us to trace the following succession of phases in landscape-climatic changes (Fig. 1):

Zl_1 – mesophytic meadows were characteristic; local proluvial processes were activated in the area;

Zl_2 – increased part of open biotope species; hygrophilous and shade-loving species appeared;

Zl_3 – open biotopes also prevailed; loess accumulation began;

Zl_4 – humidification increased (due to hygrophilic species); the part of cryophiles increased; phase of active loess accumulation;

Zl_5 – the part of cryophiles decreased, but a small amount of xerophiles appeared and the part of hygrophiles increased;

Zl_6 – humidification gradually increased; the proportion of hygrophiles was highest at the end of the phase;

Zl_7 – the climate became extremely cold, close to periglacial semi-desert or desert.

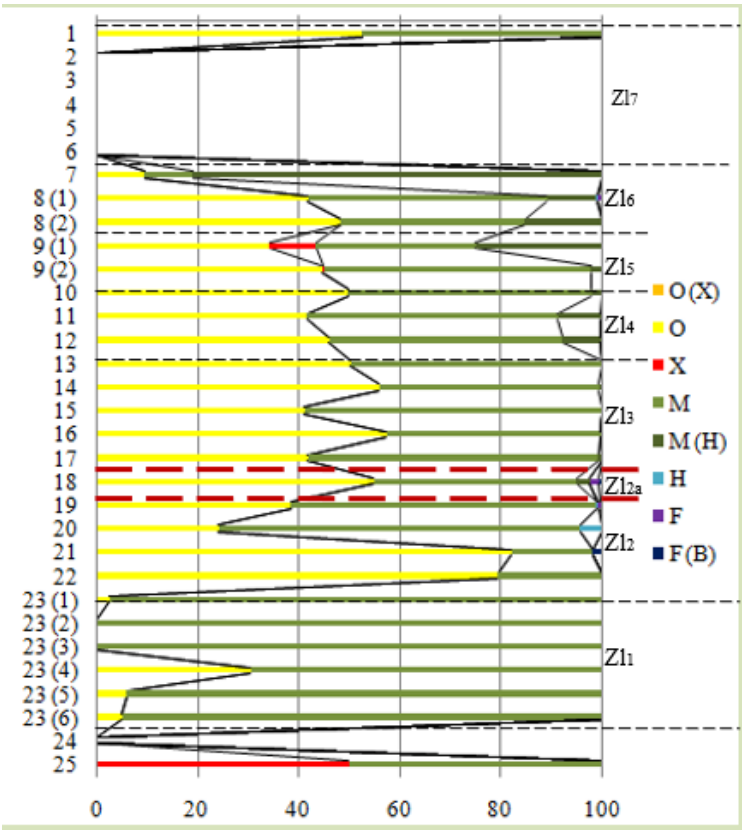

Figure 1. **Variability of the Late Pleistocene environments according to the mollusk fauna in the terrace deposits of the Zeleniv section**

Legend: 1-25 – sample numbers; Zl_1-Zl_7 – phases of the environment changes. Ecological groups [Alexandrowicz S., Alexandrowicz W. 2011]: O – species of open biotopes, M – mesophilic species, X – xerophilic species, H – hygrophilous species, F – shade-loving species, F (B) – species of shaded and partially shaded biotopes.

5. Conclusions

The approach we applied to the paleomalacological studies of the Late Pleistocene terrace deposits of the Prut allowed us to establish the following features:

1) the paleomicrorelief diversity of the studied area was reflected in significant differences in the stratigraphic and lithological-facial structure of the deposits;

2) in most cases, these changes in sediments correspond to a change in the species and, in part, ecological composition of the mollusk fauna. This made it possible to trace the short-term phasing of the development of paleogeographic conditions based on the change in the percentage of the mollusk's ecological groups;

3) there were significant differences in the natural conditions of the Upper Prut and Middle Dniester valleys during the Bug Climatolithic accumulation. Based on the study of the features of the sediments of this time in the Zeleniv section and the conclusions drawn from the mollusk fauna, we propose to consider the landscapes of the Bug Stage in the Upper Prut valley similar to periglacial semi-desert or desert.

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What can floodplain deposits of one of the last colonized catchments in central Europe tell us about Late Holocene climate and land-use changes?

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Keywords: Outer Western Carpathians, Holocene, Floodplain, Sedimentology, Environmental change, Human impact

The Bečva River catchment (eastern Czech Republic) was colonized more than one millennium later than other Central and Western European catchments and thus present uniquely long record of natural factors affecting morpho-sedimentary evolution. The anthropogenic activity superseded natural factors as late as during 12th century AD. Since the Outer Western Carpathians where the studied river originates are highly susceptible to erosion, its sub-mountainous floodplain is well developed and its alluvial record well preserved. We used coring, geophysical sounding and lithological analysis of floodplain deposits supported by AMS dating to establish stages of Late Holocene floodplain evolution. We describe six stages from Late Atlantic up to the 20th century – during three stages accumulation prevails, incision prevails during two stages, and one stage is described as mixed. We successfully linked each morpho-sedimentary stage with major driving factor that changed in the catchment.

Impacts of climate change and human activities over the Holocene using multi-proxy analysis from lake sediment records

Aritina Haliuc et al.

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Humans have modified their environmental context from millenia by altering the natural vegetation cover, aquatic ecosystems, influencing biogeochemical cycles, but large-scale and sustained land-use changes commenced only with the advent of Neolithic farming. Despite the widespread recognition of such early human-induced changes, the space, timing and magnitude of first detectable shifts unequivocally linked to human activities remain poorly-defined. A novelty in investigating the past environmental changes is the application of an integrative approach combining conventional and novel paleolimnological techniques as it offers an unprecented opportunity to investigate the extent, driving forces and impacts of climatic vs anthropogenic processes transforming the environment over longer time scales. High-resolution paleoenvironmental reconstructions are imperative in advancing the scientific understanding of the complex interaction between people, climate and nature. This project aims to provide a novel perspective on the Holocene environmental changes in a historically rich, though unexplored area (Romania, SE Europe) in relation with past climatic changes and human activity by applying integrative biogeochemical approaches to lake sedimentary archives.

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Aeolian dynamics during the last deglaciation at the northern edge of Banat Sand, Vojvodina, Serbia

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Keywords: aeolian sand, Banat Sand, climate, Danube, dune

Banat (Deliblato) Sand is one of the largest and the most unexplored areas with dominant aeolian sand sediments in Europe. Close to Iron Gate, Danube accumulated a vast amount of sediment in its alluvial plain and mostly SE wind (Košava) distributed material in the NW direction, forming the thickest

aeolian sand sediments in Serbia. At the northern edge of Banat Sand, a high-resolution archive, represented by an approximately 20 m thick dune is located.

This is the first multidisciplinary study of an aeolian dune in Serbia. Based on detailed optically stimulated luminescence chronology we calculated the sedimentation rates, which are extremely high for this region. The sand was accumulated before 13 ky to 17 ky, which represents the transition from the last glacial to Holocene. The magnetic susceptibility and colourimetric analysis were performed and interpreted in terms of local palaeoenviromental conditions. In contrast to much more explored loess sediments in this region, sedimentation rates are significantly higher, which allows much higher resolution of reconstructing palaeoclimatic and palaeoenvironmental conditions. Considering this as one of the first detailed studies of sand in this region, comparation to other sand archives is limited.

Amazon 10kyr: from the past climate to future challenges

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The Amazon Basin, comprising 7.5 million km^2 plays a key role in the global climate system, acting as a major component of the South American Monsoon System (SAMS), coupling the Intertropical Convergence Zone (ITCZ) to the South Atlantic Convergence Zone (ZACS). It is an important player in the moisture source for the tropics and sub-tropics in the South Atlantic Sector, recycling the water through the vegetation and surface soil, and contributing to the hydrological cycle of the Andean high mountains. Its evolution along the Holocene is still an issue of debate with inconclusive hypotheses about the evolution of the forest and its biodiversity. An important dry event (or megadrought) that took part during the mid-Holocene in the Amazon basin has been a matter of interest for paleoclimatologists. Although well recognized in models and in a few climate proxies, the major natural actors behind this episode are not completely described in the literature, probably due a lack of high resolved paleoclimate records in the context of the vast continental Amazonian land domain. More comprehensively, authors attribute the nature of the wet and dry phases of the Amazon Basin to the latitudinal shift of the ITCZ, according to warming periods in the North Hemisphere. In this presentation, I will discuss the results of new proxy data compilations that clarify better the mid-Holocene drought event and its duration manifested in different geochemical proxies as well as the timings with respect to other databases from the Andes and the Atlantic Ocean. We demonstrate that the Amazon megadrought left significant imprints in the Andean ice and Amazon and La Plata water river discharges. We estimate that the Amazon megadrought lasted between 1.5 and 2.0k years in a 10kyr time scale and seems to be related to the North Hemisphere Holocene Climate Optimum. Coupling the climatic and the regional archeological data, the establishment of the mid-Holocene Amazon drought may support the hypothesis of a climatic cause for the early man migrations and exodus in the Eastern South America at that time.

Winter climate variability in Europe during the Medieval Warm Period (MWP) and Little Ice Age (LIA)

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Keywords: winter, climate, Europe, MWP, LIA

Knowledge of climate variability is necessary in order to forecast it in the future, both in the short and long term. In the last millennium, the climate of Europe showed important variations, especially during the winter. In this study we present the variability of the winter climate based on high-resolution paleoclimate records (ice caves, speleothems, lake sediments, tree rings and historical evidences). The analysis on various proxy indicators indicates that the MWP was a warm and dry period in its first part (until AD 900), followed by a warm and humid phase in the second part (AD 900-1250) in Romania, the same warm and humid trend was also observed in Central and South-Western Europe. Moreover, hydroclimate analysis during the MWP reveals a warm and humid climate in Central Europe (Bunker Cave), South-Western Europe (Lake Montcortes) and the Middle East (Jeita Cave), then a humid climate in Western Asia (Bir Uja Cave) and hot and dry in North Atlas Mountains, Africa (Lake Sidi – Ali). Instead, the analysis of the climatic conditions during the LIA indicates the predominance of a cold and dry climate throughout Europe, but also in distant regions such as North Africa, the Middle East and Western Asia. In our presentation we will discuss the links to large-scale circulation patterns in Europa, (e.g. NAO, EA) and the possible forcing mechanism of climate changes.

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Geomorphometric delineation of floodplains for quaternary deposits mapping

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Keywords: Copernicus DEM, channels, fluvial terraces, Holocene, watershed segmentation, neural network

Floodplains and their morphology, including river channels and fluvial terraces, are important fluvial landforms with practical implications from many perspectives: quaternary geology/geomorphological mapping, flood risks, and planning. The availability of a medium-resolution Digital Elevation Model (DEM) like Copernicus DEM opens up the possibility of delineating channels and floodplains with better accuracy than with SRTM or other similar DEMs.

Since the elevation data comes from radar measurements, the landform shape in non-vegetated areas is very well-constrained, as the Copernicus DEM has low noise in flat areas and excellent precision, similar to LiDAR data. At the 20 m spatial resolution, the channel and floodplain of rivers up to the third

Strahler order are recognizable. The channel network was delineated using the D8 algorithm and a breaching algorithm for depressions. The floodplains were extracted by training a neural network, specifically Multilayer Perceptron (MLP), for the geomorphometric variables of watershed segments of the slope (Figure 1). MLP is a deep feedforward neural network/multilayer perceptron method that uses the neuron model, of acyclic networks, in layers that use connected functions as vector nodes to fit linear functions for an overall non-linear classification or regression.

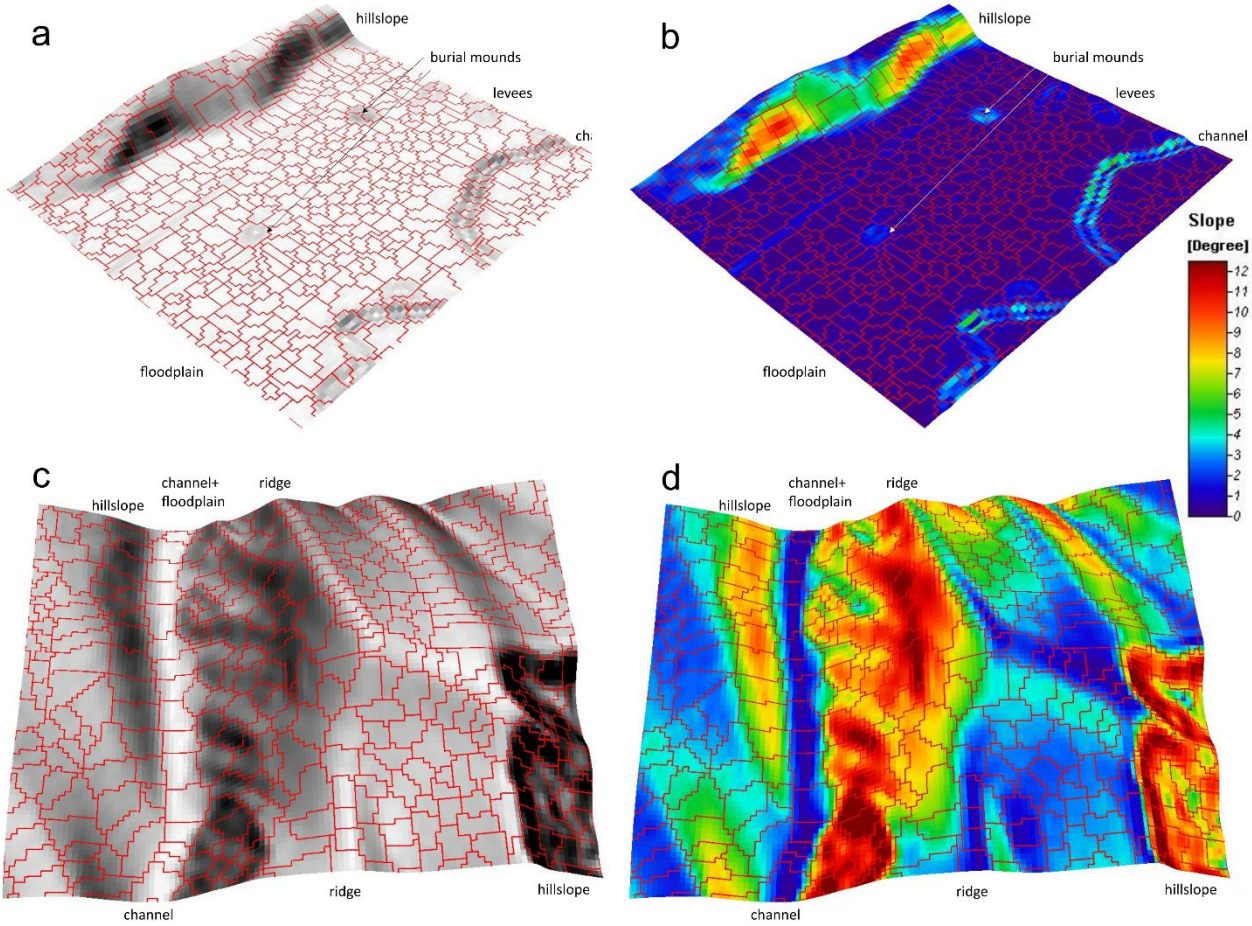

Figure 1. Examples of slope segmentation.

Because there is no source of ground truth data, the evaluation of the results was performed mainly qualitatively by comparison with LiDAR data. The results show the geomorphometry's feasibility and the Copernicus DEM for floodplain delineation and mapping of the quaternary deposits.

Considering the Quaternary age of the floodplains and terraces, with most of the floodplains dating as Holocene, their geomorphometric delineation puts the base of their mapping. As dating information improves and significantly better geological or geophysical data piles up, surface landform delineation will also be essential for depth and volume prediction.

Changes in the vegetation cover of East-Central Europe in the Holocene based on molecular diversity and distribution pattern of forest tree species

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The climate warming of the early Holocene period has shaped the distribution area of tree species forcing cold tolerant species to withdraw and promoting warm tolerant, broadleaf species to colonize new habitats towards the northern Europe. The Balkan Peninsula has served as an important refugia for many tree species during the glacial cycles of the Pleistocene, from where they were able to colonize Central Europe in the postglacial period. However, latest studies based on palynological studies as well as genetic diversity evaluations and DNA fingerprinting provided evidences of some population that survived the glacial cycles in situ, mainly at low elevations of the Carpathians and, in some parts of the Carpathian basin.

In turn conifer species characterizing the woody vegetation in the cold period of the Pleistocene suffered a strong withdrawal and were outcompeted in most habitats by the colonizing broadleaf species. Swiss stone pine (Pinus cembra) has retreated to the high elevations close to the timber line, while Scots pine (Pinus sylvestris) inhabited edaphically extreme habitat types, like the ombrotrophic peat bogs or the rocky outcrops. Starting from the Middle Holocene, spruce (Picea abies) established the conifer belt in the Carpathians, occupying elevations between 1000-1700 asl, while Abies alba has become part of the mixed forests of beech and spruce without forming pure stands in the Carpathians. Beech-fir-spruce forests of the Carpathians with their delicate structure and geobotanical and floral composition have been strongly affected by the human impact, resulting mostly in pure spruce stands. Abies alba has become rare and threatened species of the Carpathians.

Latest studies based on vegetation modelling and molecular genetic approach likely forecasted that with the ongoing climate change the more drought tolerant Abies alba may become more frequent and able to establish on new habitats where spruce looks to undergo a serious decay. Beech will move upwards forming mainly pure or mixed stands on higher elevations. However because of the longer generation time any new forest composition or the establishment of forest trees needs higher time frame and species will not be able to succeed along with the fast climate change. Fine-scale genetic structure analysis of source tree populations can enlighten future possibilities, how human contribution may facilitate reorganization of mountain forests, and how people can mitigate the effects of the climate change to prevent the decline of mountain forest communities.

