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10.1 GEOARHEOLOŠKA PREISKAVA NEVIDNIH GOMIL NA PEZDIRČEVI NJIVI

10.1 GEOARCHAEOLOGICAL STUDY OF INVISIBLE BARROWS AT PEZDIRČEVA NJIVA

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UVOD

Grobne gomile so ena glavnih arheoloških značilnosti starejšeželeznodobnih skupnosti na ozemlju dolenjske halštatske skupine (Gabrovec 1964–1965, 1966, 1987, 1999, 2008; Dular, Tecco Hvala 2007, 123 ss; Teržan 2020). Njihova prostorska umestitev, velikost in strukturiranost, načini pokopov ter pridatki v grobovih odražajo preplet socialne organizacije, identitete posameznikov in skupin, pogrebnih običajev ter načrtnega oblikovanja kulturne krajine.

Kljub temu pa je lahko topografska prepoznavnost gomil varljiva. Med njimi namreč ločimo takšne, ki so še vedno zelo dobro ohranjene in topografsko enostavno razpoznavne, spet druge, ki izkoriščajo naravno razgibano konfiguracijo terena z manjšimi namenskimi nasutji, in tretje, ki so bile zaradi poznejše poljedelske rabe tal (na primer oranja, rigolanja, terasiranja) delno ali povsem izbrisane iz reliefa in uničene v stratigrafskem zapisu. V takih primerih se lahko ključne informacije o obstoju ali neobstoju namenskih nasutij ter razmerju med naravnim in antropogeno ustvarjenim reliefom ohranijo le v obliki fizikalno-kemijskih in mikromorfoloških signalov v tleh.

V zadnjih desetletjih se zato čedalje bolj uveljavlja spoznanje, da interpretacija arheološke krajine zahteva dopolnitev klasičnih arheoloških metod s pedološkimi, sedimentacijskimi in geoarheološkimi pristopi (glej na primer Goldberg, Macphail 2006; Macphail, Goldberg 2018; Karkanas, Goldberg 2019). Slednji namreč omogočajo razločevanje med naravnimi in antropogenimi sedimentacijskimi procesi ter s tem med naravnimi in antropogenimi elementi reliefa v kulturni krajini. Enako pomembno je tudi razumevanje vpliva poznej-

INTRODUCTION

Barrows are one of the principal features of Early Iron Age communities in the territory of the Dolenjska Hallstatt group (Gabrovec 1964–1965, 1966, 1987, 1999, 2008; Dular, Tecco Hvala 2007, 123 ff.; Teržan 2020). Their spatial distribution, size, structural composition, burial practices, and associated grave goods reflect an interplay of social organisation, individual and communal identities, funerary rites, and deliberate shaping of the cultural landscape.

However, the topographic visibility of barrows can at times prove elusive. Some are exceptionally well preserved and remain easily identifiable within the landscape. Others make use of pre-existing natural relief, incorporating only minor mound fills, while still others have been partly or entirely erased from the terrain – and from the stratigraphic record – by subsequent agricultural activities (e.g. ploughing, deep ploughing, terracing). In such cases, crucial evidence concerning the presence or absence of anthropogenic deposits, as well as the relationship between naturally formed and anthropogenic relief, can be recovered from physical-chemical and micromorphological signals preserved within the soil.

In recent decades, there has been growing recognition that the interpretation of archaeological landscapes requires the integration of traditional archaeological methods with soil science, sedimentology, and geoarchaeology (see e.g. Goldberg, Macphail 2006; Macphai, Goldberg 2018; Karkanas, Goldberg 2019). These approaches enable us to distinguish between natural and anthropogenic sedimentation processes, and thereby between natural and anthropogenic relief elements within the cultural landscape. At the same time, ših poodložitvenih procesov (na primer pedogeneze, poljedelstva), ki lahko preoblikujejo ali izbrišejo prvotni arheološki zapis.

V tem kontekstu prispevek obravnava širše metodološko vprašanje: kako prepoznati uničene gomile na območjih, kjer se topografski ali stratigrafski znaki nasutja niso ohranili. Analiza je usmerjena v identifikacijo parametrov tal, ki bi lahko potrjevali obstoj nekdanjih gomil ali ga, nasprotno, zavračali v korist interpretacije naravne mikrotopografije kot namensko izkoriščenega pogrebnega konteksta. V prispevku je poseben poudarek namenjen petim diagnostičnim orodjem – teksturi, pH, nasičenosti sorptivnega dela tal z bazičnimi kationi (V-vrednost), mikromorfologiji in modelu petih elementov pobočja, ki so se izkazala kot še posebej pomembna v arheološki interpretaciji grobišča na Pezdirčevi njivi. S tem prispevek presega deskriptivno obravnavo posameznega najdišča in postavlja nov metodološki okvir za študije podobno zabrisanih ali nevidnih arheoloških struktur v kraških pokrajinah, kjer je zgodovinska dinamika rabe prostora bistveno vplivala na današnjo berljivost arheološkega zapisa.

GEOARHEOLOŠKE PREISKAVE NA PEZDIRČEVI NJIVI

V letih 2019 in 2021 smo z geoarheološkim vzorčenjem želeli preveriti, ali lahko na Pezdirčevi njivi potrdimo prisotnost mlajšehalštatskodobnih gomil. Zanimalo nas je tudi, ali lahko ob morebitnem obstoju namensko nasutih gomil opredelimo gradbeni material zanje in rekonstruiramo način njihove gradnje.

V nasprotju z nekaterimi bližnjimi tumuli jasno razpoznavne gomile na Pezdirčevi njivi v času izkopavanj niso bile dokumentirane. Res je tudi, da na številnih starejšeželeznodobnih grobiščih, razpršenih po obodu Kučarja ali v njegovi neposredni bližini, najdemo razorane gomile (*sl. 4*) – od takih, ki so topografsko še prepoznavne, do takih, ki so bile z oranjem popolnoma izbrisane s površja (prim. Dular 2021).

Ker so izkopavalci želeli ugotoviti, ali so bile na Pezdirčevi njivi zemljene gomile, podobno kot velja za številne s sosednjih grobišč, v celoti uničene ali lahko pri proučevanem grobišču govorimo o mlajšehalštatskodobnih pokopih na naravno razgibanem terenu, smo pred začetkom raziskovalnega dela postavili dve delovni hipotezi. Prva pravi, da so bile gomile na najdišču razorane. Predvideli smo, da bi omenjeno hipotezo lahko potrdilo odkritje znakov poljedelstva, ostankov uničenih gomilnih plaščev in pokopanih tal, na katerih naj bi bile gomile nasute.

Po alternativni hipotezi naj gomil na lokaciji nikoli ne bi bilo, pokopi naj bi bili namesto tega izvedeni v naravno razgibani kraški pokrajini, ki je s svojim videzom spominjala na gomile. Ob tem bi pričakovali, da pod

it is equally important to understand how post-depositional processes (e.g. pedogenesis, agriculture) can transform or erase the original archaeological record.

Within this context, the present chapter addresses the broader methodological question of how to identify demolished barrows in areas lacking any discernible topographic or stratigraphic evidence of anthropogenic mound fills. Our analysis focuses on identifying soil parameters that can either confirm the former existence of barrows or, conversely, refute it in favour of interpreting the natural microtopography as having been deliberately utilised in a funerary context. Particular emphasis is placed on five diagnostic tools – texture, pH, base saturation (V value), micromorphology, and the five-slope-element model – all of which have proved especially valuable for the archaeological interpretation of the Pezdirčeva njiva cemetery. In doing so, the chapter moves beyond a purely descriptive examination of individual sites and proposes a new methodological framework for future investigations of similarly obscured or invisible archaeological structures in karst landscapes, where historical land-use dynamics have significantly affected the present-day legibility of the archaeological record.

GEOARCHAEOLOGICAL RESEARCH AT PEZDIRČEVA NJIVA

In 2019 and 2021, we conducted geoarchaeological sampling to investigate the presence of Late Hallstatt barrows at Pezdirčeva njiva. Our research also aimed to determine whether the building materials of any putative mounds could be identified and to assess the methods used in their construction.

In contrast to several nearby barrows, no clearly discernible mounds were documented at Pezdirčeva njiva during excavation. It should also be noted that several Early Iron Age cemeteries scattered at the foot of Kučar or in its immediate vicinity contain ploughed-out mounds (*Fig. 4*), ranging from those that remain topographically identifiable to others that have been entirely erased from the surface through ploughing (cf. Dular 2021).

Archaeologists sought to determine whether the earthen barrows at the Pezdirčeva njiva site – as is the case at many neighbouring cemeteries – had been completely destroyed, or whether the cemetery under study instead represents Late Hallstatt-period burials on naturally uneven terrain. Consequently, we formulated two working hypotheses prior to the commencement of the research. According to our first hypothesis, the mounds at the site had been ploughed out. We anticipated that this hypothesis could be supported by evidence of agricultural activity, remnants of destroyed mound fills, and buried soils onto which the mounds were originally built. Our alternative hypothesis posited that no mounds had ever existed at this location; rather, the burials took place "naravnimi gomilami" ne bo pokopanih tal. Tudi v tem primeru bi bilo treba upoštevati, da bi lahko dolgotrajna poljedelska raba izravnala naravno valovito topografijo.[1]

Izhodiščni hipotezi smo preverjali z geoarheološkimi preiskavami štirih profilov tal (profili P1–P4; *sl. 2*) z grobišča in dodatnih dveh vzorčenih točk (profila P5 in P6), ki služita kot kontrolna profila naravnih tal zunaj grobišča.

METODE DELA

V raziskavi smo uporabili večmetodni pristop, ki je vključeval mikromorfološke, pedološke in geomorfne analize tal. Mikromorfologija je metoda, ki jo uporabljamo za proučevanje neporušenih vzorcev arheoloških plasti, tal in sedimentov na mikroskopski ravni. Analiza orientiranih vzorcev v zbruskih standardne debeline 30 µm z uporabo petrografskega mikroskopa omogoča prepoznavanje posameznih antropogenih, geogenih in pedogenih komponent na podlagi njihovih morfoloških lastnosti na mikroskopski ravni. Po opredelitvi vseh komponent sledi določitev njihovih medsebojnih prostorskih razmerij. S skupkom naštetih informacij v okviru interpretacije rekonstruiramo naravne in antropogene, odložitvene in poodložitvene procese, ki so sooblikovali analizirane plasti.

Pedološke in geokemijske analize omogočajo razločevanje sedimentacijskih, pedogenih in antropogenih procesov na podlagi fizikalno-kemijske opredelitve analiziranega gradiva. V primeru Pezdirčeve njive so te vključevale analizo teksture, pH, nasičenosti sorptivnega dela tal z bazičnimi kationi (V-vrednost), vsebnosti organske snovi ter razmerja ogljika in dušika (C/N).

Geomorfne analize so še posebej uporabne pri proučevanju lastnosti tal v širšem kontekstu pokrajine. V tej študiji smo jih uporabili za analizo razmerja med sedimentacijskimi in pedogenimi procesi na najdišču ter za oceno vpliva obeh tipov procesov na debelino tal in ohranjenost arheološkega zapisa.

VZORČENJE

V letih 2019 in 2021 smo vzorčili šest profilov tal (P1–P6) na različnih koncih grobišča in v njegovi neposredni bližini (*sl. 1*). Izbiro lokacij je pogojevala metodologija dela na najdišču. Ker so bili na celotni površini izkopnega polja strojno odstranjeni (glej poglavje 10.2) vsi humusno akumulativni (A) in prehodni (AB) horizonti do nivoja mineralnih (B) horizontov, v katerem so bila zaznana polnila grobnih jam, so bile temu primerno vsakokratne lokacije vzorčenja postavljene na robove izkopnega polja. Tako smo na izbranih točkah grobišča v celoti povzorčili vertikalno zaporedje horizontov tal.

[1] Prim. tu poglavje 4.5, sl. 4.17.

within naturally undulating karstic terrain whose form merely mimicked that of mounds. In this case, we would expect no buried soils beneath such "natural mounds." This second hypothesis also needed to account for the possibility that naturally uneven topography may have been levelled through long-term agricultural use.[1]

To test our two initial hypotheses, we conducted geoarchaeological examinations of four soil profiles (P1–P4; *Fig. 2*) from within the cemetery, as well as two additional profiles (P5–P6) sampled from natural soils outside the cemetery, which served as controls.

METHODS

This study employed a multi-method approach that integrated micromorphological, pedological, and geomorphological soil analyses. Micromorphology involves the study of undisturbed samples of archaeological layers, soils, and sediments at the microscopic scale. The analysis of oriented thin sections, prepared to a standard thickness of 30 µm and examined under a petrographic microscope, allows for the identification of individual anthropogenic, geogenic, and pedogenic components based on their morphological properties. Once all components present have been identified, their mutual spatial relationships are examined. In the interpretative phase, this accumulated body of information enables the reconstruction of the natural and anthropogenic depositional and post-depositional processes that shaped the analysed layers.

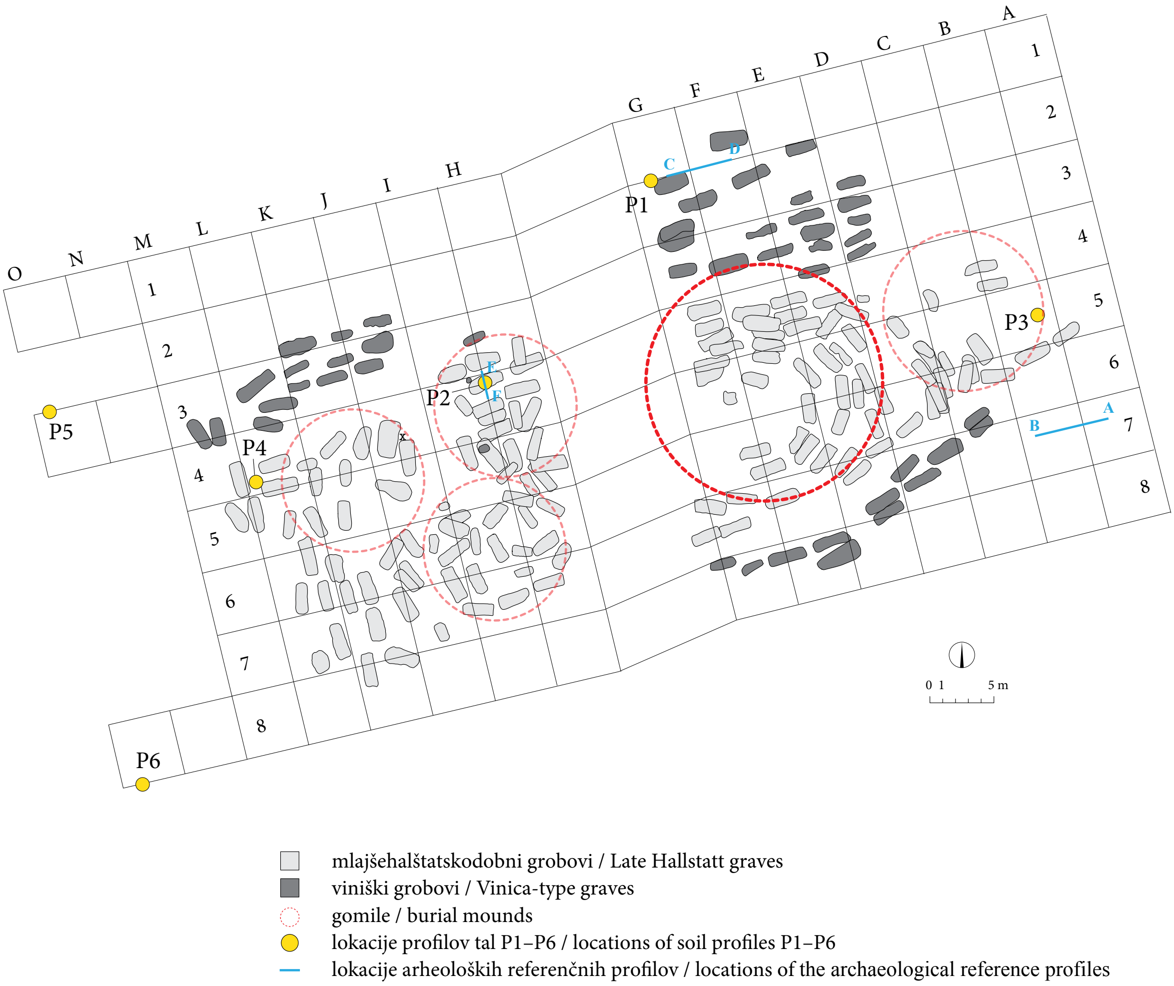
Pedological and geochemical analyses differentiate sedimentary, pedogenic, and anthropogenic processes based on the physico-chemical characterisation of the analysed materials. At Pezdirčeva njiva, these analyses included soil texture, pH, base saturation (V value), organic matter content, and the carbon-to-nitrogen ratio (C/N).

Geomorphological analyses are particularly useful for examining soil properties within a broader landscape context. In this study, they were employed to determine the relative contributions of sedimentary and pedogenic processes at the site and to assess how these processes influenced soil thickness and the preservation of the archaeological record.

SAMPLING

In 2019 and 2021, six soil profiles (P1–P6) were sampled at various points within the cemetery and in its immediate vicinity (*Fig. 1*). The selection of sampling locations was guided by the field methodology applied at the site. In the excavation area, all humus-accumulative (A) and transitional (AB) horizons had been mechanically removed down to the level of the mineral (B) ho-

[1] Cf. Chapter 4.5, Fig. 4.17 in this volume.



Sl. 1: Lokacije profilov tal P1–P6.
Fig. 1: Locations of soil profiles P1–P6.

V skladu s potekom arheoloških izkopavanj smo leta 2019 najprej vzorčili v vzhodnem delu grobišča. Na meji kvadrantov G1/G2[2] smo naredili profil P1, ki je presekal mlajšeželeznodobni grob 50 na severnem robu grobišča. Istega leta smo v H4/I4 vzorčili tudi profil P2, ki je presekal mlajšehalštatskodobni grob 18a v osrednjem delu najdišča, in v kvadrantu B5 profil P3, ki je ležal severno od mlajšehalštatskodobnega groba 98 na vzhodnem robu grobišča. Leta 2021 smo nadaljevali vzorčenje v zahodnem delu grobišča. V kvadrantu L4 smo naredili profil P4, ki je bil lociran zahodno od mlajšehalštatskodobnih grobov 172 in 173 blizu skrajno zahodnega roba grobišča. Vzorčili smo tudi dva kontrolna profila tal zunaj grobišča, in sicer v O2/O3 profil P5 na skrajnem severozahodnem robu izkopnega polja ter v O8/O9 profil P6 na skrajnem jugozahodnem robu izkopnega polja (*sl. 1*).