Vegetation dynamics in the Bulgarian Black Sea coastal area during the last 26000 years

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Keywords: Climate changes, Late Pleistocene, Holocene, Palynostratigraphy, Marinopalynology

1. Introduction, Materials and Methods

Pollen analysis and radiocarbon dating were performed on marine sediments from three new cores from the shelf, continental slope and deep-water zone of the Black Sea in order to provide a detailed reconstruction of the vegetation development during the Late Pleistocene and Holocene. Fifteen sediment layers were selected for radiocarbon dating in two laboratories. An "Age vs. Depth" model (Fig. 1) was developed for all three cores by 2σ-range calibration, using the MARINE13 curve with an application of a Reservoir effect of 363±41 yrs. All 105 pollen samples were processed according to the standard procedures.

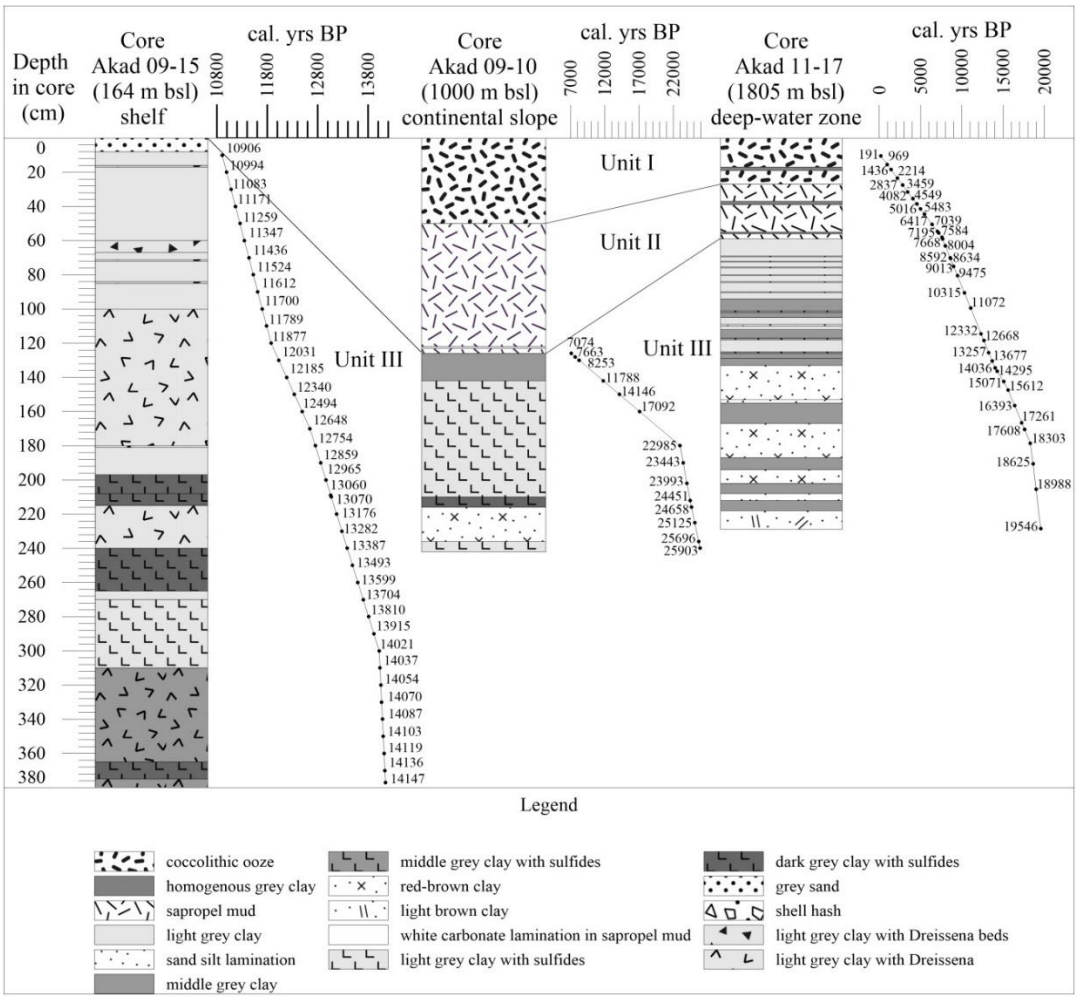

Figure 1. Lithological description and sedimentation rate of studied cores AKAD 11-17, AKAD 09-10 and AKAD 09-15, based on the established age vs. depth model. Black Sea sedimentology: **Unit I** is a micro-laminated sediment, rich in plankton-derived carbonates, with relatively low levels of organic carbon; **Unit II** is a micro-laminated sapropel deposited under anoxic marine conditions. The onset of Unit II is characterized by the occurrence of thinly laminated layers rich in aragonite crystals and by a sharp increase in Total Organic Carbon; **Unit III** is deposited when the Black Sea was an oxic freshwater lake and is characterised by a mix of organic-poor clays and silts.

2. Results and Discussion

Fifteen local pollen assemblage zones named after the dominant taxa in the pollen spectra were recognized. Because these zones are present in two to several sediment cores in adjacent areas, they are further delimited as regional pollen assemblage zones (Table 1).

Table 1. Palynostratigraphy of the Bulgarian Black Sea coastal area for the last 26000 years with a correlation between local and regional pollen assemblage zones and subzones (modified after Filipova-Marinova, 2006).

cal. kyrs. BP	Northemeuropean climatostratigraphy (Blytt 1876 – Semander 1908)		Regional stages and substages (Shopov, 1991)	Archaeological Chronology (Todorova, 1986)	Regional PAZ	subzones	Pollen assemblages (Filipova-Marinova, 2006)	2345 Local PAZ	2345 Pollen assemblages (Filipova-Marinova, 2003)	09-15 Local PAZ	09-15 Pollen assemblages	GGC18 Local PAZ	GGC18 Pollen assemblages (Filipova-Marinova et al., 2013)	09-10 Local PAZ	09-10 Pollen assemblages	544 Local PAZ	544 Pollen assemblages (Filipova et al., 1989)	11-17 Local PAZ	11-17 Pollen assemblages
2.8	HOLOCENE	Subatlantic	BLACK SEA New Black Sea	Iron Epoch	IX		*Q-U-Al-Cb-Sa-F*	8	*Q-U-Al-F*			6	*Q-Al-Cb-U-F*	6	*Q-Al-U-Cb-F*	6	*Q-Al-Cb-U-F*	6	*Q-Al-U-Cb-F*
5.5		Subboreal		Early Bronze Age	VIII		*Q-Cb-Co-F-Cor-Ce*	7	*Q-Cb-Co-F*			5	*Q-Cb-F*	5	*Q-Cb-F-Co-Cor-Ce*	5	*Q-Cb-Co-F*	5	*Q-Cb-Co-F*
8.2		Atlantic	Old Black Sea	Transi-tional Period / Late Eneo-lithic	VII		*Q-Co-Cb-U-Tr-Ce*	6	*Q-Co-U-Cb-Ti*			4	*Q-Co-Cb-U-F-*	4	*Q-Co-Cb-U-Ce-Tr*	4	*Q-Co-U-F-Cb*	4	*Q-Co-Cb-U-Ce-Tr*
10.3		Boreal		Neo-lithic	VI	b	*Q-U-Co-Art*	strati-graphic hiatus				3	*Q-U-Art*	3	*Q-Art-Co*	3	*Q-Co-U-Cb-Art*	3	*Q-Art-Ch*
		Preboreal				a	*Q-P- Art*					2	*Q-P-Art*						
13	PLEISTOCENE	Younger Dryas	Upper-New-euxinian		V	d	*Art-Ch*	5	*Art-Ch*	3	*Art-Ch*	1	*Art-Ch-P*	2	*P-Art-Ch*	2	*Art-Ch*	2d	*Art-Ch*
14	Late Würm / Late Glacial	Allerød				c	*P-Art-Ch*	4	*P-Art-Ch*	2	*P-Art-Ch*					1	*P-Art-Ch*	2c	*P-Art*
14.3		Older Dryas				b	*Art-Ch-Po*	3	*Art-Ch-Po*	1	*Art-Ch-P*							2b	*Art-Ch*
15.6		Bølling				a	*P-Art*	2	*P-Art*									2a	*P-Art-Ch*
		Oldest Dryas			IV		*Art-Ch-P*	1	*Art-Ch-P*					1	*Art-Ch-P*			1	*Art-Ch-P*
25.9		Late Pleniglacial																	

Legend: Al=*Alnus*, Art=*Artemisia*, Cb=*Carpinus betulus*, Ce=*Cerealia*-type, Ch=Chenopodiaceae, Co=Corylus, Cor=*Carpinus orientalis*, F=*Fagus*, P=*Pinus diploxylon*-type, Po=Poaceae, Q=*Quercus*, Sa=*Salix*, Ti=*Tilia*, Tr=*Triticum*, U=*Ulmus*

Regional Pollen Assemblage Zone IV (*Artemisia* – Chenopodiaceae – *Pinus*) 25903-15612 cal. yrs BP, Late Pleistocene, Late Pleniglacial-Oldest Dryas Stadial of Late Glacial.

The sedimentation started during the Late Pleniglacial which is characterized by steppe vegetation dominated by cold-resistant and heliophyllous taxa such as *Artemisia* and Chenopodiaceae and stands of *Pinus* and *Quercus*. The growing season soil moisture deficit and low winter temperatures as low as minus 20°C would have maintained open vegetation. The dominance of *Artemisia* suggests rather dry environments during these glacial periods. However, climate aridity along the Bulgarian Black Sea coast was not so extreme because the presence of the desert shrub *Ephedra distachya* which is an indicator of dry continental climate and an important constituent of the glacial flora, is constant but low. The presence of *Juniperus* pollen shows the availability of open areas with these shrub taxa within the herb communities. The arboreal vegetation was reduced to some isolated small patches, dominated mainly by eurythermic conifers such as *Pinus*. The relatively high values of *Pinus diploxylon*-type pollen could

also be an effect of long-distance transport which became significantly more pronounced in an environment with sparse vegetation. Temperate deciduous arboreal taxa such as *Quercus, Corylus, Ulmus, Betula* and *Alnus* show low but constant presence in the pollen diagrams. Probably, isolated stands of these taxa must have survived in microenvironmentally favourable pockets in the Black Sea coastal mountains and played an important refugial role in the survival of temperate tree taxa along southeastern Europe during the Last Full Glacial.

Regional Pollen Assemblage Subzone Va (*Pinus* – *Artemisia*) 15612 – 14295 cal. yrs BP, Late Pleistocene, Bølling Interstadial of Late Glacial. Around 15500 cal. yrs BP open *Pinus-Quercus* forests expanded at the same time as red-brown clay sediments started to be deposited, marking the first interstadial warming phase (Bølling). The basic characteristic of vegetation change is the restriction of areas occupied by steppes dominated by *Artemisia* and the existence of scattered stands with *Pinus* and *Quercus* along the coast.

Regional Pollen Assemblage Subzone Vb (*Artemisia* – Chenopodiaceae – Poaceae) 14295 – 14036 cal. yrs BP, Late Pleistocene, Older Dryas Stadial of Late Glacial. A sharp decrease of *Pinus* and increase of *Artemisia* and Chenopodiaceae pollen reflect the vegetation response to the cooling during Older Dryas stadial and widespread of xerophytic and halophytic herb communities along the coast.

Regional Pollen Assemblage Subzone Vc (*Pinus* – *Artemisia* – Chenopodiaceae) 14036-12965 cal. yrs BP, Late Pleistocene, Allerød Interstadial of Late Glacial. Between ca. 14000 and 13000 cal. yrs. BP the forest composition shows rather warm climate oscillation that may probably correspond to Allerod interstadial. The pollen record shows an AP increase because of increased *Pinus diploxylon*-type pollen and the presence of temperate arboreal taxa such as *Quercus, Corylus, Salix* and *Betula.* The maximum of *Pinus diploxylon*-type pollen might signal approaching changes in climate: an increase in temperature and humidity. The increase in temperate arboreal pollen indicates the limited migration of some trees from the Southeastern European refugia.

Regional Pollen Assemblage Subzone Vd (*Artemisia* – Chenopodiaceae) 12965-10315 cal. yr BP, Late Pleistocene, Younger Dryas Stadial of Late Glacial. Between 13250 and 10500 cal. yrs BP a revival of steppe vegetation occurred and light-grey clay was deposited indicating a return to significantly colder conditions, which may correspond to the Younger Dryas stadial. This stage of vegetation development reflects the expansion of xerophytic herb (steppe) vegetation. Palynological data show that besides the prevailing light-demanding xerophytic and halophytic taxa such as *Artemisia* and Chenopodiaceae, many other taxa have also participated in these steppe communities. The prevalence of *Artemisia* suggests that the YD climate of the Bulgarian Black Sea coast is analogous to that of the Late Glacial maximum. Chenopodiaceae is always subdominant to *Artemisia* during the Pleniglacial and the Late Glacial Stadials. This confirms that Younger Dryas is the coldest and driest period along the central Bulgarian Black Sea coast during the whole Late Glacial.

There is a steep decline in AP, marked by the decrease of *Pinus diploxylon*-type pollen and almost all deciduous arboreal taxa from 13500 cal. yrs BP onwards. Only restricted stands of *Pinus*, *Quercus*, *Corylus*, *Carpinus betulus*, *Ulmus*, *Tilia* and *Betula* were sparsely distributed in favourable moisture localities and formed refugia in the Eastern Balkan Range (Stara Planina Mts.).

Regional Pollen Assemblage Zone VI (*Quercus* – Artemisia – Chenopodiaceae) 10315-8253 cal. yrs BP, Early Holocene, Preboreal-Boreal. After 10500 cal. yrs BP, a forest-steppe phase of vegetation development is registered. *Quercus* and other temperate deciduous taxa such as *Ulmus, Corylus, Tilia* and *Alnus* responded to the temperature increase, characteristic for the beginning of the Holocene (Preboreal). The percentage values of non-arboreal taxa, such as *Artemisia,* Chenopodiaceae and Poaceae are still high and may indicate that the humidity was not enough for more widespread of forests along the coast. The primary role in this initial stage of vegetation palaeosuccession was taken by *Quercus,* in contrast to the central and northern Europe, where the light-

demanding *Corylus avellana* appeared as a pioneer element. A rapid and very short forest decrease event is established. A very low sedimentation rate, a decrease of AP, mainly of *Pinus* and *Ulmus*, presence of *Ephedra distachya*, and increase of *Artemisia* are observed between 8500 and 8344 cal. yrs BP and could indicate temporary aridity. This event could represent the effects of the "8200 yrs BP cold event".

Regional Pollen Assemblage Zone VII (*Quercus - Corylus - Carpinus betulus - Ulmus - Triticum - Cerealia*) 8253-5483 cal. yrs BP, Middle Holocene, Atlantic. After 7500 cal. yrs forest vegetation was already relatively stable. Dense mixed oak forests, dominated by *Quercus, Ulmus, Corylus, Tilia, Fraxinus excelsior* and *Acer* expanded at the same time as organic-rich sapropel sediments started to be deposited. The optimal climate conditions (high temperature and humidity) stimulated the extensive spreading of these forests. The presence of *Hedera* confirms an increase in humidity and a rise in mean annual temperatures. The maximum percentage values of *Corylus* could be associated with a short-term fluctuation of climate parameters, but also with a clearance of mixed oak forests for the enlargement of cultivated areas along the coast as it is seen by the synchronous maximum values of *Cerealia*-type pollen. The most prominent feature of the Bulgarian Black Sea coastal zone during the Late Atlantic is the increase of *Carpinus betulus* after 6417 cal. yrs BP. Submediterranean elements such as *Carpinus orientalis* also occurred near the coastline and probably occupied some areas after the degradation of mixed oak forests due to a human impact that influenced the natural vegetation. The first appearance of pollen of anthropophytes such as *Cerealia*-type, *Triticum, Plantago lanceolata* and *Polygonum aviculare* marks the human impact during the Late Eneolithic period, 6100-5850 yrs BP.

Regional Pollen Assemblage Zone VIII (*Quercus - Carpinus betulus - Corylus - Fagus - Carpinus orientalis - Cerealia*) 5483-2837 cal yrs BP, Middle Holocene, Subboreal. After 5500 cal. yrs BP at the end of Atlantic and beginning of Subboreal, *Carpinus betulus* and *Fagus* expanded simultaneously and became more important components of the forest vegetation, while *Quercus, Corylus, Ulmus* and *Tilia* diminished probably due to some climate oscillations, human activities and/or interspecies concurrence. *Carpinus betulus* occurred as part of the mixed oak forests and presumably also formed separate communities and migrated from the south to the north. The decrease of *Ulmus* and the increase of *Carpinus orientalis* coincide also with the increase of anthropogenic indicators, including *Cerealia*-type, *Triticum*, *Plantago lanceolata* and *Polygonum aviculare*, which marked the destructive human activities during the Early Bronze Age.

Regional Pollen Assemblage Zone IX (*Quercus - Ulmus - Alnus – Carpinus betulus - Salix - Fagus*) 2837 cal. yrs BP – present, Late Holocene, Subatlantic. From about 2900 cal. yrs BP onwards the increase of *Alnus* and *Fraxinus excelsior* along with some lianas such as *Hedera, Vitis* and *Humulus/Cannabis* was a response to climate cooling and humidity increase during the Subatlantic. Mixed oak forests remain abundant, but are influenced by human impact during the Iron Epoch, 3200-2600 yrs BP, as is marked by the persistent presence of *Cerealia*-type and *Triticum*, as well as anthropophytes *Plantago lanceolata* and *Polygonum aviculare*. The increase of the percentages of *Alnus, Fraxinus excelsior*-type, and *Salix* is due to the increase of humidity and cooling of climate that is connected with the vegetation succession and formation of the specific flooded riparian "longoz" forests along the river valleys dominated nowadays by *Alnus glutinosa, Fraxinus oxycarpa, Ulmus minor, Carpinus betulus*, and *Quercus pedunculiflora.*

3. Conclusions

This study refines the climate changes and vegetation dynamics of the Bulgarian Black Sea coastal area during the last 26000 years. The established regional pollen assemblage zones and subzones apparently correspond to the European intervals marking the end of Late Pleniglacial and Late Glacial of the Würm Glacial (including Oldest, Older and Younger Dryas Stadials and Bølling and Allerød Interstadials), and the Preboreal, Boreal, Atlantic, Subboreal and Subatlantic chronozones of the Holocene.