[2] Navajamo terenske oznake kvadrantov. Glej tu poglavje 2.2, sl. 2.7.

rizons, where grave pit fills were recorded (cf. Chapter 10.2 in this volume). Consequently, the soil profiles were positioned along the edges of the excavation area. This approach enabled us to capture the complete vertical sequence of soil horizons at selected points within the cemetery.

In line with the progression of archaeological excavations, sampling began in 2019 in the eastern part of the cemetery, where Profile P1 was cut across Late Iron Age Grave 50 on the northern edge of the cemetery, at the boundary between quadrants G1 and G2.[2] In the same year, Profile P2 was sampled in H4/I4, cutting across Late Hallstatt Grave 18a in the central part of the site and Profile P3 in quadrant B5, north of Late Hallstatt Grave 98, on the western edge of the cemetery. In 2021, sampling continued in the western part of the cemetery, where P4 was cut in quadrant L4, west of Late Hallstatt Graves 172 and 173, near the far western edge of the

[2] We are using field designations of quadrants. See Chapter 2.2, Fig. 2.7 in this volume.

Lokacije profilov P2–P4 so bile izbrane z namenom zajeti horizonte tal znotraj domnevnih gomil. Profila P2 in P3 sta znotraj oboda gomil v osrednjem in vzhodnem delu najdišča (*sl. 1*). Ob začetku del v letu 2021 smo načrtovali, da nam bo takrat določeni zahodni rob izkopnega polja prav tako omogočil umestitev profila P4 v eno od gomil v zahodnem delu grobišča, vendar se je po koncu terenskega dela izkazalo, da je izbrana lokacija zunaj gomile. Profila P5 in P6 sta bila vzorčena kot naravna kontrola, saj ležita od 15 do 20 m proč od skrajno zahodnega roba grobišča (*sl. 1*).

Za pedološke analize je bilo v letih 2019 in 2021 pridobljenih 42 porušenih vzorcev iz sistematično vzorčenih horizontov tal v profilih P1–P6. Mikromorfologija je bila v načrt raziskav vključena pozneje. V profilih P4–P6 smo leta 2021 odvzeli 12 neporušenih vzorcev, iz katerih so bili pripravljeni mikromorfološki zbruski (*sl. 2*).

PRIPRAVA VZORCEV TER LABORATORIJSKE IN PROSTORSKE ANALIZE

Pedološki profili so bili izkopani in opisani v skladu z mednarodnimi navodili klasifikacije WRB (FAO 2006). Za pedološke analize smo iz posameznih horizontov odvzeli od 0,5 do 1 kg porušenega vzorca tal. Analize so bile izvedene v laboratoriju Katedre za pedologijo in varstvo okolja na Biotehniški fakulteti Univerze v Ljubljani. Vzorci so bili homogenizirani, zračno posušeni, ročno zmleti in presejani skozi sito z odprtinami 2 mm (SIST ISO 11464 2006). pH tal je bil določen elektrometrično v suspenziji tal in $CaCl_2$ v razmerju 1/5 (v/v) (SIST ISO 10390 2006). Vsebnost karbonatov v tleh je bila določena po volumetrični metodi (reakcija karbonatov z 10 % HCl) (SIST ISO 10693 1995). Na podlagi vsebnosti karbonatov smo izračunali delež mineralnega ogljika (C_{min}). Skupni ogljik (C_{skupni}) in dušik (N_{skupni}) sta bila določena po metodi s suhim sežigom (SIST ISO 10694 1996; SIST ISO 13878 1995), organski ogljik (C_{org}) je bil določen kot razlika med C_{skupni} in C_{min}. S sedimentacijsko pipetno metodo (SIST ISO 11277 2011) smo določili teksturo tal. Kationska izmenjalna kapaciteta je bila določena po metodi dvojne izmenjave (NH4OAc/KCl, pH = 7) (ISO/DIS 22171 2022). Po ekstrakciji z amonlaktatom (Egnér et al. 1960) sta bila določena dostopni fosfor in kalij.

V laboratoriju Terrascope (Troyes, Francija) je bilo za pričujočo raziskavo 12 neporušenih vzorcev iz profilov P4–P6 (*sl. 2*) izdelanih v mikromorfološke zbruske velikosti 68 mm × 139 mm in standardne debeline 30 μm. Mikromorfološko preiskavo, opis in interpretacijo horizontov tal, zajetih v zbruskih, smo izvedli s stereomikroskopom Leica E74 W in optičnim mikroskopom Zeiss Axio scope A1 A Pol v presevni svetlobi pri vzporednih nikolih (II nik), v presevni

cemetery. We also sampled two control soil profiles outside the cemetery: Profile P5 in quadrants O2/O3, at the far north-western edge of the excavation field, and P6 in quadrants O8/O9, at the far south-western edge of the excavation field (*Fig. 1*).

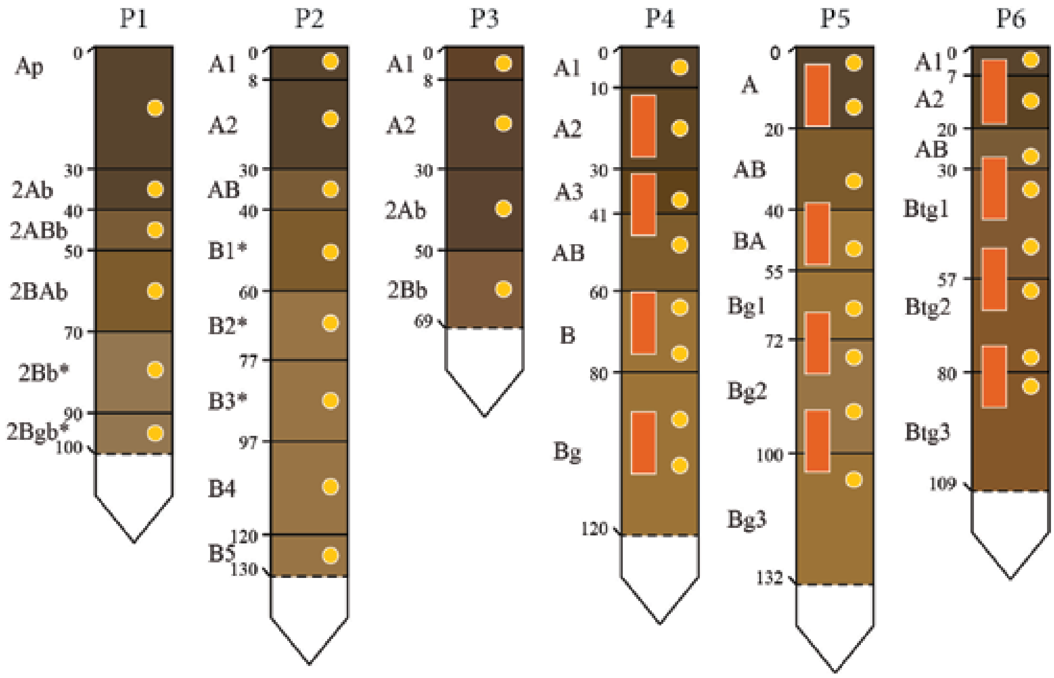
The placement of profiles P2–P4 was intended to include soil horizons within putative barrows. Profiles P2 and P3 were positioned within the perimeters of mounds located in the central and eastern parts of the site (*Fig. 1*). At the beginning of our fieldwork in 2021, we assumed that the western edge of the excavation area, as defined at the time, would allow us to position profile P4 within a barrow in the western part of the cemetery. However, by the end of the excavations, it became clear that the chosen location fell outside the mound. Profiles P5 and P6 were sampled as natural controls, positioned 15–20 m beyond the western edge of the cemetery (*Fig. 1*).

A total of 42 bulk samples were collected in 2019 and 2021 from systematically sampled soil horizons in profiles P1–P6. Micromorphology was incorporated into the research design at a later stage. In 2021, 12 undisturbed micromorphological blocks were extracted from profiles P4–P6 and manufactured into thin sections (*Fig. 2*).

SAMPLE PREPARATION, LABORATORY AND SPATIAL ANALYSES

Soil profiles were excavated and described according to the WRB classification guidelines (FAO 2006). For laboratory analyses, 0.5–1 kg of bulk soil was collected from each horizon. Analyses were carried out at the laboratory of the Centre for Soil and Environmental Sciences, Biotechnical Faculty, University of Ljubljana. Samples were homogenised, air-dried, manually ground, and sieved through a 2 mm mesh (SIST ISO 11464 2006). Soil pH was measured electrometrically in a soil-to-$CaCl_2$ suspension (1:5 v/v) (ISO 10390 2006). Carbonate content was determined volumetrically via reaction with 10% HCl (SIST ISO 10693 1995), from which mineral carbon (C_{min}) was calculated. Total carbon (C_{tot}) and total nitrogen (N_{tot}) were quantified by dry combustion (SIST ISO 10694 1996; SIST ISO 13878 1995), and organic carbon (C_{org}) was calculated as $C_{tot} - C_{min}$. Soil texture was determined by the sedimentation pipette method (SIST ISO 11277 2011). Cation exchange capacity was measured by the double-exchange method (NH_4OAc/KCl, pH 7) (ISO/DIS 22171:2022), while available phosphorus and potassium were determined after ammonium lactate extraction (Egnér et al. 1960).