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Speleothem stable isotopes as recorders of climate change from the Eastern part of Europe and Turkey

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The region comprising of East Central Europe, South East Europe and Turkey contributed to the SISAL (Speleothem Isotopes Synthesis and AnaLysis) global database with stable carbon- and oxygen isotope time-series from 37 speleothems from 24 caves. The temporal distribution of the compiled records from the region reach back to ~236 ka with sporadic data from the Sofular Cave (Turkey). The currently available oldest record from the studied region is the SO-14B record (Sofular Cave) reaching back to MIS 16. The regional subset of SISALv2 records displays a continuous coverage for both $\delta^{13}C$ and $\delta^{18}O$ for the past 160 kyr, with a mean temporal resolution of ~14 yr for the Holocene, and ~75 yr for the pre-Holocene period. The relationship between $\delta^{18}O$ of modern precipitation (amount weighted annual and winter season mean values) and climatological parameters show a strong positive correlation in East Central Europe reinforcing the link between modern day precipitation $\delta^{18}O$, temperature and large-scale circulation (North Atlantic Oscillation) expected to be preserved in the speleothem $\delta^{18}O$ record; while a negative relationship was documented between precipitation amount and oxygen isotope compositions in South East Europe. Variations of $\delta^{13}C$ values are primarily interpreted as reflecting dry/wet periods across the region.

Cave sediments and tectonic movements: records in gypsum karst of the Prut River valley

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Keywords: gypsum karst, cave sediments, liquification, Zolushka Cave, Upper Prut valley

The allochthonous cave sediments usually contain different paleogeographical records. The most common records are sediments, pollen, bone remains, and paleomagnetic records. We studied the section of cave sediments in Zolushka Cave.

Zolushka (Popeliuszka, Emil Rakovica) Cave is a huge maze in Miocene gypsum, 92 km long, in the border zone between Ukraine and the Republic of Moldova, on the right bank of the Prut River valley. Tectonically it is situated on the eastern edge of the Novoselytsia tectonic depression. The territory has a block structure and consists of a series of different size blocs at different elevations.

It was discovered in 1977. The entrance was outcropped by the industrial production of gypsum by a quarry between villages Criva on the Moldova side, and Podvirne on the Ukrainian side. Besides the large dimensions of galleries, the cave differs from other huge gypsum labyrinths such as caves Optymistychna, Ozerna, Mlynky, and others, with the fact that by the recent time most of the cave was below the water table. Only after the beginning of gypsum exploration in the 1950s, the groundwater table was decreased up to 28 m. Only 2-3 m of the gypsum strata were naturally bedded above the groundwater table. The karst process touched all thicknesses of the sulfate strata because the cave system is of hypogenic origin and was developed by the waters from the underlying aquifer. The regional geological and karstological settings were described in detail by (Andreychouk, 2007; Klimchouk and Andreychouk, 2017).

A significant part of the cavities is filled with allochthonous sediments represented with almost only clay. In one of the widest places of the maze, in the Chernivtsi Cavers' Chamber, in the clayey sediments, we dig a prospection pit with the next sequence (Table 1).

Table 1

Depth, m	Layer description
0.0 – 0.075	light brown, massive loam (redeposited paleosol from the nearby collapse cone), with smears of yellow loess. On the contact - "parquet" – a polygonal structure.
0.075-0.47	soft plastic thinly laminated clay
0.075-0.18 (0.075-0.125)	dark gray clay, light gray below. On the uneven contact of dark and light gray clay, an interbed of red ocher 1 mm.
0.47	an interbed of dusty white quartz sand up to 1 mm.
0.47 – 0.7	the same layering of laminated light gray and yellow clay.
0.7 – 0.74 (0.8)	clay is light brown, lumpy, with manganese oxide at the contacts of the lumps.
0.74/0.8 – 0.87/0.9	brownish-yellow sandy loam, hidden layered
0.9 – 0.94	lumpy loam / clay
0.94 – 1.1	sandy loam
1.1 – 1.14	yellow loess
1.14 – 1.53	gravel-sand
1.53 – 1.73	greenish-gray clay, rigid plastic, massive
1.73 – 1.83	rigid plastic yellow clay, at 1.83 – an interbed of ferrugination with drying “parquet”. The surface of the "parquet" - the floor is inclined to the middle of the gallery by 10-15° - the evidence of the sediments subsidence at the center of the gallery.

Depth, m	Layer description
1.83 – 1.9 (2.0)	greenish-gray, rigid plastic to semi-hard clay. At 2.0 (1.9-1.8) with a slope, a layer of ferrugination over the carbonate ash with traces of manganese oxide.

In the north wall, at 1.65 m can be seen a layer of carbonate plates – a so-called "drapery" that fell from the wall or the ceiling, the same in the eastern wall - a block of the "drapery".

So, the sediments consist mainly of thin-laminated clays of grey, brown, and brown-grey clays. The clay usually is mild and hemymild. Partly, in the upper part of the sequence, it was dried, decreased in volume, and therefore cracked by the dehydration fissure on the polygons. At the depth of 7.5 cm, it was a very thin interlayer, bear 1 mm thick, of the red clay (Fig. 1, *A*). 47 cm below the floor surface the clay thickness was interrupted by a very thin (nearly 1 mm) interlayer of the fine white quarts (Fig. 1, B). The sand was bedded on the ancient clay floor, also dissected by polygonal fissures. The clay is the product of a very slow erosion of the overlaying Neogene marine clays, that collapse from time to time inside the cave, forming huge collapse cones. The breakdown mechanism in the cave was described by (Klimchouk and Andrejchuk, 2002). Initially, this white quartz sand is bedded below the sulfate strata. The only explanation for the uprising of sand is its liquification at the moment of the ancient seismic event, and the injection of this pulp upwards through the cracks in the sediments.

The three layers with polygonal cracks of dehydration, at the level deep below the natural water table, show us that previously the tectonic block containing the cave was at a much higher altitude, and the cave floor was dried from time to time. The block significantly descended during the Quaternary. The physical dating of the mentioned sediments and their paleomagnetic, palynological, and mineralogical studying will allow us to know the time of such a strong earthquake, as well as to estimate the time and speed of the tectonic block descending.

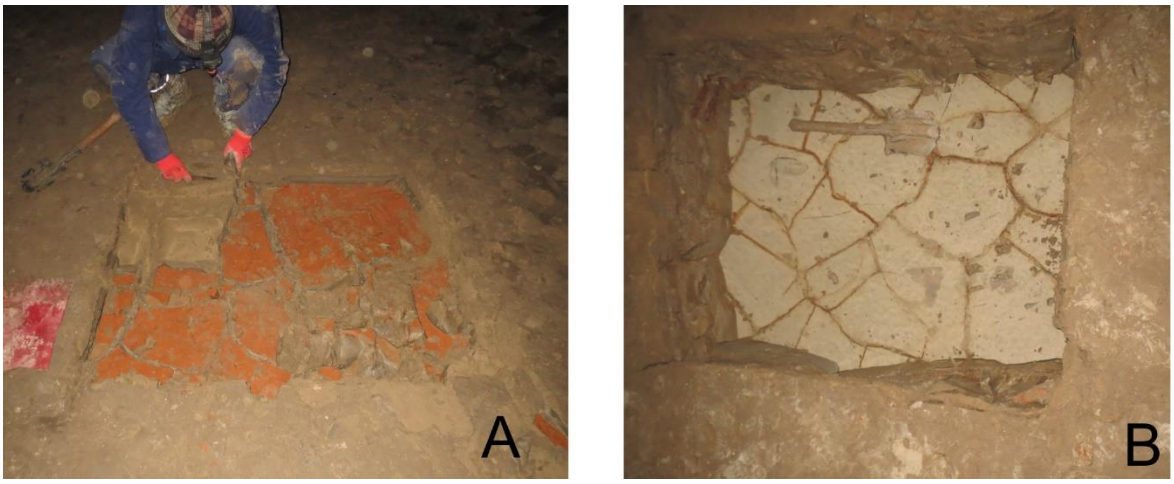

Figure 1. Polygonal structures in the sediments of Zolushka Cave. A – ferrugination interbed at the depth of 7.5 cm; B – quartz sand interbed at the depth of 47 cm.

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Environmental changes from 30 to 15 ka ago according to malacofauna from Veliki Surduk loess-palaeosol sequence(Serbia)

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Keywords: malacofauna, Titel loess plateau, loess-palaeosol sequence, Serbia, Veliki Surduk

Veliki Surduk is a well-studied loess-palaeosol sequence located at Titel loess plateau, Serbia. The main aim of this work is to present and interpret the mollusk shells found at the loess layer accumulated over the Marine Isotope Stage 2. Sampling was done at 5 cm resolution, and each of the 43 samples had a volume of 10 l. A total of 29988 shells were manually picked from the sediments, of which 28501 could be identified. Temporal interpretation of results was possible due to previous luminescence dating. There were 25 identified species, with the dominance of *Pupillamuscorum* and *Valloniacostata*, which were present in each sample. The cold-loving and hygrophilous *Columella Columella* has its maximum at 26 ka. The snail abundance per sample during the Last Glacial Maximum was in some samples higher than 1100, which is a large number compared to other malacologicaly investigated loess-palaeosol profiles in Serbia. The biggest environmental change recorded in Veliki Surduk section was from 21 ka to 13 ka. Here the results show possible existence of opened habitat and/or forest with highly tolerant species, in contrast with the warm dry steppe and mildness preferring species which existed before and after this period. According to malaco thermometer, the July malaco temperature was varying between 16.5°C and 19.6°C. The lowest temperature at Veliki Surduk was not related to Last Glacial Maximum, but rather a Heinrich Event 1.This study confirms the relatively stable environmental conditions and small July temperature variation for the southern part of Carpathian basin at studied time.

Using GPR technique on historical limestone quarry from Magura Calanului – Hunedoara County

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Keywords: GPR, measurements, historical quarry, geoarcheology

1. Introduction

The GPR technique has proven useful in a wide range of environmental, geological and engineering applications, with very encouraging prospects for results in other sciences, such as archaeology. Specialists in archeology, geology, and even those in the field of construction recognize this method as a precise and fast one. The principle is simple: emitted radio waves travel at a speed that depends on the material in which they propagate. The high-frequency radio waves used by the GPR system are

sensitive to both changes in conductivity and dielectric properties of the materials traversed. The electromagnetic characteristics of materials are related to their composition and their degree of saturation (Zielińskey et.al, 2016). This affects the propagation speed of radio waves and the attenuation of electromagnetic waves in the medium under study (Reynolds 1997).

Considering the relatively small depth of investigation, most geological studies using georadar target the stratigraphy of quaternary formations, related to sand dunes (Botha et al., 2003; Bristow et al., 2007), or lacustrine formations (Havholm et al., 2003;) and rivers (Roberts et al., 2003; Woodward et al., 2003; Teixeira de Oliveira, 2019; Menezes, 2021) or glacial deposits (Bakker et.al. , 2003; Kelly et al., 2021). However, it has been proven that the method can also be used for the research of other types of geological formations, or of some older than the Quaternary: Paleogene bauxites (Ball and O'Connor, 2021), Jurassic oolitic limestone used as ornamental stone (Duarte et.al. , 2019), Cretaceous fluvial deposits (Corbeanu et al., 2001), Jurassic sandstones (Jol et al., 2003), Carboniferous turbidites (Pringle et al., 2003) and is even used to explore the surface of the Moon (Lai et al., 2020).

The study focused on the use of the GPR technique for the preliminary research of the oolitic limestone formation from the historic Măgura Călanului quarry. In this sense, two field campaigns were carried out in the study area to perform measurements and calibrate the method on this type of formation.

By applying the GPR method in the ancient limestone quarry from Măgura Călanului, we want to highlight the oolitic limestone layers, estimate their compactness in the studied perimeter as well as the degree of porosity of the calcareous structure.

It is well known that ground-penetrating radar identifies variations in electrical permittivity of materials and renders them visually through radargrams. When propagating through the geological environment, absorption and scattering effects attenuate the signal transmitted by the GPR antenna. These effects are mainly revealed on the radargram as a loss of resolution with increasing depth (ie the return time of the signal to the receiving antenna). As a result, the amplitude spectrum decreases and the shift of the center frequency to the lower frequency components can cause a spectral imbalance.

2. The research history of the limestone quarry from Măgura Călanului

The initial research (19th - 20th centuries) started with the petrographic and mineralogical determination of the type of the rock from which the walls of the Dacian fortresses were built, because using a simple location of the perimeters of the fortresses, on the geological map (fig.1), it is shown that most of them are located in areas of crystalline schists. Only two of the fortresses are, from a geological perspective, located in the limestone area, respectively Bănita and Piatra Roşie, but the limestone in these areas is not identified with the type of limestone from which the walls of the fortresses are built.

In the northwest of the Şureanu Mountains represents the location of the source from which the limestone from the fortresses of Piatra Roşie, Feţele Albe and Grădiştea de Munte was mined and it was first made public in 1805, in a report of the Habsburg treasury (Cetean and Petan, 2017), and the first researches according to a scientific methodology that is still followed today were those published in 1995 by Professor Ioan Mârza from the Faculty of Geology and Biology in Cluj-Napoca.

Later, in 2014, the research was carried out through the project "PETRODAC - Petrographic and mineralogical investigations in the Piatra Roşie area and adjacent areas" by Dr. V. Cetean and Dr. A. Peţean that confirmed the conclusions of the previous studies and succeeded in a more detailed description , both from a petrographic and mineralogical point of view, of the limestone varieties found in Măgura Călanului (Cetean and Peţan, 2017).

Geologically, the area where the measurements were carried out includes Neogene (Sarmatian) limestone from the sedimentary succession of the Haţeg depression.

In 1999, six of the fortified settlements dating from the Dacian period were included in the UNESCO Heritage list under the name Dacian Citadels from Orăștiei Mountains (Sarmisegetuza Regia, Piatra Roșie, Costești Blidaru, Costești Cetătuie, Căpâlna and Bănita).

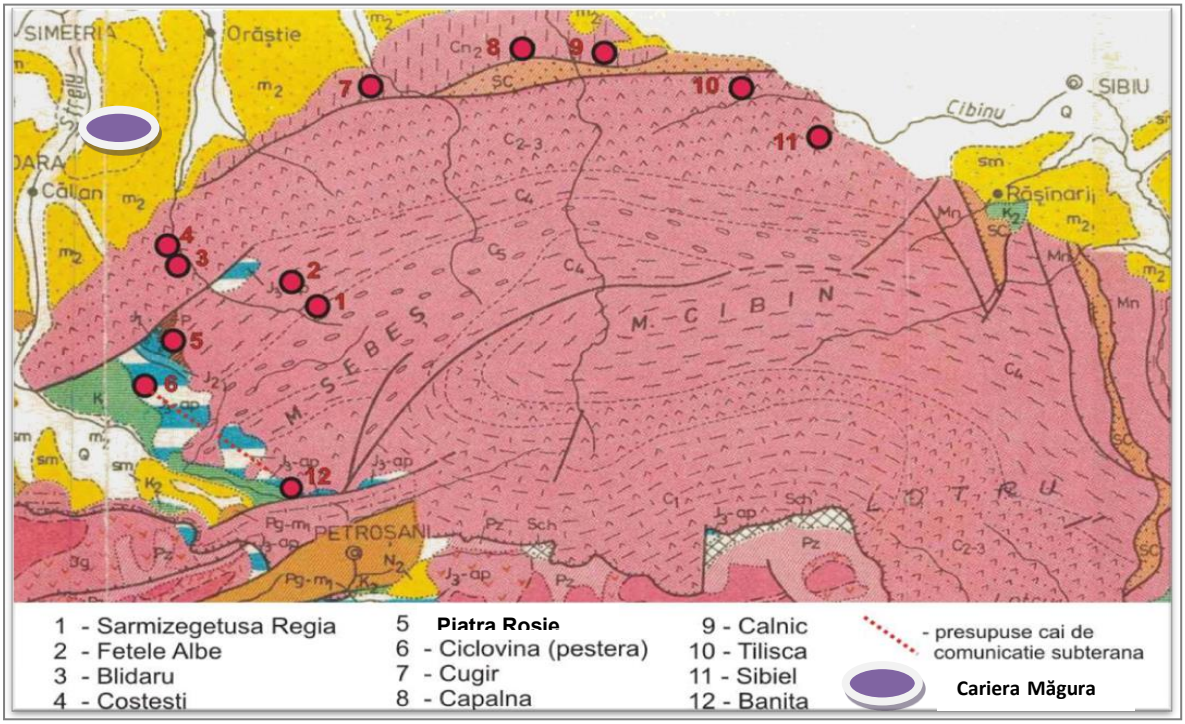

Figure 1. Location on the 1:200,000 geological map of the Dacian Citadels in the area of the Șureanu mountains. (adapted from V. Cetean, 2021).

The ancient limestone quarry has so far not been declared a historical monument and has not benefited from preservation or valorization programs, although it has been demonstrated that the Dacian fortresses in the Șureanu Mountains were built with limestone from Măgura Călanului.

However, the area is registered in the National Archaeological Repertory under the name of the Archaeological Site of Călan - Măgura Călanului (RAN code 87433.03) with archaeological evidence belonging to the Coţofeni and Dacica cultures.

Until this moment, this ancient stone quarry is the best preserved in Romania.

Administratively, the area of the ancient limestone quarry in the Măgura Călanului hill belongs to the city of Călan, respectively its component localities Sântămăria de Piatră and Valea Sângeorgiului, Hunedoara county. The access to the ancient quarry is quite difficult, because the road is under the administration of Romsilva, which uses it as a forest road for the transport of wood, and in rainy periods it is impassable even for off-road vehicles.