At the Terrascope laboratory (Troyes, France), 12 undisturbed samples from profiles P4–P6 (*Fig. 2*) were prepared as micromorphological thin sections measuring 68 mm × 139 mm, with a standard thickness of 30 μm. The soil horizons represented in these sections were examined, described, and interpreted using a Leica



Sl. 2: Profili tal P1–P6. Zaradi variacij v vremenskih razmerah med vzorčenjem na terenu so bile barve horizontov še enkrat določene v laboratoriju pod enakimi pogoji, tj. na podlagi vlažnega barvnega razmaza. Na profilih so shematično prikazane lokacije porušenih vzorcev (rumene pike) in mikromorfoloških blokov (oranžni pravokotniki). Z zvezdico (*) označeni horizonti B v profilih tal P1 in P2 predstavljajo ohranjene spodnje dele polnil grobnih jam. Zaradi poodložitvenih procesov homogenizacije ti na podlagi morfoloških značilnosti in večine analiziranih parametrov izkazujejo predvsem lastnosti, značilne za pedogenetske procese, zato so v tej študiji obravnavani tudi kot talni horizonti.

Fig. 2: Soil profiles P1–P6. Due to variations in weather conditions during field sampling, the colours of the horizons were re-determined in the laboratory under uniform conditions, i.e. based on moist soil smears. The profiles schematically indicate the locations of bulk samples (yellow dots) and undisturbed micromorphological blocks (orange rectangles). B horizons marked with an asterisk (*) in soil profiles P1 and P2 represent preserved lower parts of grave pit fills. Due to post-depositional homogenisation processes, these horizons exhibit morphological characteristics and most analysed parameters typical of pedogenetic processes and are therefore also treated as soil horizons in this study.

svetlobi pri navzkrižnih nikolih (+ nik) in v poševno lomljeni svetlobi pri osem- do 200-kratnih povečavah. Pri delu smo upoštevali standardne protokole mikromorfološkega opisa po Bullocku in sodelavcih (1985) in Stoopsu (2021) ter pri tem uporabljali ključne priročnike (Nicosia, Stoops 2017; Macphail, Goldberg 2018; Stoops et al. 2010; Karkanas, Goldberg 2019). Na podlagi opisa in kvantifikacije posameznih mikromorfoloških komponent smo izdelali semikvantitativni tabeli (*tab. 2, 3*), ki na zgoščen in jasen način ponazarjata glavne mikromorfološke značilnosti analiziranih horizontov tal ter sta kot takšni podlaga za njihovo nadaljnjo interpretacijo.

Analiza geomorfnih procesov na širšem območju najdišča je bila izvedena z uporabo modela petih elementov pobočja (Miller 2014; Miller, Schaetzl 2015) in orodja *The Relief Analysis Toolbox* (https://www.agron.iastate.edu/glsi/analysis-tools/relief-analysis-toolbox/), razvitega za prostorske analize v okolju ArcGIS. Za širše območje Kučarja smo pripravili digitalni model reliefa z

E74 W stereomicroscope and a Zeiss Axio Scope A1 A Pol optical microscope under plane-polarised light (PPL), crossed-polarised light (XPL), and obliquely incident light (OIL), at magnifications ranging from ×8 to ×200. The study followed standard protocols for micromorphological description as outlined by Bullock et al. (1985) and Stoops (2021), with reference to key manuals (Nicosia, Stoops 2017; Macphail, Goldberg, 2018; Stoops et al. 2010; Karkanas, Goldberg 2019). Based on the description and quantification of individual micromorphological components, two semi-quantitative tables (*Tabs. 2, 3*) were compiled to summarise the main micromorphological features of the analysed soil horizons. These tables formed the basis for subsequent interpretation.

Geomorphic processes in the broader site area were analysed using the five-slope-element model (Miller 2014; Miller, Schaetzl 2015) and the Relief Analysis Toolbox (https://www.agron.iastate.edu/glsi/analysis-tools/relief-analysis-toolbox/), a spatial analysis tool within the ArcGIS environment. For the wider Kučar area, a ločljivostjo 0,5 m (*sl. 13:* b) ter nato v treh korakih izvedli analizo relativne višine, naklona pobočja in ukrivljenosti profila pobočja. Na podlagi vseh treh sklopov podatkov je bila za izbrano območje izvedena klasifikacija elementov pobočja v pet kategorij: vrh, rame, hrbet, vznožje in konci pobočja (*sl. 13:* c).

REZULTATI

GEOMORFNI IN PEDOGENI PROCESI NA ŠIRŠEM OBMOČJU KUČARJA

Za razumevanje lastnosti tal je bistveno poznavanje tlotvornih dejavnikov, in sicer matične podlage, podnebja, reliefa, organizmov in časa (glej na primer Jenny 1994; Schaetzl, Anderson 2005). Širše območje Kučarja ter njemu pripadajočih gomilnih grobišč je del slovenskega Dinarskega krasa, za katerega sta značilna predvsem apnenčeva in dolomitna matična podlaga, prisotni pa so tudi pliocenski in pleistocenski klastični sedimenti ter ob rekah mlajši aluvialni nanosi (*sl. 3*). Območja apnenca in dolomita zaznamujejo procesi kemičnega raztapljanja karbonatne matične podlage, ki so ključni za nastanek površinskih in podpovršinskih makro- in mikroreliefnih kraških oblik (*sl. 3*; glej tudi Mihevc 1999; Gams 2004). Resedimentirano pliocensko in pleistocensko gradivo, ki je po geokemijski sestavi podobno izvorni preperini apnenca in dolomita, prekriva in zapolnjuje kraške reliefne oblike. Prepletanje *in situ* nastalega ter resedimentiranega karbonatnega gradiva je značilno za številne predele Dinarskega krasa v Beli krajini in tudi za širše območje Kučarja (*sl. 3*). Južno od Kučarja najdemo mlajše, prodnato glinene in ilovnate kvartarne aluvialne nanose Kolpe (*sl. 3*; glej tudi Bukovac et al. 1983).

Med podnebnimi dejavniki izpostavljamo zlasti veliko letno količino padavin, ki se v Beli krajini giblje od 1100 do 1200 mm (ARSO 2016) in zaradi katere imajo eluvialno-iluvialni procesi, ki vodijo do nastanka izpranih tal, pomembno vlogo v regionalni pedogenezi (Turniški, Grčman 2018).

Širše območje Kučarja je mogoče razdeliti na tri izrazite geomorfne enote. Prva zajema območje severno in zahodno od okljuka Kolpe, ki se razteza do vasi Kapljišče. Na makrotopografski ravni prevladuje uravnana poplavna ravnica z meandrirajočim Kolpinim rečnim kanalom, omejenim z naravnimi rečnimi nasipi na obeh bregovih. Za to enoto so značilni izraziti aluvialni procesi. Prevladujejo razvite oblike obrečnih tal, nastale na prodnatem, ilovnatem in glinenem aluviju, ki lahko v mineralnih horizontih kažejo znake oglejevanja (*sl. 3*; TIS ICPVO 2025).

Druga geomorfna enota je Kučar (222 m n. v.), ki se kot osamelec z dvema vrhovoma blago dviga iz obkolpske ravnice. Hrib, na katerem je bilo dokumentirano

0.5 m resolution digital elevation model was generated (*Fig. 13:* b), followed by a three-step analysis of relative elevation, slope gradient, and profile curvature. The resulting datasets were used to classify slope elements into five categories – summit, shoulder, backslope, footslope, and toeslope – within the selected area (*Fig. 13:* c).

RESULTS

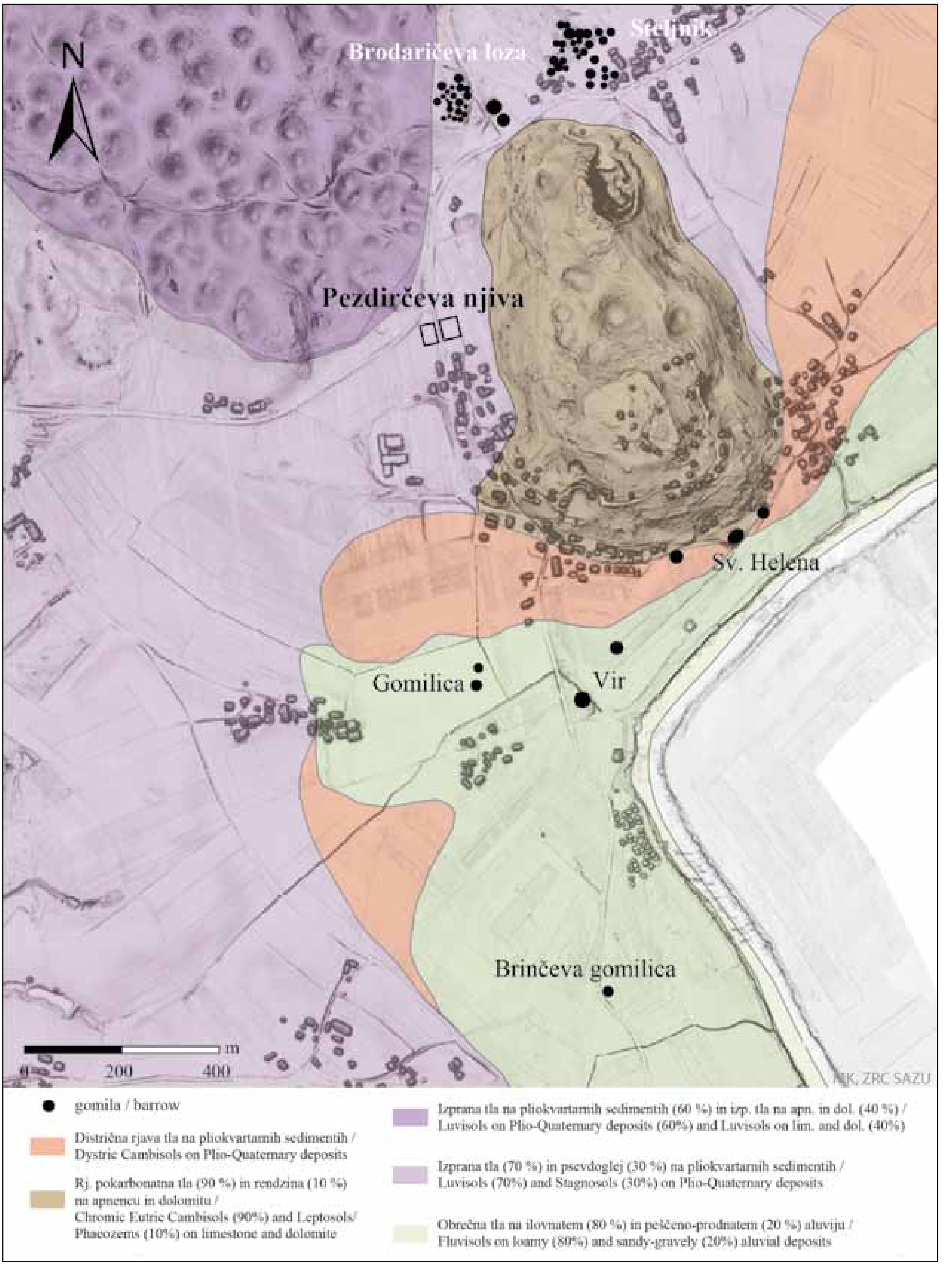
GEOMORPHIC AND PEDOGENIC PROCESSES IN THE WIDER KUČAR AREA

An understanding of the factors involved in soil formation – including parent material, climate, relief, organisms, and time (e.g., Jenny 1994; Schaetzl, Anderson 2005) – is vital for interpreting soil properties. The wider Kučar area and its barrow cemeteries form part of the Slovenian Dinaric Karst, which is primarily characterised by limestone and dolomite parent material, as well as by the presence of Pliocene and Pleistocene clastic sediments and, along river valleys, younger alluvial deposits (*Fig. 3*). Areas underlain by limestone and dolomite are marked by the chemical dissolution of the carbonate substrate, a process fundamental to the formation of surface and subsurface karst landforms at both macro- and microscales (*Fig. 3*; see also Mihevc 1999; Gams 2004). In some areas, these karst relief forms are mantled by re-deposited Pliocene and Pleistocene sediments that are geochemically similar to soils formed *in situ* formed on limestone and dolomite. The interweaving of *in situ* and re-deposited soil material is characteristic of many parts of the Dinaric Karst in Bela Krajina, as well as of the wider Kučar area (*Fig. 3*). South of Kučar, later Quaternary alluvial deposits of the Kolpa River – consisting of gravelly clay and loamy sediments – are also present (*Fig. 3*; see also Bukovac et al. 1983).

Among climatic factors, particular mention should be made of Bela Krajina's high annual precipitation, which ranges between 1100 and 1200 mm (ARSO 2016) and drives eluviation-illuviation processes that lead to the formation of leached soils, playing an important role in regional pedogenesis (Turniški, Grčman 2018).

The wider Kučar area comprises three distinct geomorphic units. The first encompasses the area to the north and west of a meander in the Kolpa River, extending to the village of Kapljišče. At the macrotopographic scale, the landscape is dominated by a flat floodplain with the Kolpa's meandering river channel, bordered on both banks by natural levees. This unit is characterised by pronounced alluvial processes. Its well-developed alluvial soils, which formed on gravelly, loamy, and clayey alluvium, may exhibit signs of gleying within the mineral horizons (*Fig. 3*; TIS ICPVO 2025).

The second geomorphic unit, Kučar (222 m a.s.l.), is an inselberg with two peaks that rises gently from the



Sl. 3: Izris pedološke karte 1 : 25.000 (TIS ICPVO, 2025) za širše območje najdišča. (Osnova: Atlas okolja © ARSO; obdelava in vizualizacija podatkov lidarskega snemanja: E. Lozić in Pedološka karta Slovenije 1 : 25.000; pomanjšana).
Fig. 3: Soil map at a scale of 1: 5,000 (TIS ICPVO, 2025) for the wider site area. (Base map: Environmental Atlas © ARSO; Lidar data processing and visualisation: E. Lozić; Soil Map of Slovenia 1:25,000; reduced size).

prazgodovinsko gradišče (Dular et al. 1995; Grahek, Kovač 2020), sestavljajo spodnjekredni bioklastični apnenci (Bukovac et al. 1983). Za vzpetino so značilne stabilne ter erozijske in depozicijske površine, pri katerih se razmerje med erozijskimi in koluvialnimi procesi spreminja, kar pogojuje razvoj različnih tipov tal (*sl. 3, 13*; glej tudi Schaetzl, Anderson 2005; Miller, Schaetzl 2015). Na osamelcu se pojavljajo tako plitvejši kot tudi bolj razviti tipi tal, značilni za apnence: rendzine, rjava pokarbonatna tla in izprana tla na apnencu. Njihova prostorska razporeditev je odvisna predvsem od lokalne mikrotopografije in stabilnosti površja. Rendzine (Phaeozems) najdemo predvsem na pobočjih, medtem ko se debelejša in bolj razvita rjava pokarbonatna tla (Eutric Chromic Cambisol) ter izprana tla (Luvisol) pojavljajo predvsem na uravnanih in stabilnih površinah obeh vrhov in grebenov, pa tudi na depozicijskih površinah na dnu večjih vrtač na vrhu vzpetine ter v manjšem obsegu v globljih žepih na manj strmih delih pobočij (*sl. 3*; TIS ICPVO 2025).

Največja geomorfna enota, v katero spada tudi grobišče na Pezdirčevi njivi, je uravnana, blago valovita kraška pokrajina v širši okolici Kučarja, ki jo na jugu in vzhodu omejuje pas poplavne ravnice. Izvorno gre za vrtačast svet, podoben tistemu severno in severozahodno od Kučarja (*sl. 3*), ki pa je bil v nasprotju s tem popolnoma prekrit z debelimi pliocenskimi in pleistocenskimi nanosi. Mikrotopografsko to območje ne izkazuje izrazitih konkavnih depresij. Na območju Pezdirčeve njive koluvialni procesi odlagajo gradivo z osamelca, pri čemer so depozicijske površine kljub temu dovolj stabilne, da omogočajo razvoj bolj razvitih tipov tal. Tla na širšem območju enote so na pedološki karti Slovenije opredeljena kot izprana tla (Luvisol) ali distrična rjava tla (Dystric Cambisol), torej kisla, nasičenost sorptivnega dela z bazičnimi kationi (V-vrednost) pa je manj kot 50 %. Če je v profilu znatna teksturna razlika med zgornjimi in spodnjimi horizonti, tj. ko je razmerje med vsebnostjo gline v Bt- in E-horizontih večje od 1,2, so klasificirana kot izprana tla (Turniški, Grčman 2018). Zaradi težje teksture se pri obeh tipih pojavljajo tudi znaki oglejevanja (*sl. 3*; TIS ICPVO 2025).

Od reliefa in lastnosti tal je odvisna njihova raba. Medtem ko večino osamelca prerašča gozd, pa na njegovem južnem, prisojnem delu najdemo vinograde. Tla na pliocenskih in pleistocenskih nanosih ter na prostoru aluvialne ravnice ob Kolpi so v kmetijski rabi kot njive in trajni travniki (*sl. 4*).

PEDOLOŠKA ANALIZA TAL NA NAJDIŠČU

Tla na območju Pezdirčeve njive je mogoče razumeti kot rezultat prepleta naravnih in antropogenih procesov. Med naravnimi izstopajo koluvialni doprinos s Kučarja ter eluvialno-iluvialni procesi. Med antropo-