3. Field measurement campaign - methodology applied

During this preliminary research, the delimitation of 3 areas of interest (the quarry area, the tailings deposit area and the undisturbed area) was considered, as well as the determination of the following characteristics:

a. The compactness of limestone layers (highlighting of cracks, voids, areas with high humidity) – for measurements located in the quarry area.

b. Delimitation of limestone layers (based on dielectric permittivity) in the tailings area and in the area unaffected by historical exploitation.

The scanning of the area with the georadar was done in survey mode, i.e. simple scanning through 13 profiles, not being able to apply the array mode, i.e. the orthogonal grid, due to the vegetation and the quite rugged terrain. The antenna used was the FLB-390, a type of shielded antenna that is frequently used in the identification of underground voids, but also for highlighting the layers in a lithological sequence. The signals emitted by the antenna can provide relevant information up to a depth of 10 m. For a better validation of the images obtained from the profiles considered to be of major importance, it was considered that the direction of the profiles should follow the line of the encountered outcrops, as far as they were accessible, so that the geological significance of the discontinuities determined by the georadar method could be established.

During the field campaigns, electrometry measurements were also carried out and in some areas it was possible to overlap them with the GPR profiles. The overlapped profile (profile 8) will be described in this abstract (fig2). Two resistivity measurement methods were used in the Măgura Călanului perimeter. The Wenner method, which provides a general picture of the disposition of geological formations in the basement, and the dipole-dipole method, which provides a better lateral resolution, thus detailing the investigated structure. The measurements were carried out with the SuperSting R8/IP terramer which allows reaching investigation depths of up to 600 m. The GPR profiles were carried out in a wet period, a fact that was also highlighted in the processed images, more precisely in the 0-0.5m interval where multiple areas with increased humidity can be observed.

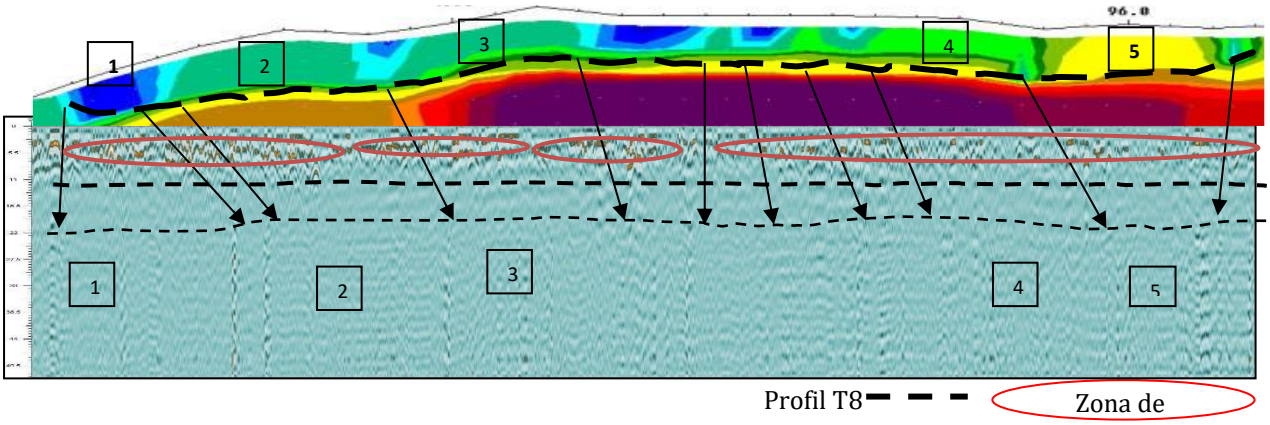

Figure 2. Detail of the geoelectrical profile highlighting the areas identified with the GPR-T8 profile.

Profile recorded, for the section delimited by the 1-3 m interval, areas with low resistivity and high permittivity. From the processing of the radargrams and their correlation with the images provided by SuperSting R8, it is possible to observe the transposition of the areas identified as minimum anomalies into changes in the georadar signal intensity. Thus, for most of the anomalies identified on the electrometry profile, areas of approximately the same size are outlined on the GPR profile.

4. Conclusions

The GPR method proved to be easy to apply, without the need to prepare the chosen perimeter for measurements, allowing the calibration of the acquisition parameters and the real-time visualization of the result. From this preliminary study we can conclude the following:

The method requires a critical spirit and increased attention to the interpretation of the radargrams, because there are external factors that influence the results, among which we mention the degree of saturation in the water.

The properties of sedimentary structures and the presence of discontinuities are factors that influence the amplitude of the reflected signal; In terms of data acquisition and processing, GPR proves to be a fast method that allows a good resolution visualization of existing structures and discontinuities.

After processing of the radargrams obtained at Măgura Călanului, the following emerged:

1. In the measurements carried out in the quarry area, a homogeneity of the material is clearly observed, homogeneity interrupted by 2 discontinuities/ruptures with a high inclination and an interval with high humidity (the areas coincide with the markers in the field).

Up to a depth of 2 m, the material is more compact; between 2 and 6 m, the degree of compactness and porosity of the massif changes. After the depth of 6 m, the data is no longer relevant.

2. Measurements in the "relay" pasture area - the area not affected by quarry activities. And in this area, we could observe a discontinuity in the basement. Up to approximately 2 m depth, the signal is quite scattered, suggesting that the substrate is inhomogeneous in terms of dielectric permittivity, probably composed of several types of materials.

After the first 2 m, up to a depth of 4-5 m, the signal is relatively uniform and similar to that in the quarry area (between 2-6 m), indicating the same type of sedimentary formation. In the same way, the signal intensity decreases with the investigation depth, the background noise being significant after reaching a depth of 5 m.

3. The measurements in the storage area do not reveal a normal succession, being the remains (fragments) of stone left after processing. Therefore, the processed images do not show a uniform structure, nor can a continuity of signal be determined within the constituent material.

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Rock slope failure in the Southern Carpathians - risks and rewards in Quaternary landform mapping and interpretation

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A newly-published first comprehensive inventory of montane RSFs in the Southern Carpathians identifies 215 cases affecting almost 150 km² - about 1.3% of range extent above 600 m asl. The large majority are slope deformations, but rockslides and rock avalanches have significant impacts. In a marginally-glaciated range, it is important to recognise

(a) the existence of RSF as a locally major landshaping process

(b) the risks of non-recognition, or of mimicry and mis-identification, eg. with rock glaciers and moraines

(c) the spatially-variable role of RSF in supplying debris to the sediment cascade

(d) the difficulties of dating RSFs and associating them with particular climatic shifts

(e) the full gamut of potential drivers and triggers, including (para-) glacial, (para-) fluvial, seismic, meteorological, time-decay, and longer-term tectonic uplift and incision.

This presentation gives examples of major RSFs from the high Parâng and its cirques, the eastern Făgăraş and its shrinking-by-RSF plateau landscape, and (briefly for comparison) the Rodna Mts and western High Tatra. It concludes by placing the Carpathians in a wider European context.

The paper Gunnell/Blondeau/Jarman in Geomorphology 2022 is available at https://authors.elsevier.com/c/1ft5h,3sl3tR55 including SI powerpoint slideset galleries of all RSFs in the featured massifs.

The first deglaciation chronology of south-oriented valley in Bohemian Forest (central Europe) – Preliminary results

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Keywords: Chronology of deglaciation, Bohemian Forest, Last glacial maximum

The Bohemian Forest Mountain range is situated on the border of Czechia, Germany and Austria. Paleo-glaciers in this range could thus represent connection between mountain glaciation in the Alps and continental glaciation centred on the Scandinavian Peninsula. Till now, we have information about deglaciation chronology only for north oriented valley in the Bohemian Forest. We used geophysical profiling, sediment coring, palynological analysis of sediment core and radiometric dating of blocks on moraine ridges to establish chronology of deglaciation and landscape evolution. Based on preliminary results a glacier had the largest extension about 25.66 ± 1.74 ka. In 17.42 ± 1.49 the glacier retreated to a cirque. After final glacier retreat there was a lake in the cirque which was probably infilled by sediments in the beginning of the Middle Holocene. It seems the Bohemian Forest glacier in the south oriented valley was more active than glaciers in north-oriented valleys and it disappeared earlier than glaciers in north-oriented valleys.

Deglaciation of the Prut Valley (Chornohora, Ukraine) in the light of geomorphological and sedimentological research

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Keywords: deglaciation, Chornohora, Prut Valley, Schmidt Hammer, sedimentology, moraines

1. Introduction

High mountain areas are characterized by very specific relief, which is determined by a number of factors - including geological structure, vertical variation of the environment, high energy of the relief. The high activity of morphogenetic processes is also the main reason for researchers' interest in high mountains specifically. Especially interesting is the study of forms above the upper forest boundary because conditions there were conducive to the transformation of older relief. The high mountains are a very sensitive indicator of environmental changes, they record any changes in the climate that occurred in the past. Chornohora, located in the Carpathians (Figure 1), is a high mountain range, in which we can analyze the influence of glacial, periglacial and nival morphogenesis.

The field research was conducted in the upper section of the Prut valley. This area was chosen based on the analysis of the numerical terrain model and satellite images covering the entire Chornohora and because of the geological structure - a flysch area in which the record of glaciation is very well visible. The study area is about 23 square km and the highest peak is Howerla (2061 m a.s.l.). The main goal of the research is to determine the course of the deglaciation of the Prut Valley in Chornohora based on

the morphostratigraphic relations, the degree of weathering moraine cover using the Schmidt's hammer test.

Figure 1. Prut Valley, Chornohora (red rectangle) - region of interest.

2. Environment of research area

The Chornohora consists of three units - the Chornohora, Dukla and Porkulec units. The Chornohora Unit consists of the Skupova subunit and the Chornohora (Howerla) subunit. The main ridge is built from of the flysch of Chornohora sandstone formation, where sandstones and conglomerates to marls and shales occur in a ratio of 8/2.

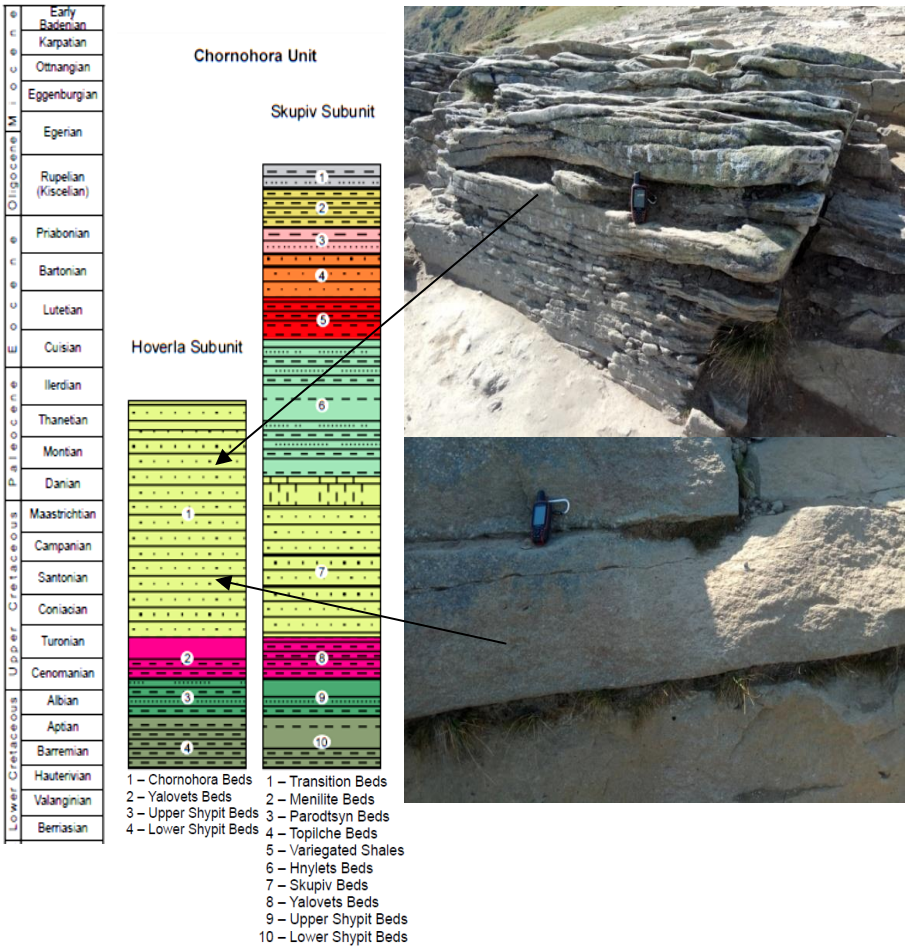

Figure 2. Rock formations of Chornohora (source: Jankowski et al. 2012). Photos of the Chornohora Beds from the slopes of Howerla (source: Murawska-Kącka).

The Choronohora strata are divided into three parts:

- the oldest are the Lower Cretaceous thin-bedded black, calcareous shales with siderites, fucoid marls, and thin-bedded sandstones (Shypot strata separated by a quartzitic sandstones - Barremian-Albian)
- younger shale and marls of the Porkulec strata (Cenomanian-Turonian)
- upper Cretaceous thick- and thin-bedded sandstones and conglomerates of the Chornohora – where we can find a characteristic system of thrust fractures, are strongly foliated.

Chornohora excellently distinguishes itself from the neighboring Svidovec and Gorgany ranges by its height, being higher than these ranges by about 200 m, despite the presence of a not very resistant flysch, it also distinguishes itself from the Maramureş Mountains built of complex metamorphic, volacano-sedimentary and flysch rocks. Very characteristic features of Chornohora is the high relative and absolute height and NE-SW asymmetry of the ridge but its most important feature is well-preserved glacial landscape inherited from Pleistocene glaciations (Kłapyta et al., 2021).

3. Research methods

Geomorphological mapping, sediment sampling and Schmidt hammer test were carried out in 2019-2021. The degree of weathering of the sandstone boulders was tested at 40 sites using a Schmidt hammer. Sites on the alluvial cone, present-day alluvium, and rock outcrops were treated as a benchmark place for studied moraines. Appropriate procedures should be used in the study to avoid errors that affect the results obtained and to classify forms into the appropriate morphostratigraphic systems. The procedures used in this study were those used adopted from works of Glasser (2005); Mentlik (2006) and Kłapyta (2012). The values that deviated most from the averages were rejected.

Clast morphometry analysis and sedimentological analysis were carried out at 32 test sites including moraine, fluvial and slope sediments. Clast morphometry analysis were based on measuring the shape and roundness of 50 clasts in the dominant 5-10 cm fraction, at each test site.

In order to understand the characteristics of the sediments collected in the field fractional composition and extraction of quartz grains ranging from 0.5 mm to 1 mm in diameter were performed in the laboratory. From each site, 100 quartz grains were selected from the given fractions under a Zeiss Stemi 508 microscope with a PC camera attached. Photographs of the grains were taken, separately for each site, using an automatic Morphologi G3 microscope. After obtaining images of quartz grains, parameters for each grain - circularity, convexity, compactness, elongation - were calculated in the software for the device.

4. Research results

Based on morphostratigraphic relation 5 group of moraines were distinguished in the Prut valley: pre-LGM moraines, Foreszczenka LGM moraines and Zaroślak, Breskul and Dancerz recessional moraines (Fig. 3).

The most extensive are the Foreszczenka LGM moraines which are very clearly distinguishable in the field - with a 30-50 m high outer ridges, and boulder-rich inner moraines seperating small peat bogs depressions. The Zaroślak moraines represent the 1-st recessional moraine system in the Prut valley and are mostly destroyed, in contrast to Breskul system moraines which is the most legible system of moraines with distinct latero-frontal ridges built with large boulders. The youngest morain system is represented by the Dancerz system.

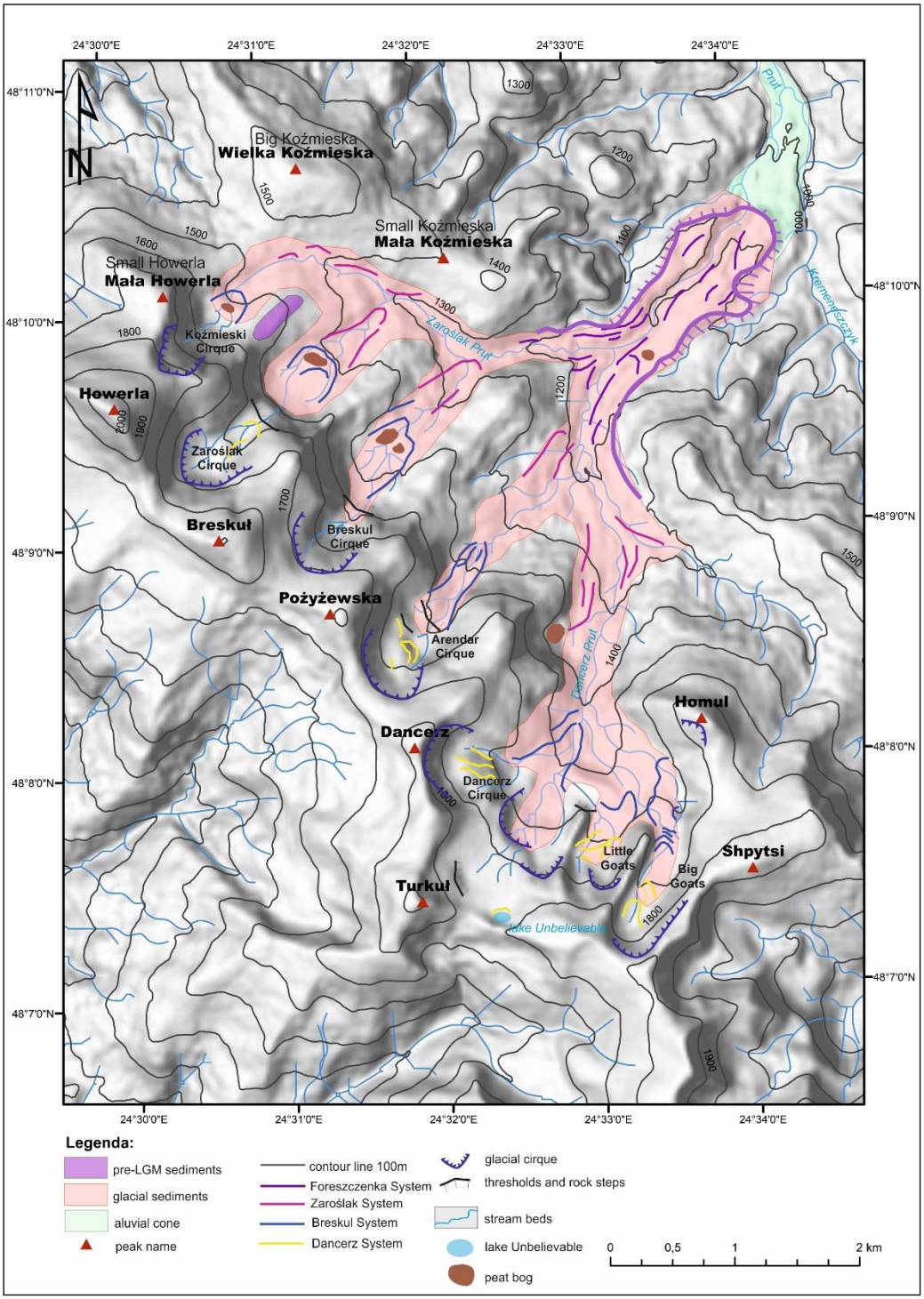

Figure 3. Map of Pleistocene glaciation in the Prut valley, with marked maximal extent and groups of recessional moraines.