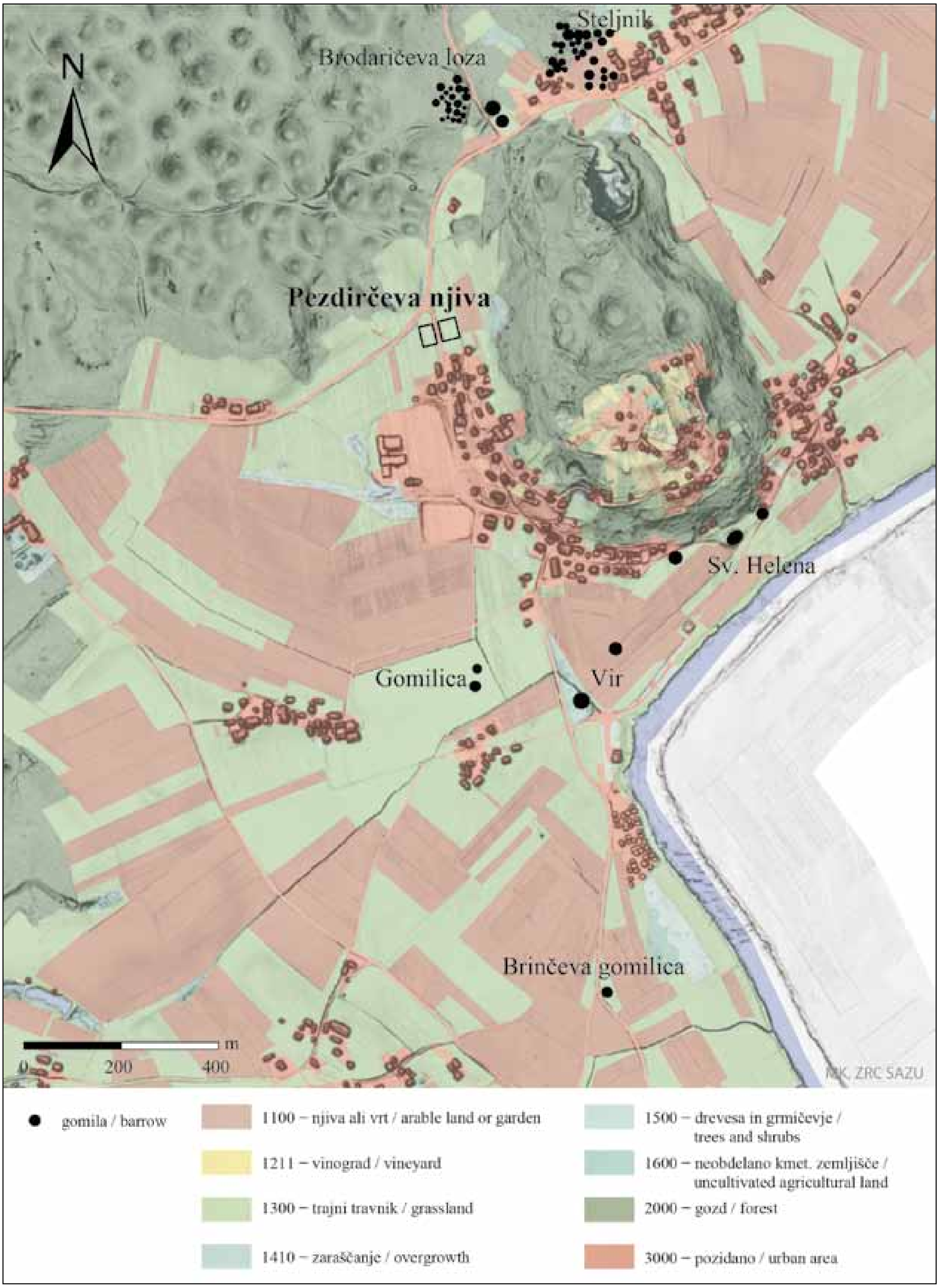
Kolpa floodplain. The hill, documented as the site of a prehistoric hillfort (Dular et al. 1995; Grahek, Kovač 2020), is composed of Lower Cretaceous bioclastic limestones (Bukovac et al. 1983). It features both stable and erosional-depositional surfaces, with a varying balance between erosional and colluvial processes that influence the development of different soil types (*Figs. 3, 13*; see also Schaetzl, Anderson 2005; Miller, Schaetzl 2015). As a result, the inselberg is covered by both shallow and more developed soil types characteristic of limestone: rendzinas, brown decalcified soils, and leached soils on limestone. Their spatial distribution is primarily determined by local microtopography and surface stability. Rendzinas (Phaeozems) occur predominantly on slopes, whereas thicker and more developed brown soils on limestone (Eutric Chromic Cambisols) and illuvial soils (Luvisols) are found mainly on level and stable surfaces on the two peaks and ridges, on depositional surfaces at the bottom of larger dolines at the summit, and – to a lesser extent – in deeper soil pockets on less steep slope sections (*Fig. 3*; TIS ICPVO 2025).

The largest geomorphic unit, which also includes the Pezdirčeva njiva cemetery, is the level to gently undulating karst landscape surrounding Kučar, bounded to the south and east by a strip of floodplain. Originally, this terrain was dominated by dolines, as is still the case in the area to the north and northwest of Kučar (*Fig. 3*). However, unlike those areas, this unit was entirely covered by thick Pliocene and Pleistocene deposits. At the microtopographic scale, the surface shows no distinct concave depressions. In the Pezdirčeva njiva area, colluvial processes transport material downslope from the inselberg, yet the depositional surfaces remain sufficiently stable to allow the development of more mature soil types. In the Slovenian Soil Map, soils of this broader unit are classified as lluvial soils (Luvisols) or dystric brown soils (Dystric Cambisol). The latter are acidic, with a base saturation of the soil's adsorptive complex (V value) below 50%. If the soil profile exhibits a significant textural difference between the upper and lower horizons – specifically, if the ratio of clay content in the Bt to E horizons exceeds 1.2 – the soils are classified as leached (Turniški, Grčman 2018). Owing to their heavier texture, both soil types also show signs of gleying (*Fig. 3*; TIS ICPVO 2025).

Soil and relief characteristics also play a key role in shaping land use. While most of the inselberg is covered by forest, its southern, sun-facing slopes feature vineyards. Soils developed on Pliocene and Pleistocene deposits, as well as those within the Kolpa floodplain, are cultivated as arable fields and permanent meadows (*Fig. 4*).

PEDOLOGICAL ANALYSIS OF SOILS AT THE SITE

The soils of the Pezdirčeva njiva site can be understood as the product of natural and anthropo-



Sl. 4: Raba tal na širšem območju najdišča. Številna gomilna grobišča so na območju poljedelske rabe, kar je vplivalo na ohranjenost gomil. (Osnova: Atlas okolja © ARSO; obdelava in vizualizacija podatkov lidarskega snemanja: E. Lozić)
Fig. 4: Land use in the wider site area. Numerous barrow cemeteries are located in areas of agricultural land use, which has affected the preservation of the mounds. (Base map: Environmental Atlas © ARSO; Lidar data processing and visualisation: E. Lozić).

genimi so najpomembnejši več kot tristoletna uporaba prostora za grobišče v starejši in mlajši železni dobi (glej tu, pogl. 6), poznejša – predvidoma novoveška in morda že srednjeveška – poljedelska raba tal ter recentna gradnja gramozne ceste, ki je presekala prazgodovinsko grobišče.

Glede na pH-vrednost in delež bazičnih kationov tla na najdišču uvrščamo med evtrična rjava tla z zaznanimi procesi izpiranja (*tab. 1, sl. 5*).[3] Blago postopno naraščanje gline z globino v kontrolnih profilih naravnih tal (P5 in P6) kaže, da se eluvialno-iluvialni procesi na obravnavani lokaciji odvijajo vse od konca transporta in odložitve pliokvartarnih sedimentov (*tab. 1, sl. 5*).

V profilih P1, P4, P5 in P6 je trend naraščanja gline z globino podoben (*tab. 1, sl. 5*). V P1, P4 in P5 je v zgornjih horizontih delež gline manjši od 20 %, natančneje od 16,6 do 18,9 %, v spodnjih horizontih obsega od 24 do 28,2 %. V P6 je delež gline v spodnjih horizontih še višji in preseže 35 %. Naraščanje gline z globino je postopno. Povečanje deleža peska v spodnjem horizontu P1 (2Bgb) in s tem povezano zmanjšanje deleža gline na globini 90–100 cm je verjetno posledica preperelega kamninskega gradiva, odloženega na dnu viniškega groba 50 (*tab. 1, sl. 1–2, 5*). Pri vseh drugih profilih trda kamninska podlaga med izkopom ni bila dosežena.

Odmik od prej opisanega naravnega trenda naraščanja gline z globino izkazujeta profila P2 in P3. V profilu P2 smo ugotovili z glino bogatejši (25,1 %) zgornji horizont A1 debeline 8 cm, ki se nato nadaljuje v sicer značilno prej opisano teksturno sekvenco (18,5–27,5 % gline) v horizontih A2–B5 (*tab. 1, sl. 2, 5*). Najmanj izrazita razlika v teksturi je v profilu P3, kjer je vsebnost gline že v zgornjem, 8 cm debelem horizontu A1 25,3 % in ta se nadaljuje v teksturno še težji A2 horizont debeline 22 cm z 29,8 % gline. V tem profilu plasti z manj kot 20 % gline niso bile identificirane (*tab. 1, sl. 2, 5*).

Zaradi velikega deleža melja in gline (skupaj od 86,2 do 99,4 %) ter majhnega deleža peska (od 0,6 do 13,8 %) so tla slabše prepustna. V vseh profilih je zaznati procese psevdooglejevanja, ki se kažejo v pojavljanju pedogenih formacij, tipičnih za hidromorfna tla, zlasti sivo rjave lisavosti ter pogostih in velikih železomanganovih konkrecij (*sl. 11)*.

Na najdišču je med profili P1–P3 in P4–P6 opazna razlika v kislosti tal ter deležu karbonatov in bazičnih kationov (*tab. 1, sl. 2, 5, 13:* a). Vrednosti pH($CaCl_2$) so v P1 in P3, tj. v vzhodnem in nekaj malega višje ležečem delu grobišča, od 5,5 do 6,7 in torej višje za približno 0,2 do 0,7 enote kot v P4–P6, kjer so od 5,3 do 6,0. Prav

[3] Klasifikacija tal na najdišču na pedološki karti merila 1 : 25.000 (*sl. 3*; pomanjšana) je drugačna, saj jih opredeljuje kot izprana tla. To neskladje odraža razliko v merilu opazovanja, pri čemer so imele geoarheološke preiskave na najdišču višjo prostorsko ločljivost. Natančna opredelitev tal na lokaciji je torej tista, ki jo podajamo na podlagi analiz, opisanih v tem poglavju.

genic processes. Among the natural processes, the most prominent are colluvial inputs from Kučar and eluviation-illuviation processes. The principal anthropogenic influences include more than three centuries of cemetery use during the Early and Late Iron Age (see Chapter 6 in this volume), subsequent agricultural land use – presumably dating to the Modern period and perhaps already to the Medieval period – and, more recently, the construction of a gravel road that cut through the prehistoric cemetery.