Clear differences can be observed in R-values in all groups of sites (Figure 4.). The lowest R-values (39,98 ±0,74) was obtained for the pre-LGM sites which indicates that these moraine covers are the most weathered and the oldest. The next two systems – the Foroszczenka LGM moraines (R-value: 42,88±2,95) and Zaroślak 1st recessional stage moraines (R-value: 43,00±2,15) have average R-values close to each other, which indicates a similar time of formation. The R-values obtained for next recessional stages Breskul and Dancerz on the other hand, are slightly higher (R-value: 45,55±2,67 for Breskul and 45,12±1,42 for Dancerz) and are very close to each other, which also indicates a similar time of formation.

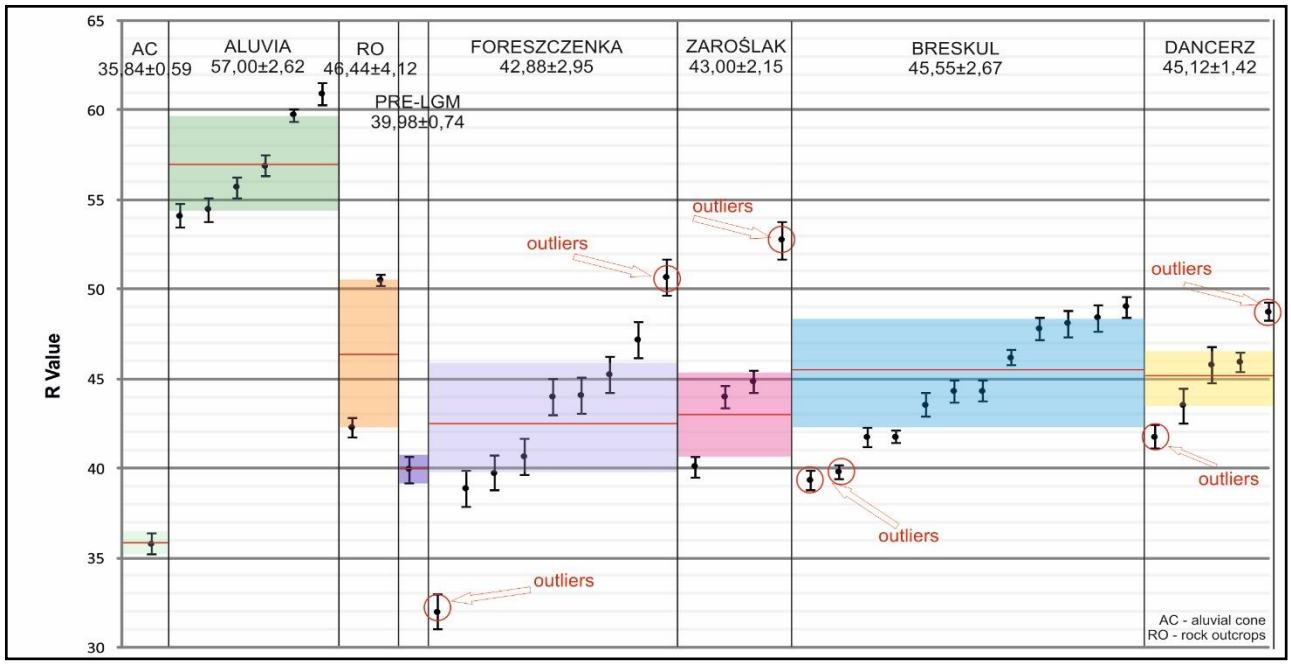

Figure 4. R-Value in all groups of sites in Prut Valley.

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Can ERT analysis near Großser Rachel, Bavaria, tell us more about glaciation extent of the area and the mountain range?

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Keywords: Bohemian Forest, Großser Rachel, ERT, glacial relief, glacial deposits, glaciation extent

The existence of glaciers and glacier related relief forms in the Bohemian Forest is indubitable. However, the opinion on the glaciation extent of this mountain range is not unified and approach to it varies throughout the researcher communities on both sides of the range. One premiss anticipates that a large-scale glaciation once affected the range, the other one that only isolated glaciers formed there.

Even though a glaciation more extensive than the one of LGM is known from other Variscan mountain ranges in central Europe, the evidence from the Bohemian Forest is insufficient. Due to a location of the setting in the heart of Bavarian Forest National Park, application of a method of non-destructive nature was essential. Using the method of electrical resistivity tomography (ERT) as the most widely chosen geophysical method in geomorphology nowadays, the results of geophysical analysis carried out in the vicinity of Rachel-Nordkar (Bavaria) are presented. Since the nature of this method is not destructive, the data are merely indirect. Nevertheless, we identified a location of possible glacier deposits of a more extensive and/or probably older glaciation than that of LGM.

Evaluation of underground pollution and soils by geophysical and geochemical methods near the Novaci town, Giurgiu county, Mihailesti area - Romania

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Keywords: human impact, waste, pollution, geoelectrical measurements

1. Introduction

From a geomorphological point of view, the perimeter is located within the Titu Plain, a subdivision of the Romanian Plain, located in the hydrographic basin of the Argeş River, in the terrace formations on the right shore, as follows:

The location is located near the town of Novaci, Giurgiu county (44031`68`08``N; 25098`4801``E) where, in the area of an active mineral aggregates exploitation, waste was deposited in some excavated spaces, which later were covered with the sterile material resulting from the uncovering of the exploitable area.

Geological and hydrogeological considerations

From a geological point of view, the study perimeter falls within the structural unit known as the moesic platform. In the study area, the formations are the meadow formations and belong to the Upper Holocene layer.

From a hydrogeological point of view, the underground waters in the study area are represented by the phreatic aquifer located in the alluvium of the terrace of Argeş river.

The phreatic aquifer layers located in the Argeş terrace generally have a hydrostatic level that varies in the depth range of 5-15 m, while the aquifer layer in the Argeş riverside has an important development, with depths of the phreatic level of up to 5 m.

Pedological considerations

The pedogeographic cover of the study area is classified according to the mode of use in the category of agricultural land with specific features determined, for the most part, by its functions in the agricultural area. As a result of specific activities carried out in the areas of interest, the soil cover undergoes mechanical transformations, but also physico-chemical transformations as an impact exerted on the soil by some practices carried out, such as temporarily or definitively storing different types of waste (industrial, glass, construction, plastic, etc.). The soil acts as a repository for pollutants emitted into the environment by these wastes.

2. Field measurement campaign - methodology applied

The geophysical research highlights through a quick, non-invasive, indirect method, the unauthorized changes that have occurred recently on location (Mihăileşti) in relation to environmental degradation.

For this purpose, geoelectrical measurements were carried out in the area by the resistivity method, the procedure of vertical electrical resistivity sounding in direct current, using the SuperSting R8 inverted resistivity automatic image generator system with 8 channels and passive multi-electrode cables with 5 meters electrodes equidistant. Primary data processing was done with the dedicated software EarthImager 2D, licensed. The investigations were carried out on profiles 75 and 155 meters long, which ensured an investigation depth of 20 and 35 meters, respectively.

Figure 1. Location of geoelectrical profiles.

The BUT1 profile starts near the lake (meter 155), crosses a recently leveled area and ends after a dirt road. Between meters 45-75, a sudden lowering of the conductive median horizon is observed, which betrays a former excavation much deeper, of almost 30 meters, later filled with resistive material.

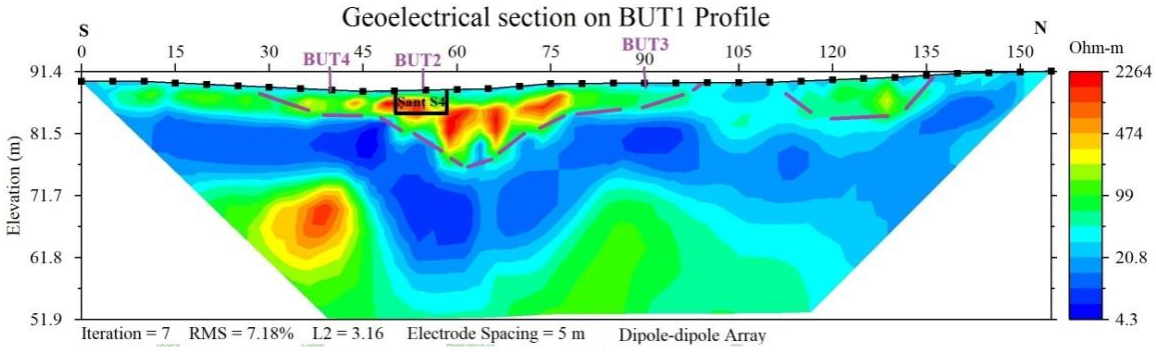

Figure 2. Geoelectrical section on BUT1 profile.

Profile BTU3 starts at the reed bank of a waterhole and covers the recently leveled central area, and profile BUT4. The resistivity section shows that the fill is up to 7 meters thick.

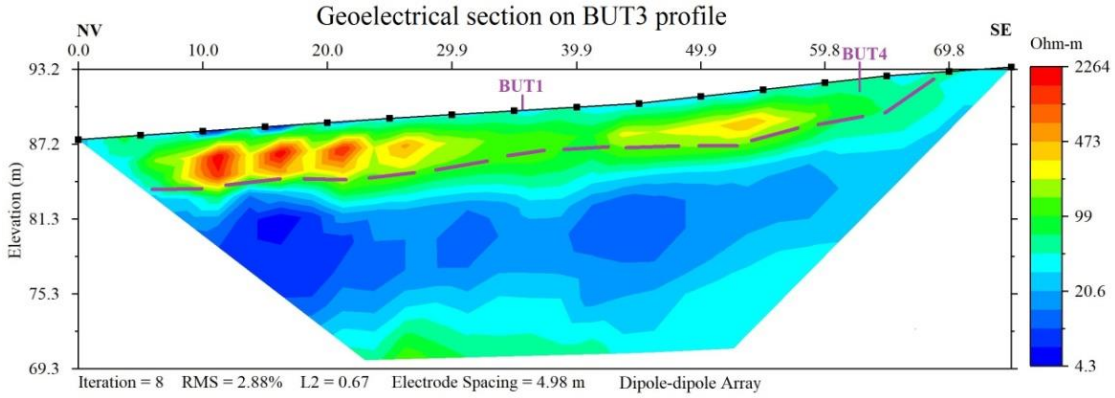

Figure 3. Geoelectrical section on BUT3 profile.

Figure 4. Ditch from 40 meter (left); S1 ditch (center); S2 ditch (right).

3. Soil cover investigation methods

In order to characterize the soil cover and evaluate the degree of pollution induced by the presence of waste stored in the location, field and laboratory research was carried out. The degree of pollution is evaluated in relation to a series of pollutants, selected according to the degree of dangerousness and leachability. A series of heavy metals (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg) were chosen, metals with high toxicity whose contents can be processed in relation to the reference values (alert threshold and intervention plan) and can generate pertinent conclusions regarding the degree of pollution with these metals.

Observations, measurements and sample collections were carried out in the field. The observations referred to the way of land use, to microrelief formations, to the nature of polluting sources and anthropogenic impact, as well as to the establishment of locations where soil profiles were opened and described. The measurements consisted of: establishing the geographical coordinates (latitude, longitude) of the points with the help of GPS and measuring the thickness of the genetic horizons.

Coordonate probe		
Proba	E	N
1.1	25.98473333	44.31798333
1.2	25.98468333	44.31763333
1.3	25.98448333	44.31733333
1.4	25.98506667	44.31726667
1.5	25.98505	44.31628333
1.6	25.98425	44.31566667
1.7	25.98411667	44.31528333
1.8	25.98393333	44.31503333
1.9	25.98481667	44.3149
1.10	25.98525	44.31463333
1.11	25.98525	44.31528333
1.12	25.98495	44.31541667
1.13	25.98308333	44.31558333
1.14	25.9833	44.31606667
1.15	25.98351667	44.31675
1.16	25.98376667	44.31691667
1.17	25.98393333	44.31675
1.18	25.98391667	44.31751667
1.19	25.98423333	44.31746667
1.20	25.98441667	44.31818333

Figure 5. Distribution of location testing points.

In the laboratory, sub-samples weighing approximately 200 g were obtained from each raw soil sample, the quantitative reduction of the useful sample was done by the manual quartering method. The resulting subsamples were sent to the ALS Life Sciences Romania Laboratory, a RENAR accredited laboratory, in order to quantitatively determine the tracked pollutants (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg), as well as the pH and humidity of the samples of soil researched.

The statistical analysis of the analytical data obtained for As, Cd, Cr, Cu, Ni, Pb, Zn and Hg, shows contents of these metals at the level of the upper soil horizon, comparable to those reported in the literature for sandy soils.

In more than 99% of the analyzed samples, the concentration of the investigated heavy metals is placed around the recommended normal values, which indicates the absence of pollution with these metals at the surface soil level in the two investigated locations.

Copper is the only heavy metal that produces significant soil pollution within the Site. Significant deviations from the recommended normal values occur in the waste dump area identified at this location. Here, the copper concentration determined at soil level is maximum (413 mg/Kg), with exceedances of the alert threshold of 100 mg/Kg, but also of the intervention threshold of 300 mg/Kg, the pollution being significant.

The lack of significant heavy metal pollution in the surface soil at the site can be correlated with the early degree of degradation of the improperly deposited waste at the soil surface. This conclusion only reflects the situation where anthropogenic sources of pollution are present at the surface of the soil.

4. Conclusions

In the studied area, the electrometric method highlighted, through the positive anomalies near the surface, the delimitation of the area contaminated with illegal waste.

After processing of the resistivity sections obtained at Mihailesti, the following emerged:

1. In the measurements carried out, an alternation of areas with high resistivities (up to 2000 ohm meters) is observed, followed by a conductive horizon that descends suddenly between 50 and 70 meters on the geoelectrical section, punctually representing an area later filled with resistive material (waste) on the first profile and a filling with a thickness of up to 7 m on the other profile.

2. From a geochemical point of view, the lack of significant pollution with metals and chemical-non-metallic parameters at the surface water level in the the location can be correlated with the incipient degree of degradation of waste, improperly stored on the land surface.

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First borehole drilling for permafrost detection and present climate change impact monitoring in Romania at Detunata Goală overcooled scree, Apuseni Mountains

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Keywords: cold scree, low altitude permafrost, borehole, drilling and coring, climate change, Detunata Goală

On the framework of the postdoctoral research project FrozenCORE (2020-2022) it was set the ambitious goal to drill the first borehole in a scree affected by prolonged freezing conditions during summer from Detunata Goală, Apuseni Mountains. This is challenging from a technical point of view because of the *i)* difficult access to location, *ii)* unstable nature of openwork basaltic talus, *iii)* the high probability to melt the ice during drilling in such hard rocks as andesitic basalts. Also, it was intended to recover the cores for subsequent analysis especially of the ground ice. The goal was to analyze the internal structure of the talus and to install thermal sensors in the borehole for permafrost detection and long-term monitoring of climate change impact. The latter is important because permafrost, if present, is an essential climate variable (ECV), as defined by World Meteorologic Organization, and its monitoring helps understanding the climate change.

The drilling was successfully performed in June 2021 down to 20 m and it showed that *i)* the talus is 12.4 m thick on top of cretaceous marls deposits and *ii)* the ice occur down to almost 9 m but only of low concentration. Isotopic analysis indicated that the ice is probably recent. The thermistors installed in the borehole indicated that the coldest conditions are at 7 m depth where temperature was <0°C between October 2021 and October 2022 almost continuously excepting two afternoons of August where temperature rose slightly above 0°C for a few hours. These findings indicate that ground ice might persist only in some colder years. Or it might have persisted multiannually in the recent past when climate conditions were colder. All in all, the ground freezing conditions are at least in the present at the thermal limit of permafrost existence. The boundary between seasonal and perennial freezing of

the ground might have been in favor of permafrost in the past while recently might have inclined for seasonal freezing. The future thermal monitoring of the Detunata borehole will show how climate change affect the cryosphere in this part of the world along with the other boreholes included in the Global Terrestrial Network for Permafrost (GTN-P).