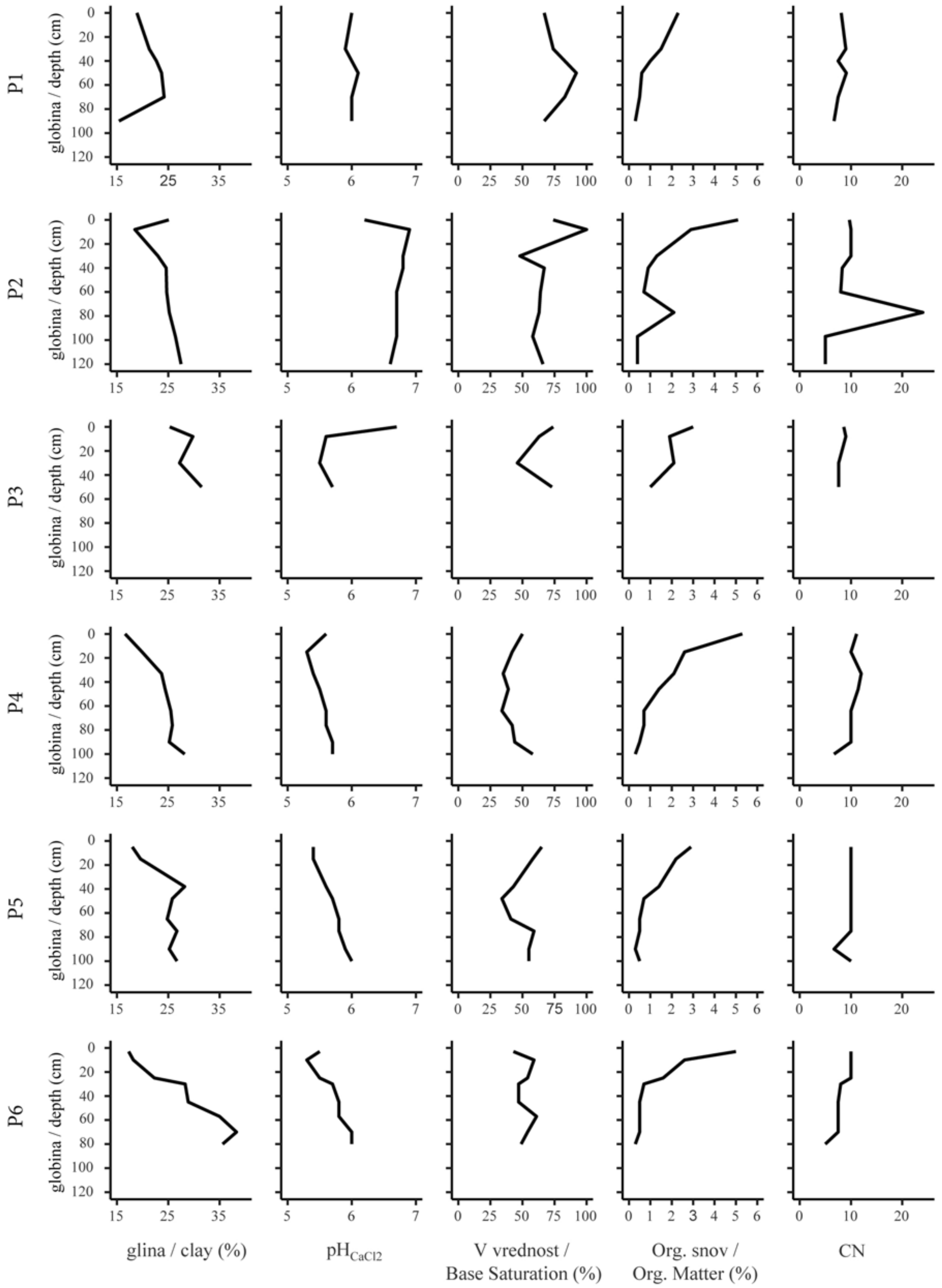
Based on pH values and the proportion of base cations, the soils at the site are classified as eutric brown soils with evidence of illuvial processes (*Tab. 1; Fig. 5*).[3] In the control profiles of natural soils (P5–P6), clay content increases gradually with depth, indicating that eluviation-illuviation processes at the site have remained continuously active since the deposition of the Plio-Quaternary sediments (*Tab. 1; Fig. 5*).

Profiles P1, P4, P5, and P6 exhibit a similar trend of increasing clay content with depth (*Tab. 1; Fig. 5*). In P1, P4, and P5, the clay fraction in the upper horizons (16.6–18.9%) is below 20%, rising to 24–28.2% in the lower horizons. In P6, the clay content in the lower horizons is even higher, exceeding 35%. This downward increase in clay content is gradual. The rise in sand content in the lower horizon of P1 (2Bgb), accompanied by a simultaneous decrease in clay content at a depth of 90–100 cm, is most likely the result of weathered carbonate material deposited at the base of the Vinica-type Grave 50 (*Tab. 1; Figs. 1–2, 5*). Hard bedrock was not reached in any of the analysed profiles.

Profiles P2 and P3 deviate from the above-described trend of increasing clay content with depth. In profile P2, the upper 8 cm-thick horizon A is rich in clay (25.1%), after which the typical sequence reappears, with clay content rising from 18.5% to 27.5% in horizons A2–B5 (*Tab. 1; Figs. 2, 5*). Textural differentiation in profile P3 is the least pronounced, beginning with a clay content of 25.3% in the 8 cm-thick horizon A1 and continuing into the texturally even heavier 22 cm–thick horizon A2, which contains 29.8% clay. In this profile, no layers with less than 20% clay were identified (*Tab. 1; Figs. 2, 5*).

Due to the high proportion of silt and clay (86.2–99.4% combined) and the low proportion of sand (0.6–13.8%), the soils are poorly permeable. All profiles exhibit signs of pseudogleying, expressed through pedogenic features characteristic of hydromorphic soils, particularly grey-brown mottling and frequent large iron-manganese concretions (*Fig. 11*).

[3] The soil classification at the site, as depicted on the pedological map at a scale of 1:25,000 (*Fig. 3;* reduced size), differs from our findings, as the map designates the soils as leached soils. This discrepancy reflects a difference in observational scale: the geoarchaeological investigations conducted at the site offer a much higher spatial resolution. Consequently, we provide here the precise characterisation of the soils at this location, based on the analyses presented in this chapter.



Sl. 5: Glina, pH, V-vrednost (nasičenost z bazičnimi kationi), organska snov in razmerje C/N v profilih tal P1–P6.
Fig. 5: Clay content, pH, V value, organic matter, and C/N ratio in soil profiles P1–P6.

tako je v P1 in P3 zaznan večji delež karbonatov (od 0,8 do 1,7) in bazičnih kationov na sorptivnem delu tal (V-vrednost od 46 do 92). Takšen trend lahko razumemo v kontekstu koluvialnih procesov in/ali vpliva s karbonati obogatene površinske in podpovršinske vode, ki se lateralno premika po pobočju in ob vznožju Kučarja, zvišuje vrednosti pH ter bogati tla s karbonati in bazičnimi kationi.

V profilu P2, ki je lociran približno 5 m zahodno od ceste, ki preseka grobišče, je pH nepričakovano visok in doseže vrednost 6,9. Takšne vrednosti verjetno odražajo kombinacijo vpliva vode s Kučarja in dodatnega recentnega antropogenega vpliva. Kot je razvidno s fotografij iz leta 1974 (prim. Dular 2021, sl. 480B/2), je bila cesta, ki vodi v Podzemelj in preseka grobišče, nekdaj grajena iz gramoza, kar je prispevalo k obogatitvi vode s karbonati in povišani vrednosti pH na mestu vzorčenja. Vpliv ceste na tla je razviden tudi v povečani količini karbonatov (do 1,6 %) ter V-vrednosti (do 100).

Humusno akumulativni horizonti (A), prepoznavni po značilni strukturi in temnejši barvi, dosegajo globine 20–50 cm, kar odraža razvoj in rabo tal v zadnji fazi na najdišču ter prisotnost pokopanih Ab-horizontov na nekaterih lokacijah (*tab. 1, sl. 2, 5,* glej tudi poglavje 10.2, sl. 2: faza 2, faza 3; 3). V profilu tal P1 je bila recentna ornica (Ap), medtem ko so bili površinski horizonti v profilih tal P2–P4 in P6 diferencirani na horizonta A1 in A2, kar kaže na spremembo nekdanjih poljedelskih površin (A2) v travniške (A1). Zaradi recentne travniške rabe je v teh profilih vidna sekundarna obogatitev organske snovi v zgornjih 10 cm (*tab. 1, sl. 2, 5*).

V profilih P1 in P3 je bil na terenu prepoznan pokopani A-horizont (2Ab) (*sl. 1–2,* prim. pogl. 10.2, sl. 2), kar je v primeru profila P3 potrdila tudi pedološka analiza, saj je bila zaznana nenadna povečana vsebnost organske snovi na 2,1 % (*tab. 1; sl. 5*). Vsebnost organske snovi v horizontu 2Ab v profilu P1 ne kaže nezveznosti (*tab. 1; sl. 5*), čeprav je bil pokopani A-horizont potrjen tudi v arheološkem referenčnem profilu C–D v neposredni bližini (*sl. 1;* glej tu, pogl. 2, sl. 2.8). Takšno neujemanje med barvno prepoznanimi pokopanimi tlemi in vsebnostjo organske snovi kaže, da je v horizontu že potekla mineralizacija organske snovi večje frakcije, medtem ko je organski pigment, ki daje plasti značilno temno barvo in jo melanizira, še vedno dobro ohranjen.