Figure 1. Drilling and coring at Detunata Goală (June 2021) and seasonal ice lens between rock joints at 4.6 m depth

Drought from air to underground – a multiscale analysis for Different Type of Drought in Eastern Romania

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Droughts through the multitude of types of appearance and spatial and temporal manifestation imprint a series of changes in all natural components. Therefore, the analysis of this phenomenon must be performed at multiscale level by evaluating the manifestations both in the atmospheric environment (meteorological drought) and in the hydric or geological one (hydrological and hydrogeological drought). In this sense a series of standardized evaluation indices like SPI, SPEI, SDI SGI can be used to evaluate meteorological drought, hydrological and hydrogeological drought respectively. These indices have been applied to evaluate drought phenomena in Eastern Romania, for 1, 3, 6 and 12 months' time-scales in the last decades (1983-2020). The results of the analysis highlight the occurrence of quite frequent meteorological droughts in the last two decades with excessive manifestations in the years 2000, 2007, 2012, 2017, 2020 and 2022. These were accompanied by sequences of hydrological and hydrogeological drought that practically complete a rather gloomy scenario regarding the decline of water resources in this region. In the wider context of regional climate scenarios, which predict an increase in air temperature and, at the same time, a decrease in atmospheric hydrological input, it is clear that increasing the frequency and duration of different types of drought will have major implications for all natural components and anthropogenic activity in the region.

Spatial variations in sedimentation and inferred climate changes as revealed by new XRF records from Lake Saki

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Keywords: lacustrine sediments, XRF analysis, saline lake, palaeoclimate, Holocene

1. Introduction

Lake Saki is a hypersaline lake is the southwestern part of the Crimean peninsula. It is separated from the Black Sea by a sandbar, which is around 500 m in width. The lake is 5.5 km in length and 1.6 m in width. The average depth is 0.5 m and the maximum depth is 1.2 m. The area of the lake is 8.1 km^2. The waterbody is located in the mouths of two connecting ravines and its bedrock is composed of reddish clays and loams of the middle and upper Pliocene age. At present, the lake is divided into seven basins, which have their own functions in recreation and salt mining. The salinity of the lake mud ranges from 150 to 180‰. Geomorphological setting around the lake is characterised by hilly plains 50–100 m a.s.l. The study site is characterised by temperate climate with uneven distribution of precipitation: the precipitation rates decrease from the shoreline inland. Mean annual temperature is +10…+11°C, mean July temperature is +23…+24°C, and mean January temperature is −1…+1°C. The annual precipitation rate is around 400 mm. The regional vegetation cover is represented by grass steppes and the lake itself is surrounded by thin communities of xerophytic and halophytic plants.

Laminated lake sediments from the Lake Saki basin provide high-resolution records of climatic variability in the Black Sea region, which is especially sensitive to changing climatic conditions. The first XRF analysis of the lake sediments was performed by Veselova (2012) and later by Morozova et al. (2015), which gave basis to establish three periods of distinct depositional processes: (i) shallow basin with a high level of hydrodynamical regime, (ii) deepening of the lake and stable hydrological conditions, and (iii) shallowing of the basin and an increase in hydrodynamical regime. Here we present a correlation of XRF datasets from two cores from the lake and discuss changes in depositional environment and inferred climate variations, as well as human impact on the lake system.

2. Materials and methods

In 2011, two sediment cores were retrieved from the central and eastern parts of the lake by V. Vasenko and I. Pustovoitov. The core from the central part (S-46-12) is 150 cm long; the coring below 150 cm was hindered by a thick salt layer below the lake sediments (see Popov et al., 2015). The core from the eastern part (S-45-12) is 400 cm long. Here we focus on the top part (1.5 m) of S-45-12 core, as well as core S-46-12, to correlate and compare sedimentary changes within the lake basin. XRF scanning was performed in the Department of Geology, Lund University, using Thermo Scientific portable XRF analyser Niton XL3t GOLDD + X-ray fluorescence instrument detecting elements set in the Cu/Zn mining calibration mode. Total elemental contents were determined on 60 dried and homogenized sediment samples, collected at every 5 cm. All analyses were performed by using an 8 mm radius spot size in order to get a representative analysis. The elemental detection depends partly on the duration of the analysis at each point and for this reason the measurement time was set to 4 min. To facilitate interpretation and highlight main changes in elemental composition the elemental profiles were smoothed using a 3-point moving average. The datasets were subdivided into geochemical zones using cluster analysis (UPGMA) and visual interpretation.

3. Results and Interpretation

The sediments of the two cores consist mainly of Ca, S, and Si, with lesser concentrations of Cl, Al, Fe, K, Ti, Sr, Mn, Zr, and Rb (Fig. 1, 2). Most lithogenic elements (Ti, Si, Zr, and Rb) are more abundant in core S-46-12, whereas elements associated with evaporites (Ca, Sr, S) are more dominant in core S-45-12. Aluminium, Fe, and K are characterised by similar concentrations in both cores. Overall, both datasets display similar trends in the changes of elemental concentrations, however the elemental curves in the S-46-12 dataset are characterised by fewer fluctuations than the ones in the S-45-12 dataset, suggesting that depositional environment was more stable in the central part of the lake than in its eastern part, which more frequently experienced lake level lowering as indicated by higher contents of elements associated with evaporites.

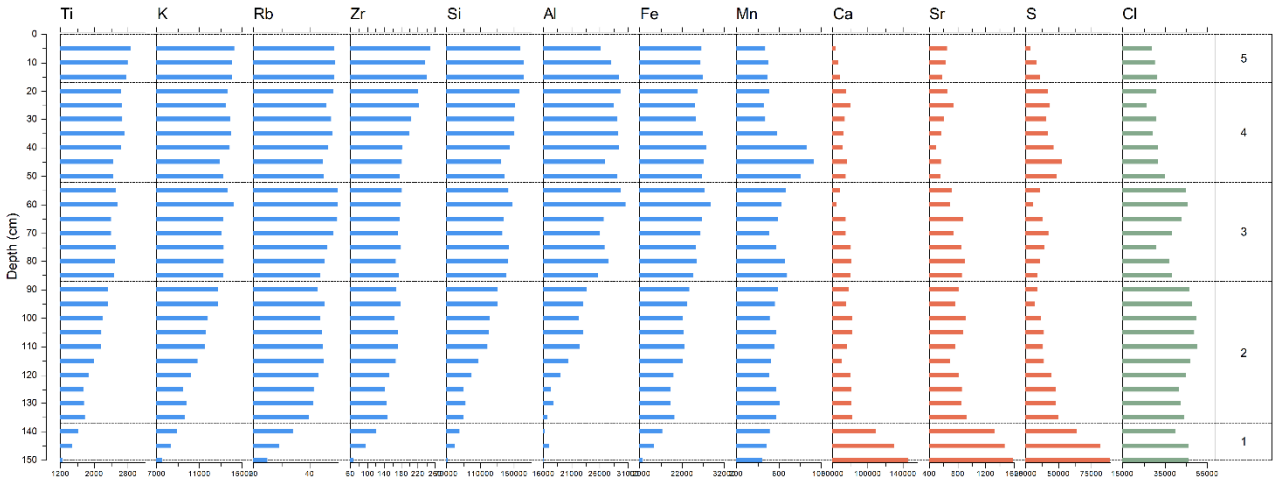

Figure 1. Depth profiles of the selected elements from core S-46-12 (central basin).

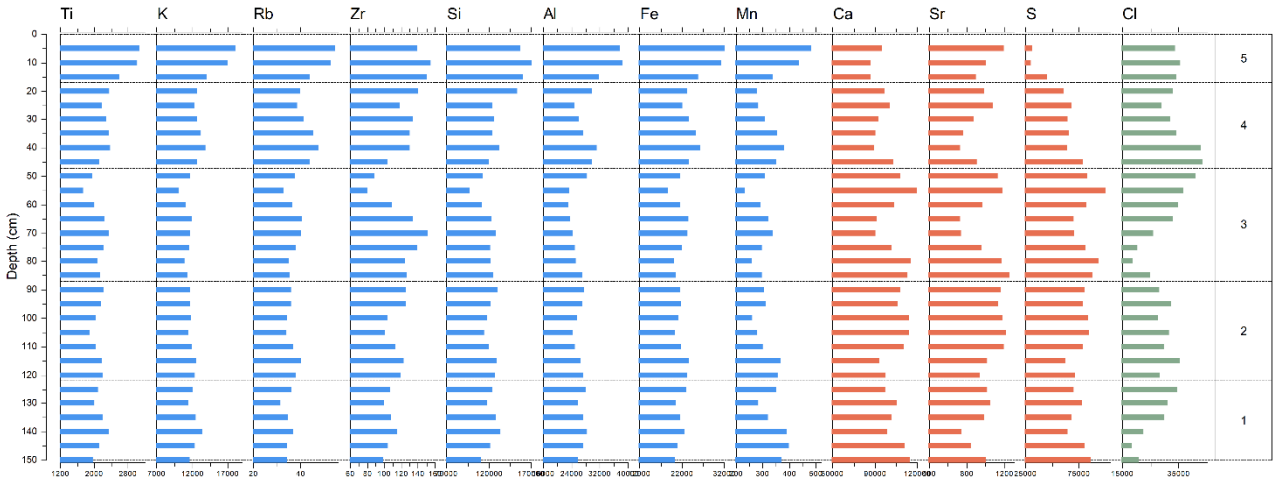

Figure 2. Depth profiles of the selected elements from core S-45-12 (eastern basin).

Principal Component Analysis (PCA) was performed on the geochemical variables of the core samples to reveal the main sedimentary processes induced by environmental and climate changes. In the S-46-12 dataset, PC1 explains 67.5% of the total variance while PC2 – 12.8% (Fig. 3). PC1 is characterised by the positive loadings of Si, Ti, Zr, Rb, K, Fe, Al, and Mn, and the negative loadings of Ca, Sr, S, and Cl. In the S-45-12 dataset, PC1 explains 67.1% of the total variance and PC2 – 12.5%. Similarly, PC1 is tied by the positive loadings of Si, Ti, Zr, Rb, K, Fe, Al, Mn, but also Cl, and by the negative loadings of Ca, Sr, and S. Therefore, PC1 might be interpreted as related to the terrigenous influx into the lake (siliciclastic

particles) versus the mineral autochthonous precipitation such as carbonates and sulphates. PC2 of the S-46-12 dataset is tied by the positive loadings of all elements, except for Cl and Rb, whereas the negative loadings of PC2 of the S-45-12 dataset are attributed to Zr and Si. Chlorine may be incorporated in the sediment pore water (Neugebauer et al., 2015) and Rb is abundant in fine-grained, siliciclastic material (Dypvik and Harris, 2001), which together might indicate changes in sediment porosity. On the other hand, Zr and Si are common components of coarser deposits, which might indicate input of coarser sediments into the lake. Therefore, we assume that the sedimentation in the lake was primarily controlled by influx of terrigenous material alternated by precipitation of evaporites. Secondary processes, revealed by PC2, are believed to indicate changes in sediment grain-size.

The chronology of the studied cores is based on pollen correlation of core S-45-12 with the dated core S-13-05 (Gerasimenko, Subetto, 2011; Rohozin, Gerasimenko, in preparation) and further projected on core S-46-12, based on similarities of geochemical composition. The tentative correlation of the cores showed that the basal sediments of both cores were most probably deposited around 2000 yr BP. On the basis of geochemical zones (GZ 1–5) subdivided by cluster analysis and the results of PCA, the following reconstructions can be made.

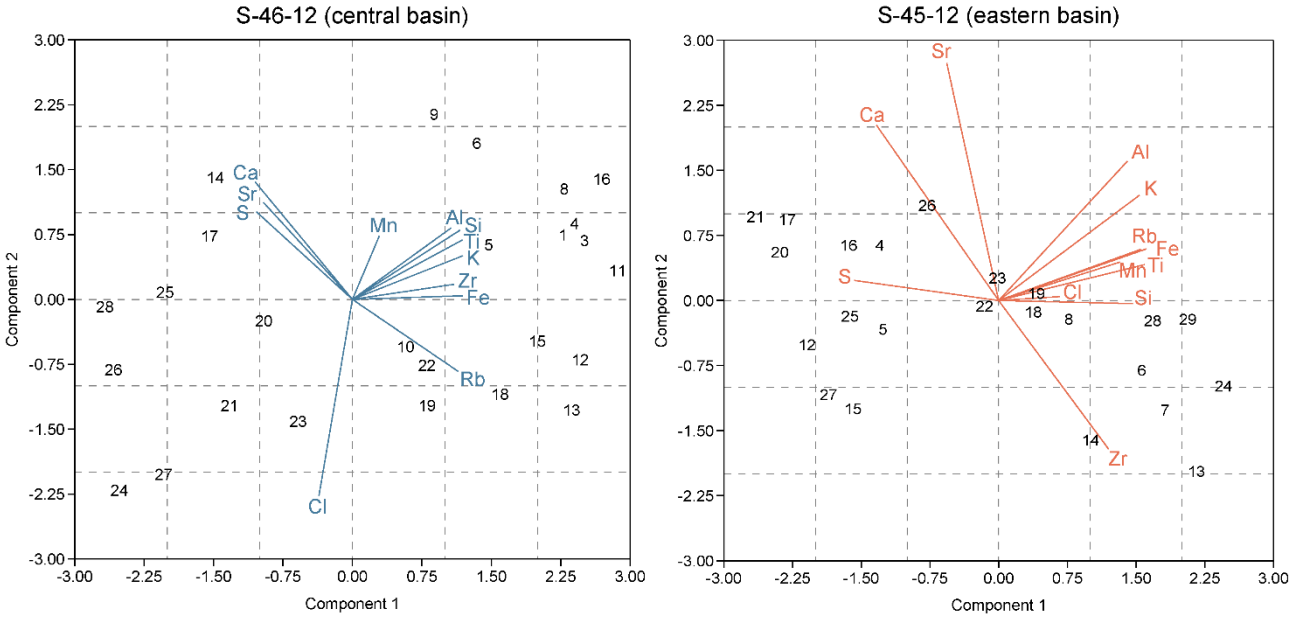

Figure 3. 2D-plots of distribution of PCA loadings of geochemical elements and core samples.

The phase between ca. 2000 and 1600 yr BP was characterised by active precipitation of evaporites in the lake. These processes are evidenced by the highest content of Ca, Sr, and S in the core from the central part of the lake. Relatively high concentrations of Ca, Sr, and S are also observed in the eastern core, where the active evaporite precipitation is supported by the occurrence of thick salt layers around 2000 yr BP as observed by I. Pustovoitov (personal communication). Thus, it can be concluded that the level of the whole lake was low, which led to precipitation of salts from the brine. The concentrations of lithogenic elements are the lowest in core S-46-12 and are slightly higher in core S-45-12, which might be explained by primary accumulation of evaporites in the deep part of the lake, while the more marginal eastern basin witnessed enhanced clastic deposition. The later part of the Early Subatlantic (2200–1600 yr BP) was characterised by warm and arid conditions in the Crimea with expansion of xeric steppe vegetation around the lake (Gerasimenko, 2007; Gerasimenko, Subetto, 2011), which is clearly reflected in our XRF record.

The phase after ca. 1600 yr BP was characterised by more humid conditions, which led to the higher rates of erosion in the catchment (indicated by higher content of lithogenic elements). The obtained

XRF records display different patterns in elemental profiles for this interval. The elemental curves of core S-45-12 show slight fluctuations during this period, but otherwise remain unchanged, while the elemental profiles of core S-46-12 (in particular, Ti, K, Al, and Si) show a continuous increase throughout this phase. The increase in Ca and S in core S-45-12 suggests that precipitation of evaporites continued in the eastern part of the lake, while terrigenous influx largely prevailed in the central part. Interestingly, both datasets display a short dry event in the middle of this phase, which could be correlated with a dry spell in the SW Crimea between 1400 and 1200 yr BP (Gerasimenko, 2007).

The next phase (ca. 1100–500 yr BP) is notable for the increase in marine productivity as evidenced by the highest concentrations of Ba in both datasets. Sedimentation regimes were probably most contrasting during this phase. While the clastic deposition continued the in-filling of the central part of the lake, the eastern basin experienced lowering of the water level and precipitation of evaporites (mainly gypsum), interrupted by a short phase of increased erosion. The marked lowering of the eastern basin at the end of this phase could be a result of a significant aridification after 650 yr BP, revealed by pollen data from Lake Saki (Gerasimenko, 2007).

After 500 yr BP, the accumulation processes in the central basin were stabilised, indicating calmer depositional environment. On the other hand, relatively stable sedimentation conditions, which prevailed before in the eastern basin, were replaced by increasing runoff in the catchment and deposition of thicker annual laminae. The rates of evaporite precipitation in the lake became slower as indicated by decreasing contents of Ca and S. The highest representation of Cl probably suggests the increased sediment porosity, as no salt layers were observed in this interval.

Starting from the mid-XIX century, the detrital deposition became more significant, as indicated by the highest contents of most lithogenic elements in core S-45-12. In core S-46-12 these changes are reflected in the elevated values of Ti, K, Zr, and Si. The rates of evaporite precipitation further decreased, which might indicate an increase in the lake level. This interval also marks the start of human exploitation of the lake, when in 1885 a channel, connecting the Black Sea and the lake, was built to saturate the lake with seawaters (Kurnakov et al., 1936). The relative increase in As, V, Nb, Pb, and Cr values in both datasets also confirms industrial development in the region. In the early XX century, the lake was subdivided with dams and cofferdams for salt extraction.

The obtained XRF records reveal some new insights into the lake sedimentation history during the late Holocene. The PCA analysis suggests that deposition in the lake was controlled by allochthonous input of siliciclastic material alternated by autochthonous precipitation in the lake. The comparison of two XRF datasets shows that while the central part of the lake experienced virtually continuous influx of terrigenous material over the last 2000 years, the eastern basin was more susceptible to climate changes, which led to fluctuations of the lake level and deposition of evaporites.

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IR Spectroscopy of clay fraction of Pleistocene loess-paleosol successions

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Keywords: spectroscopy, loess, paleosol, Pleistocene, quaternary research

1. Introduction

The goal of loess research is to identify and document the main Pleistocene climate changes and try to reconstruct the paleoenvironments of interglacial periods in the Ice Age. There are some well-established methods (as traditional loess proxies: e.g. magnetic susceptibility, grain-size distribution carbonate content). These proxies help identify the main units (mainly loess layers and paleosols) in the investigated successions, which refer to the changes of cooler/dryer and warmer/wetter periods of Pleistocene. Geochemical and mineralogical changes can be monitored by XRF and XRD measurements, which help reconstruct the climate conditions of glacials and interglacials.

Spectroscopy is an accepted method for the investigation of loess-paleosol sequences (e.g., Vlaminck et al. 2016). However, the changes of clay minerals has not yet been investigated by this technique, even though it is important for climate reconstruction. In general, the clay minerals of loess-paleosol successions is investigated by geochemical methods (especially XRD), but the standard procedures are complex, time-consuming and expensive (Hillier et al. 2003). The IR spectroscopy are alternative ways to reveal the most important parameters of soils and sediments to complement the mineralogical results. Its advantage is that it is simple, rapid and cheap (Viscarra Rossel et al. 2006), and characterized by ultra-low detection limits of mineral composition (e.g. Balsam et al. 2014).

Several selected loess and paleosol units (sampling in Carpathian Basin) were investigated by IR spectroscopic measurements. The aim of our study is to understand the accuracy and reliability of spectroscopy within the loess research.

2. Methods

Preparation: The bulk samples were air-dried and dry sieved through a 250 μm sieve. Clay fraction (< 4 μm) was separated from all paleosol and all transition samples, and every second-third loess sample (in total 35) by pipette method (Gee and Bauder 1986).

Spectroscopy: The IR spectra is primarily formed by the mineral composition (Clark 1999). The DRIFT (Diffuse Reflectance Infrared Fourier Transform) spectroscopy measures the reflected electromagnetic radiation in the infrared band. This provides information on the mineral composition of the samples, which is a widely used technique in Earth Sciences (e.g.; Filep et al. 2016). DRIFT measurements were carried out in order to identify the spectral characteristics of the clay fraction in the SWIR and MID infrared range (700-4000 cm^{-1}).

Mineralogy: XRD measurements help to recognize the mineral composition of samples. Crystal phases of a solid mixture could be identified by using X-ray diffraction. In an X-ray diffractogram, one phase has more reflections according to the relevant crystal structure. Quantitative composition can be estimated from the significant reflection of phases with some factors. The quantitative mineral composition was determined for the full profile by the Rietveld refinement method.

Comparison: Partial Least Squares Regression (PLSR) is a way to reveal the relationship between spectroscopic results and the factual mineral composition (XRD). This method is available to predict the relative ratio of mineral components based on spectral characteristics (e.g. Hecker et al. 2012). Six models were built for the investigation of the clay minerals (chlorite, illite, smectite, kaolinite), calcite and quartz. Correlation and error analysis are important indices to evaluate quantitative methods. The performance of models was controlled by the following factors: correlation coefficient (R^2) and root mean squared error of cross-validation (RMSECV). In case of a cross validation the RMSECV value can be taken as a criterion to judge the quality of the method. Higher R^2 and lower RMSECV indicated that the model had a good performance (e.g. Deng et al. 2018). Partial Least Squares Regressions were carried out using Quant2 methods module of OPUS 8.1 software. The calibration models were developed based on 105 spectra.

3. Results and discussion

The IR spectra were evaluated by the PLS regression technique, hereby relative ratio of minerals was predicted by using spectral characteristics. Generally, samples contained high amounts of calcite (1-52%; average: 23%), smectite (15-37%; average: 23%) and illite (9-25%; average: 18%). In contrast, chlorite (7-16%; average: 12%), quartz (3-15%; average: 10%), and kaolinite (5-15%; average: 8%) were characterised by lower values. The RMSECV values were lower than 1.5 in the case of calcite, quartz and kaolinite models, whereas the models of smectite, illite and chlorite could be characterised by higher RMSECV values (4.7, 2.6 and 1.6, respectively). This indicates the possibility of minor-medium errors.

XRD measurements showed that clay minerals (42-83%) and carbonate (0-53%) were the dominant components, whereas quartz (3-16%) and feldspar (0-4%) were of secondary importance in the clay fractions of the investigated samples. Dominant clay minerals were smectite (13-37%) and illite (9-30%), while less amount of chlorite (8-18%) and kaolinite (6-13%) were detected. As expected, loess samples could be characterised by higher chlorite (10-18%), and higher quartz (11-16%) concentrations then the paleosols.

The PLSR prediction provided useful and detailed information. Strong relationships were detected between the PLSR prediction values and the XRD values of calcite (0.98) and quartz (0.89), while clay minerals could be characterised only by moderate or weak relationships (0.41-0.67) (Fig. 1/a). The judgement of the quality of models was explained by RMSECV values, which is a good tool for predicting estimation errors (underestimation and/or overestimation). Well- characterised trend was observed: generally, the lower the RMSECV value was, the smaller the differences were between PLSR and XRD data (Fig. 1/b).

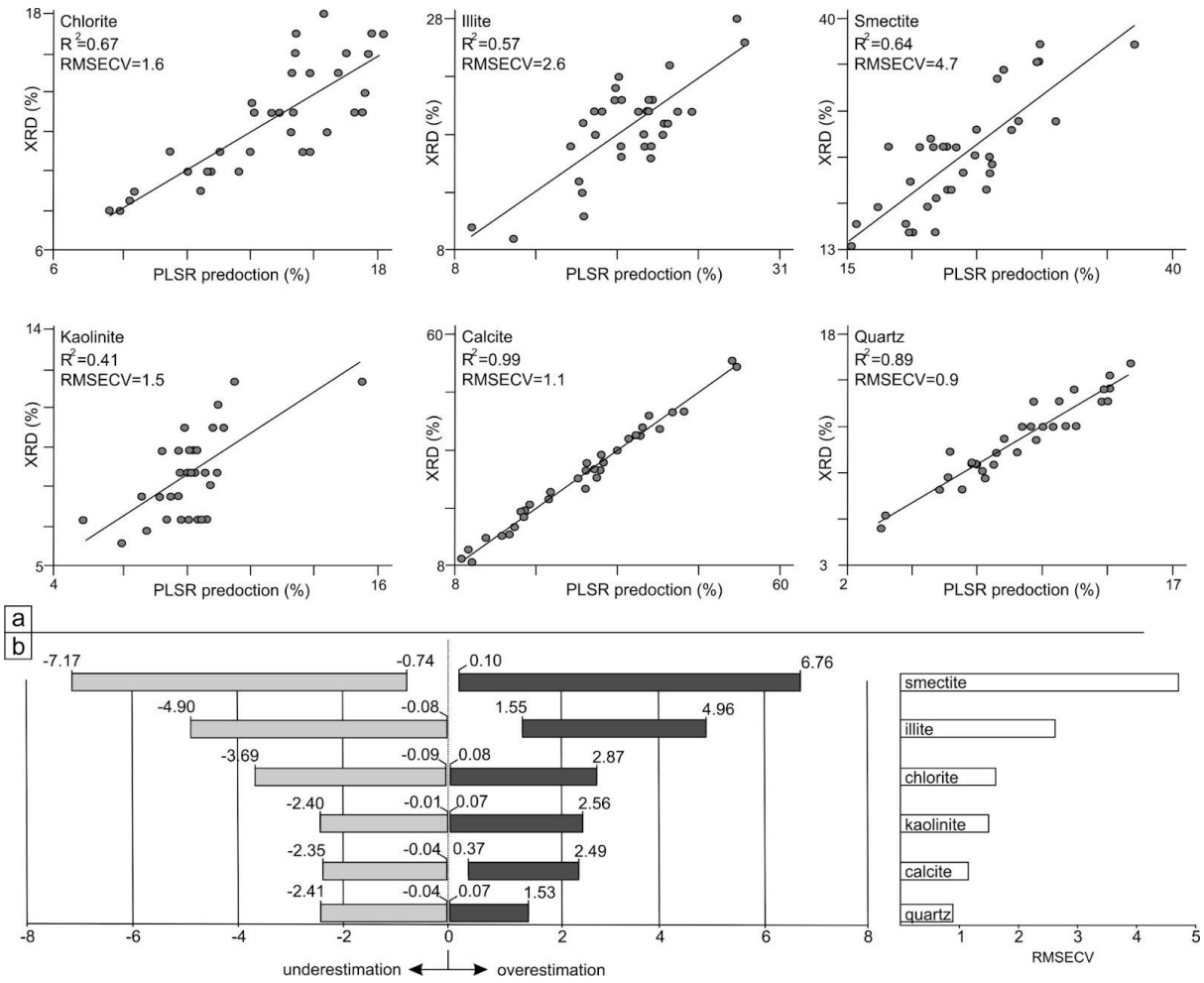

Figure 1. Results of comparison of XRD and PLSR prediction values: Relationships Correlation coefficient (a) and estimation errors (b). Left: under and overestimations (%); right: RMSECV values.

4. Conclusion

Clay fractions of loess-paleosol profiles were investigated by IR spectroscopy and XRD. In general, the spectroscopic measurements were compatible with the XRD values. The uncertainty in the quantitative estimation of clay minerals may be related to the high carbonate content of the samples. The degree of this phenomenon is definitely related to the crusts on the minerals. Its importance in loess-paleosol sequences is significant because the vertical distribution of carbonates is a determining factor of the system. As a solution we propose the carbonate extraction before the clay fraction separation for spectral measurements, primarily in the case of loess-paleosol samples.

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Environmental change in the Bolătău-Feredeu catchment over the last ~600 years

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Keywords: Lake sediment; Palaeoenvironment; Bukovina

1. Introduction

Palaeoclimate and palaeoenvironmental research have become some of the most well-developed disciplines of earth science in recent decades. Lake sediments stand out as complex archives used for modern palaeoclimate research and can provide valuable data for a variety of disciplines. Ideally, the sediments reaching lake basins are deposited in layers to form stratified lacustrine sediment accumulations. However, finely stratified lake sediments are relatively rare, due to frequent sediment mixing within these depositions.

Depending on the rate of sedimentation, a layer may carry information about a particular period. This information can be used to understand the past climate and to reconstruct environmental conditions in the catchment with a high degree of accuracy. The use of large-scale analytical methods provides an excellent opportunity to extract and interpret the information determined based on sediment analysis. Moreover, organic geochemical analyses, with a particular emphasis on n-alkanes, can provide data on the vegetation in the area. The results can be refined by stable isotope measurements (i.e., $\delta^{13}C$ and $\delta^{15}N$). Elemental analysis data can be used to gain insight into changes in catchment conditions and precipitation events. This study focuses on the interpretation of complex geochemical data determined from the analysis of lacustrine sediments extracted at Bolătău-Feredeu Lake (Romania), aiming at understanding of the events of the last ~600 years.

2. Study Site

The Bolătău-Feredeu Lake (47° 37′ 20.74″ N, 25° 25′ 54.43″ E) is located in Bukovina, Romania. The name refers to a small-sized lake, which is a common name in the region (Grădinaru et al., 2012). The site is located in the Feredeului Mountains, just below the Obcina Feredeului peak (1364 m asl) and adjacent to Lake Iezer.

The lake had a maximum depth of 5.2 m and an area of 0.3 ha during a survey carried out in 2010. In terms of water quality data, the total phosphorus concentration in the lake was 0.014 mg/L (Mîndrescu et al., 2010), while dissolved oxygen at the top of the lake varied between 8 and 9 mg/L (Karlik et al., 2018; 2021).

The diameter of the lake catchment is only 700 m, but the amplitude of the elevation within the catchment is significant, of about 227 m, within an area of about 30 ha (Mîndrescu et al., 2013). Of this total area, 6 ha of the catchment consist of herbaceous vegetation, comprising several medicinal plant species. The main species pertaining to the coniferous forest (24 ha) include spruce (Picea abies) and silver fir (Abies alba), goat willow (Salix caprea), alder (Alnus incana), quaking aspen (Populus tremula), birch (Betula pendula), which is found on the lake shore, whereas the aquatic herbaceous plants include sedge (Bolbosschoenus sp.)(Mîndrescu et al., 2010). The drill cores were extracted in 2010 (Figure 1).

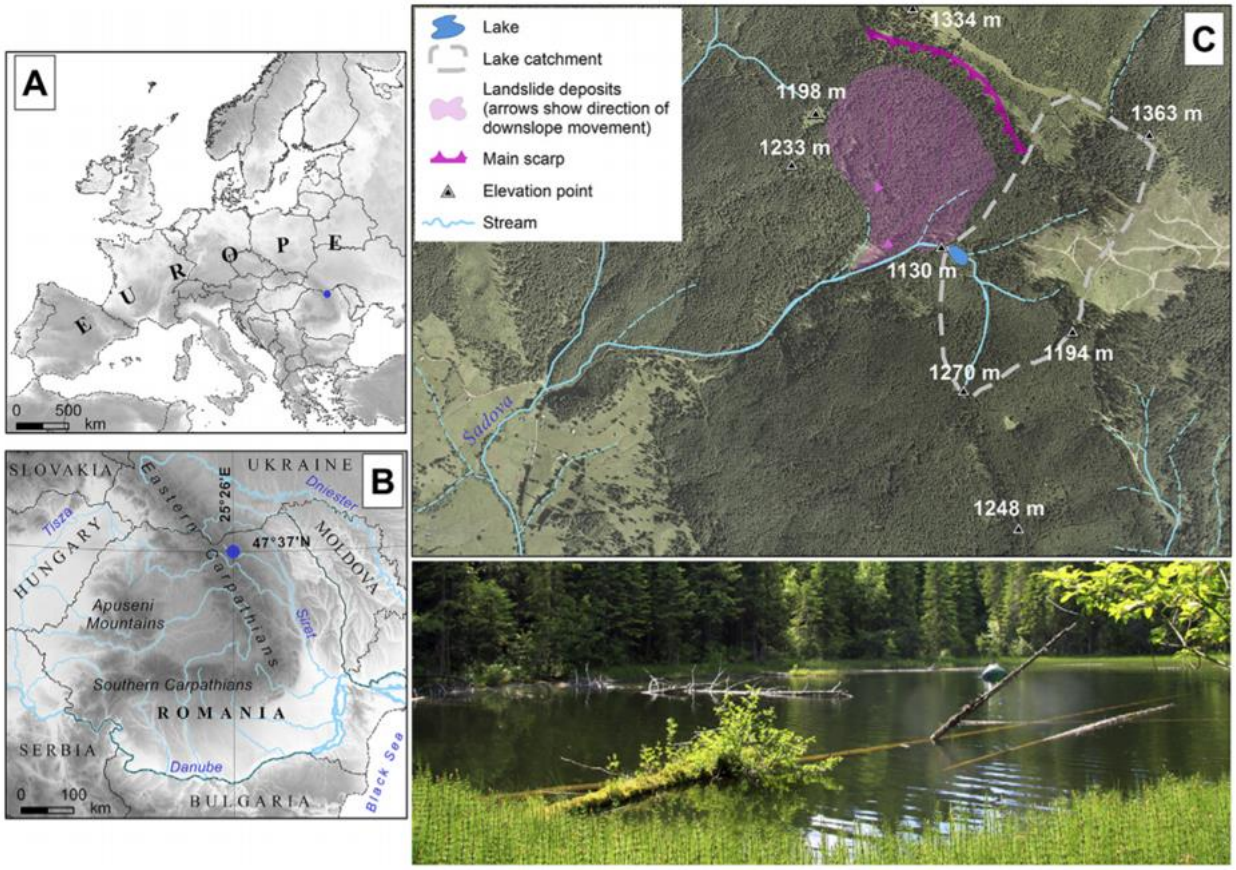

Figure 1. Location of research area a) at continental scale; b) in the Eastern Carpathian region; c) a closer view of the Lake Bolătău-Feredeu. The grey dashed line shows the catchment boundary. A site photo is displayed below the map.

3. Chronology

An initial sediment chronology was established for the Bolătău-Feredeu sequence based on 8 AMS radiocarbon dates from terrestrial macrofossils and validated for the recent section by the double peaks

of the ^{137}Cs flux (i.e. mid-1960s: global fallout maximum; 1986: Chernobyl event) (Mîndrescu et al., 2016). The sediment chronology of the top 24 cm has been significantly improved using the ^{210}Pb chronology (Bihari et al., 2018). The ^{210}Pb ages for the top 20 cm (with an uncertainty of the estimated ages below 30%) and all ^{14}C dates were included in the Bayesian age-depth model using the P_Sequence function of the OxCal v.4.2 (Bronk Ramsey, 2009) software. The total age of the sediment was estimated at ~ 4000 yrs (Karlik et al., 2021.)

4. Methods

A number of analytical techniques were used for this research. The sampling unit was matched to the sample size required for each analytical method. The largest sample size was required for gas-chromatography. During the analysis, the organic matter content of the samples was extracted. In this stage, 20 g of the sample were placed in an extraction apparatus (ASE250) where the organic matter was extracted at 75 °C under 100 bar pressure with a 5:2 chloroform-methanol solution. Chromatograms were recorded on a Fisons 8000 GC gas chromatograph. Indices were calculated from the peak intensities of the n-alkanes. Further analyses were performed by measuring average samples in cm. The elemental composition was determined using a Rigaku Supermini wavelength dispersive X-ray spectrometer. The values obtained were interpreted both independently and as weathering indices. The stable isotope and C/N ratio were measured after preparation and packaging using a Thermo Delta V IR-MS mass spectrometer, providing an indication of productivity. Particle size determination was performed on the samples using a laser diffraction particle size analyzer, which greatly aids in the discovery of the shouldering of the loading conditions.

5. Discussion

Based on the n-alkane indices (e.g. P_{wax} Herbaceous/woody n-alkanes ratio), the vegetation changes over the last 600 years in the catchment area were determined. Given that a larger initial sample (~20g) is required to obtain the organic matter sample for gas chromatography, the temporal resolution of the data obtained does not allow for an accurate and detailed description. However, it is important to note that the vegetation is an essential source of information for a complete environmental reconstruction. The usage of less demanding methods, such as stable isotope measurements, helps to refine the results of events. By examining the elemental analysis data and the weather indices calculated based on them, the variations in the catchment conditions can be described. Analysis of these data series has been used to distinguish the following periods:

i. A.D. ~1500 - A.D. 1620 - Herbaceous vegetation in the catchment: The measured values indicate that herbaceous plants have appeared in the former closed forest vegetation. The spread of these plants required the opening up of ecological niches (e.g. tree fall).
ii. A.D. 1620 - A.D. 1700 - Cold period in the catchment area: The effects of the cold period, as described in numerous sources, were also felt in the catchment area of the Bolătău-Feredeu Lake. In the catchment area, the drop in temperature led to a decrease in vegetation productivity. The reduction in herbaceous vegetation was accompanied by a reduction in the filtering effect of vegetation, which resulted in the ingress of larger particles of sediment into the water body.
iii. A.D. 1700 - A.D. 1780 - Nearly stable period: The catchment area is characterised only by short-lived events, which do not cause significant variation.
iv. A.D. 1780 - A.D. 1860 - Cold period and deforestation in the catchment area: During this cold period, human impact manifested in the catchment area. Deforestation took place mainly between 1811 AD and 1820 AD. New vegetation started to grow in the area.

v. A.D. 1860 - A.D. 2010 - Modern landscape change in the catchment. The resulting vegetation cover is still visible in the catchment area today.

A combined analysis of the parameters shows that, apart from anthropogenic influences, the catchment area is dominated by the influence of ambient temperature. The variation in temperature affects the composition and productivity of herbaceous and woody vegetation, which greatly influences the quality of the material entering the lake. Among the biogenic elements, the concentration of phosphorus follows the temperature gradient well, which can be explained by the gradient of herbaceous vegetation.

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Palaeoenvironmental conditions and associated human habitation dynamics over the Holocene in the north-eastern Romanian lowlands derived from palaeoenvironmental and archaelogical archives

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Keywords: palaeoenvironmental archive, archaeological sites, human habitation dynamics, Holocene, Romanian lowlands

The human activities have had an impact on global land cover and climate for millennia and the climatic and environmental conditions have always been main factors for human settlement dynamics. This study builds on a record of environmental history derived from the investigation of sediments recovered from the Dersca-Lozna fen, that could explain the context for human habitation dynamics over the Holocene in the north-eastern Romanian lowlands. To assess palaeoenvironmental changes in the area, we derived downcore lithostratigraphic information, bulk density and humidity values over a continuous time window that spans the last ca. 12000 years. To reconstruct the dynamics of human

habitation, we surveyed published archaeological studies and traces of human settlement in the area. The archaeological sites were subjected to a morphometric analysis based on relevant factors (slope, proximity to major waterways and relief) underlining the evolution of preferred environmental conditions for settling. The main results of spatial distribution analysis converge to conclude the following: hotspots of human habitation throughout millennia have been identified in the study area; as the population number grew, the number of sites and the altitude range of the populated landscape increased (particularly in the bronze Age); the sites expansion followed the accessibility of the valleys and proximity to water resources. The morphometric analysis outputs overlap the preliminary paleoenvironmental picture inferred from the peat stratigraphy, revealing long-term human impact on the landscape. Thus, two main conclusions emerge: i) first clear signs of increased erosion in the peat record coincide with settlement expansion in the Bronze Age (ca. 3300 years ago); ii) a second intensification in erosion corresponds to the Medieval Warm Period (ca. 900-1200 years ago), and is reflected in a series of distinct layers; their driving factors still remain to be disentangled. We suggest that there is more to be derived from the combined archaeological and palaeoenvironmental perspective, as our preliminary data leaves many open questions.

Periglacial tors in Curvature Carpathians - identification, spatial distribution, climatic implications and touristic potential

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Keywords: periglacial tors, Curvature Carpathians, spatial distribution, morphometrical analysis

Periglacial tors have been defined as solid rock outcrops, originated in selective deep weathering and subsequent removal of regolith. They are one of the most characteristic landforms found at the surface of the Curvature Carpathians, especially in Ciucas Massif. Although they are representative for the geomorphological context of the area, few recent studies have been conducted regarding their spatial distribution, climatic implications and touristic potential. Ciucas Massif, located in the Curvature Carpathians, is an important area for geomorphological and climatic characteristics, making it representative for the whole region. This study focuses on analyzing periglacial tors using old maps and GIS tools for an updated inventary of the landforms, GPS tools for on site identification and telemeter for measurements. Already identified periglacial tors have been manually extracted from old maps and several new sites were added, scattered throughout the Curvature Carpathians. During the fieldtrips conducted in specific parts of the study area, GPS and morphometrical data was gathered. The data has been processed using ArcGIS software, resulting in spatial distribution and density maps. Using regional climatic studies, the connection between periglacial tors and climate was investigated. Furthermore, the analysed landforms can have touristic potential for niche tourism.

"Meteo.BN" project: a scientific approach to local climate change using PWS network in Bistrița-Năsăud County

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"Meteo.BN" is a meteorological project based in Bistrita-Năsăud County that aims to deliver to local people, all the information needed to better understand the exact image of the local weather. The project uses a network of 23 Personal Weather Stations, installed starting in June 2021, which cover the area of the entire county, at different altitudes. Using the data collected by these weather stations our goal is to analyze the impact of climate change at the spatial scale of the county, the differences which occur in terms of the seasonal weather and their social impact. Since the first station was installed, in August 2019, in Bistrița, we have already observed an increasing gap between the historical weather data records and what we are recording today. The shifts are documented in terms of the temperature regime, the amounts of precipitation, and, most importantly, a certain "migration" of the seasons. These analyses will further be used for mapping local areas of meteorological risks, particularly floods, drought and fires.

A new approach in using Rational method through GIS framework

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Predicting the peak flood discharge for ungauged rivers has always been one of the main concerns in applied hydrology. When dealing with small drainage areas, a common procedure for determining the peak flow is the Rational method.

Throughout the years, a number of well-known researchers managed to adapt the parameters of this method to fit the runoff regime in Romanian rivers. Due to the technological restrictions of the period in which these factors have been analyzed, identifying the values for each of the parameters of this method was done by approximating the location of the drainage area on a paper map, manually calculating the drainage area, the river length, the slope of the basin a.s.o. This approach proved to be both somewhat inaccurate and, most of all, time consuming.

Modern GIS-based software provides the necessary tools for digitizing all those parameter maps along with the characteristics of the river and its drainage area. This paper provides the necessary steps for creating the necessary parameter layers, an automated method for calculating each parameter value and an easy way to transpose them in the Rational formula.

DAAS – Integrated Excel application for the automatic calculation and redaction of a hydrometrical study for water discharge and suspension alluvium

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Keywords: application, hydrology, free, integrated

The paper aims to present a novel application based on a multitude of other older applications, made mainly in Word and Excel, that are currently used to various extents in our country. DAAS refers to the abbreviation in the Romanian language for water discharge and suspension alluvium. Its main advantage is that each category of data (e.g., discharge, water level, turbidity, etc.) is introduced only once in each separate application. It also proposes a simplified mode of data input and more accurate data interpretation, which are now possible due to the improvements made in computation techniques. The DAAS application has seven worksheets: "Valmezi", "Grafice iarna", "Date Intrare", "Centralizator", "Chei anuale tabel", "Cheia in lucru", "Cheia anuala grafic". While more complex applications have been developed to date and are used in other countries, for the time being they are too costly to implement in Romania, as compared to the DAAS application which is free. Furthermore, DAAS is in line with the current „Guidelines for the processing of hydrometrical data".

Comparative analysis of the periods 1961 – 1990 and 1991 – 2020 regarding the impact of climate change on the date of the last frost on the territory of the Republic of Moldova

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Keywords: climate change, dangerous frosts, frost-free period

Despite the increasingly advanced development of technology and its importance for human life and activity, our dependence on the climate is undeniable, especially in the current period due to climate change.

Thus, climatic phenomena with a risk aspect become more and more dangerous for everything alive and especially for humans, due to the random character of their manifestation. Among them are the frosts, which are quite dangerous when they occur outside the typical season.

Frosts are observed in late spring, when agricultural crops are in an active phase of development, and in early autumn, when the fruit has not been harvested yet, causing frostbite or even the death of some crops/plants annually on the territory of the Republic of Moldova.

Along with the changes that take place at the regional climatic level, there are also changes regarding the date of their manifestation, therefore for the present study we analyzed some of the parameters that are characteristic for dangerous frosts: the extreme dates of the manifestation of the first and last frost and the duration of the frost-free period specific to them. We should mention the fact that the frost-free period is an indicator that's directly proportional to the duration of the period of active vegetation of agricultural crops in which they manage to pass through all the phenological phases of development.

Data was collected from the archives of the State Hydrometeorological Service from 14 meteorological stations. The resulting database obtained was statistically processed using Microsoft Excel and Statgraphics software, and the spatialization was carried out in ArcGIS 10.2. Two time periods of 30 years each (climate periods), which include the years 1961-1990 and 1991-2020, were subjected to the spatio-temporal analysis.

The results obtained from the data analysis show us some obvious changes regarding the extreme date of the last frosts for the period 1991 - 2020, which know an advance towards the warm period of the year by about 10 days compared to the period 1961 - 1990, which tells us about the shrinking of the growing season.

Also, the date of occurrence of early frost knows some changes. It manifests itself about 6 - 13 days earlier, which represents an advance towards the warm period, thus reducing the vegetation period.

As a result, there is also a change in the frost-free period, which shows a decrease for Baltata and Tiraspol m.s. respectively by about 10 and 3 days recorded in the period 1991 - 2020 compared to the period 1961 - 1990.

The information is of interest to farmers for the correct placement of thermophilic plants, as well as for establishing areas favorable to them. Another aspect regarding the need for this study is the establishment of the optimal sowing/planting period of different agricultural crops in order to optimize the process of their active growth.

Climate fluctuations in the Carpathians during the Little Ice Age

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Keywords: Carpathians, climate fluctuations, LIA, tree ring data, historical climatology, lake sediments

The Little Ice Age (LIA) is referred to the cold climate period known foremost for Europe and North America from the early 14th century through the mid-19th century. The dramatic cold sub-millennium time is univocally asserted to be triggered by radiative forcing together with shorter cold outbreaks driven by volcanic eruptions. Still, the dating and interpretation of climate fluctuations within the LIA are under ongoing discussion. The transition period between the Medieval Warm Period and the LIA with the most significant seasonal fluctuations is another controversial research issue. The evidence of historical climatology and paleoenvironmental studies implies the variety of regional climate patterns, and the number and time of shorter wet/dry and warm/cold periods in different parts of Europe.

The differences are foremost linked to regional atmospheric circulation mechanisms and the transformative role of big landforms accordingly (Roibu et al., 2022). Here, the Carpathian region is of particular interest due to the geographical position and geometry of the mountains. Given these features, the climate of the Carpathians is the result of dynamic interaction and transformation of North Atlantic, continental, and Mediterranean atmospheric circulation over diversely stretched and distributed mountain ridges of Eastern, Western and Southern Carpathians. The growing evidence on the past climate of the Carpathian-Balkan area contributes to distinguishing regional and temporal patterns (Kern et al., 2016). Accordingly, the study provides insight on the LIA climate variability in the Carpathians based on the generalised set of proxy data (historical evidence, tree ring data, ice cores, lake and peat bog sediments, and borehole). The statements of wet/dry and cold/warm phases of fluctuations are made in response to present climatological norms. Historical climatology for the last

millennium based on agricultural phenology and economic conditions is the richest and interpreted for Western Carpathians, while tree ring data (Fagus silvatica, Pinus cembra, Picea abies) of different chronology spans are available for all the Carpathian regions showing the best correlation with the temperature model data in the warm season (Kern et al., 2016; Roibu et al., 2022). The millennium climate proxy data for the area represent foreland highlands and mountains up to 1850 m.

LIA is reported to last differently for the specific parts of the Carpathians. The tree ring data point to the most significant cold time in the 14th – 17th century in the Eastern Carpathians (Roibu et al, 2022). In the Western and Southwestern Carpathians, in the 15th century, the very cold phase of the LIA is distinguished to be shorter with bigger fluctuations and longer transition periods (Badaluta and Persoiu, 2022). The 16th and 17th centuries are also not homogenous in the temperature records. The period starting from 1570 and preceding the phase known as the Maunder Minimum (1645–1715) of a relatively low solar activity is detected to be colder in the Western Carpathians (Niedźwiedź, 2010) while it is warmer in the Eastern Carpathians (Popa and Kern, 2008). The Eastern Carpathians also show the early signs of the LIA vanishing in the end of 18th century with the separate cold years (1818, 1820s, 1840s) afterwards (Huang et al., 2000; Popa and Kern, 2008). These features don't correlate well with solar activity cycles or even big volcanic eruptions. For example, The year 1816 („the year without summer") which is well documented in Central Europe, was quite warm and favorable for harvesting in the foreland of Eastern Carpathians and lagged in the Inner Eastern Carpathians pointing to specific regional circulation patterns (Kern et al., 2016).

There is still insufficient evidence for hydroclimatic variability during the LIA in the different parts of the area. Most of the LIA in the Carpathians is considered to be relatively dry with sectoral and orographic circulation differences. However, the common hydroclimatic feature found for both Western and Eastern Carpathians is the relatively wet period of the late 18th and early 19th century (Feurdean et al., 2015; Ráczl., 2020). Altogether, the data confirm the climate fluctuations on multi-decadal timescales that show local print and are better explained by the regional circulation patterns and their transformation over the mountains.

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Meteorological phenomena of risk in the Bâc hydrographic basin

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Keywords: Bâc, fog, hail, sleet, blizzard, hail

Article 1 of the UN Convention on Climate Change defines "climate changes" as "climate changes that are directly or indirectly attributable to human activities and which determines the change in the composition of the global atmosphere, overlapping with climate variability observed in the same period of time".

The climate changes in the Bâc watershed are part of the global trend of warming, and these changes can be observed by analyzing the frequency of some meteorological phenomena risk (fog, sleet, blizzard, hail). Analysis of appearance the fog tendency in the evolution aspect shows us a decrease in the Bâc hydrographic basin, starting from the'90s of the 20th century, when the rate of climate warming had been increasing. Analysis of the change trend in the annual number of days with glaze frost finds a general tendency to decrease, more significantly being expressed in the south-eastern part of basin, which is explained by regional changes as a consequence of climate change. Because of the frequent temperature alternations of the last decades during the winter, in regional aspect starting from the 80s of the 20th century, a decrease of the given phenomenon is observed. Territory analysis of the Bâc basin, in relation to the manifestation of scurvy, shows us that the territories most vulnerable to this phenomenon belongs to the northwestern part, due to the higher elevation of the relief, with a predisposition favorable for cold air advection, and the south-east of the basin is somehow more protected from cold air, the relief dropping significantly in altitude. The analysis of the obtained data shows us that in evolutionary terms the hoar-frost phenomenon shows an increasing tendency, especially in the northern and central part of basin, where the temperature changes are more significant. Annually, the largest number of blizzard days, occur in the lower plain regions of the Bâc river. Increasing the number of the blizzard days in the southeastern part could be explained by the physical-geographical position of this station, at the "mouth gateway" to the Romanian Plain, "guarded" to the north by the Carpathian Curve and to the south by the Massif Northern of Dobrogea, which causes a channeling of cold air masses of arctic origin from the north and northeastern Europe, simultaneously with their interaction with the warm ones, of tropical origin from the Mediterranean Sea. A decrease in the annual number of blizzard days was found in the urban topoclimate regions (Chisinau 1,0 days), where the high density of tall buildings diminishes its manifestation.

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The geodemographic features of a village in Bucovina: Straja

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Straja is a wonderful Bucovina village, located near the border with Ukraine, which evolved from a modest guard settlement, developed on the slopes of the Putna monastery. A village that has not changed its name throughout history, it comes from the old Slavic language, meaning the place where the guards stay or the place of the vigil, showing the occupation of the inhabitants, that of guarding the road that connected Transylvania with Moldova.

A human community with its social organization, with an economic life that ensures its existence, with its own culture, all of which give it a historical identity through the preservation and transmission of values related to civilization and spirituality. Social dimensions were captured by measuring the evolution of the volume of the population, changes in its structure by gender, age groups, ethnicity, confessions, and the influence of demographic phenomena (birth rate, mortality, migration), on the volume and quality of the population.

The analysis of statistical data indicates a progressive increase in the number of inhabitants, from 1775 to the present day, an almost unmodified ethnic structure, with more than 90 % Romanians, and a slight predominance of the male population. The town occupies the smallest area among the mountain communes, with a high population density of over 130 people per km^2.

For the knowledge of the life of a community, combining quantitative and qualitative methods is necessary; this highlights people's attachment to their native place, an attempt to preserve traditions and the sober folk attitude, the children's desire to continue their studies in prestigious high schools in the county, this being the most important reason why they would leave their native place.

People could say it is not easy to write about a village you do not belong to and only those who are bound to the place have the right to do this. But I am convinced someone may fall in love with a place because of its people and history and customs and because of nature's beautiful scenery.

The vulnerability of settlements to climate change (Botosani, Iasi and Vaslui counties, Romania)

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The altitudinal intervals between which villages are found in the three counties analyzed in this study determine the vulnerability to the thermal and rain gradient, to meteorological phenomena (early and late frost, hail, blizzard), extreme hydroclimatic conditions, the impact of temperature inversions, contamination with pollutants, and the result of those factors about the impact of villages that are located in valleys. The distance to main roads (DN, DE) is useful to determine the degree of connection or isolation, and to study the risk of exclusion generated by isolation. The distance to main rivers shows that a big proportion of villages are situated at a distance under 10 m from river valleys, which indicates high vulnerability to floods. The aspect of the terrains on which settlements are located could which areas have favorable exposition for renewable energies (e.g., solar). The proximity to a forested area has a number of environmental, ecological advantages: topoclimatic, aesthetic and recreational, but where this distance is very large, we find that the impact of gullies and torrents increases, as well as the occurrence of landslides, which is also influenced by the geological substrate.