V profilu P2 je bilo na globini 77–97 cm zaznano izrazito povečanje organske snovi (2,1 %), ki ga povezujemo s spodnjim delom polnila groba 18A (*tab. 1, sl. 1–2, 5*). V isti plasti je bilo ugotovljeno tudi izrazito povečanje razmerja C/N (24), kar je bistveno širše od vrednosti, značilnih za njivske in travniške recentne ali pokopane A-horizonte (Brezigar et al. 2020), pri katerih se običajno giblje okoli 10. Takšno povišano razmerje C/N je verjetno povezano s prisotnostjo lesa – morda krste – v grobu ter z njim povezanega počasneje razgradljivega lignina in celuloze (prim. Hejcman et al. 2013, 187). Omenjeno hipotezo

At the site, profiles P1–P3 show marked differences from profiles P4–P6 in soil acidity, carbonate content, and base cation levels (*Tab. 1; Figs. 2, 5, 13:* a). The pH ($CaCl_2$) values in P1 and P3 – located in the eastern and slightly higher-lying part of the cemetery – range from 5.5 to 6.7, approximately 0.2–0.7 units higher than those in P4–P6, where values range from 5.3 to 6.0. Profiles P1 and P3 also contain higher carbonate content (0.8–1.7%) and higher base saturation values (V values between 46 and 92). This trend can be understood in the context of colluvial processes and/or the influence of carbonate-rich surface and subsurface water moving laterally downslope from Kučar, thereby increasing pH values and enriching the soils with carbonates and base cations.

In profile P2, located approximately 5 m west of the road that cuts across the cemetery, the pH is unexpectedly high, reaching 6.9. These elevated values likely reflect a combination of carbonate-rich water originating from Kučar and more recent anthropogenic impact. As shown in photographs from 1974 (cf. Dular 2021, Fig. 480B/2), the road to Podzemelj, which cuts through the cemetery, was formerly constructed of gravel. This contributed to the enrichment of water with carbonates and, consequently, to the elevated pH values observed at the sampling location. The impact of the road on the soil is further indicated by increased carbonate content (up to 1.6%) and base saturation (V values up to 100).

Humus-accumulative horizons (A), identifiable by their characteristic structure and darker colour, reach depths of 20–50 cm. This reflects both soil development and land use during the final phase of the site's history, as well as the presence of buried Ab horizons in certain locations (*Tab. 1; Figs. 2, 5*; see also Chapter 10.2, Figs. 2: Phases 2, 3; 3). A recent plough layer (Ap) was identified in soil profile P1, whereas the surface horizons in profiles P2–P4 and P6 are differentiated into horizons A1 and A2, indicating the transformation of former arable surfaces (A2) into meadow soils (A1). As a result of recent meadow use, the upper 10 cm of these profiles show secondary enrichment in organic matter (*Tab. 1; Figs. 2, 5*).

In profiles P1 and P3, a buried A horizon (2Ab) was identified in the field (*Figs. 1–2*; cf. Chap. 10.1, Fig. 2 in this volume). This was confirmed by pedological analysis in profile P3, where a sudden increase in organic matter content to 2.1% was recorded (*Tab. 1; Fig. 5*). In contrast, no discontinuity is indicated by organic matter content in horizon 2Ab of profile P1 (*Tab. 1; Fig. 5*), even though a buried A horizon was also confirmed in archaeological reference profile C–D in the immediate vicinity (*Fig. 1;* see Chapter 2; cf. Fig. 2.8 in this volume). Such a mismatch between colour-identifiable buried soils and organic matter content suggests that mineralisation of coarse organic fractions is ongoing in the horizon, while the organic pigments responsible for its characteristic dark colour (melanisation) remain well preserved.

Profil / Profile	Horizont / Horizon	Globina / Depth		pH (CaCl2)		Pesek / Sand	Melj / Silt	glina / Clay		Ca	Mg	K	Na	CEC		V vrednost / Base saturation	Org. snov / Org. matter	$CaCO_3$		CN
		cm				%				cmol$_c$ kg^{-1}						%				
P1	Ap	0–30		6		10,6	70,5	18,9		8,29	0,94	0,41	0,05	14,56		67	2,3	1,6		8
	2Ab	30–40		5,9		5,8	72,9	21,3		7,02	0,98	0,21	0,05	11,12		74	1,5	1,6		9
	2ABb	40–50		6		12	65,3	22,7		6,05	0,89	0,22	0,02	8,70		83	1,0	1,6		8
	2BAb	50–70		6,1		2,1	74,2	23,7		5,31	0,86	0,08	0,02	6,81		92	0,6	0,8		9
	2Bb*	70–90		6		3,5	72,3	24,2		6,75	1,09	0,87	0,03	10,47		83	0,5	0,8		8
	2Bgb*	90–100		6		12,2	72,4	15,4		14,12	1,75	0,66	0,05	24,73		67	0,3	0,8		7
P2	A1	0–8		6,2		3,9	71	25,1		7,84	1,21	0,32	0,04	12,71		74	5,1	1,2		10
	A2	8–30		6,9		10,1	71,4	18,5		17,29	1,11	0,28	0,05	16,33		100	2,9	1,6		10
	AB	30–40		6,8		6,1	70,9	23,0		8,9	0,61	0,29	0,04	20,66		48	1,3	0,8		10
	B1*	40–60		6,8		5,5	69,9	24,6		7,55	0,46	0,14	0,04	12,29		67	0,9	0,8		8
	B2*	60–77		6,7		5,7	69,6	24,7		7,19	0,44	0,45	0,03	12,60		64	0,7	0,8		8
	B3*	77–97		6,7		7,4	67,4	25,2		7,12	0,40	0,18	0,04	12,29		63	2,1	1,2		24
	B4	97–120		6,7		5,5	68,1	26,4		7,17	0,40	0,31	0,03	13,67		58	0,4	1,6		5
	B5	120–130		6,6		4,9	67,6	27,5		7,74	0,40	0,17	0,03	12,66		66	0,4	1,2		5
P3	A1	0–8		6,7		9,6	65,1	25,3		12,04	2,40	0,33	0,02	20,03		74	3,0	1,7		9
	A2	8–30		5,6		6,6	63,6	29,8		7,39	1,17	0,15	0,02	13,87		63	1,9	1,4		9
	2Ab	30–50		5,5		13,8	59	27,2		6,73	1,16	0,20	0,02	17,59		46	2,1	1,4		8
	2Bb	50–69		5,7		6,4	62,1	31,5		6,15	1,01	0,13	0,02	10,09		73	1	1,2		8
P4	A1	0–10		5,6		10,6	72,8	16,6		9,38	1,82	0,19	0,06	22,81		50	5,3	<0,1		11
	A2	10–30		5,3		7	73,1	19,9		7,45	0,74	0,07	0,06	19,74		42	2,6	<0,1		10
	A3	30–41		5,4		6,2	70,1	23,7		5,97	0,64	0,07	0,04	18,92		35	2,1	<0,1		12
	AB	41–60		5,5		2,50	73,1	24,4		4,51	0,57	0,07	0,03	13,27		39	1,4	<0,1		11
	B	60–71		5,6		0,6	73,9	25,5		4,07	0,64	0,07	0,03	13,96		34	0,7	0,2		10
		71–80		5,6		3,5	70,7	25,8		4,41	0,73	0,08	0,03	12,76		42	0,7	<0,1		10
	Bg	80–100		5,7		3,2	71,6	25,2		4,72	0,80	0,10	0,03	12,94		44	0,5	<0,1		10
		100–120		5,7		10,9	60,9	28,2		5,20	0,94	0,11	0,03	10,91		58	0,3	<0,1		7
P5	A	0–10		5,4		10	72	18		7,09	1,00	0,10	0,04	12,58		65	2,9	0,2		10
		10–20		5,4		10,3	70,1	19,6		7,00	0,86	0,08	0,04	13,89		58	2,2	<0,1		10
	AB	20–40		5,6		2,2	69,6	28,2		5,63	0,74	0,09	0,03	15,25		43	1,4	<0,1		10
	BA	40–55		5,7		3,3	70,9	25,8		5,17	0,71	0,08	0,03	17,41		34	0,7	0,2		10
	Bg1	55–72		5,8		5,8	69,4	24,8		5,28	0,75	0,08	0,03	14,96		41	0,5	<0,1		10
	Bg2	72–85		5,8		3,3	70	26,7		5,96	0,81	0,10	0,03	11,76		59	0,5	<0,1		10
		85–100		5,9		5,0	69,8	25,2		5,55	0,70	0,10	0,03	11,64		55	0,3	0,2		7
	Bg3	100–132		6		3,8	69,5	26,7		5,60	0,68	0,10	0,03	11,54		55	0,5	<0,1		10
P6	A1	0–7		5,5		9,4	73,3	17,3		8,52	1,41	0,15	0,05	23,48		43	5,0	0,2		10
	A2	7–20		5,3		9,4	72,4	18,2		7,06	0,89	0,08	0,03	13,69		59	2,6	<0,1		10
	AB	20–30		5,5		9,9	67,8	22,3		6,44	0,82	0,08	0,03	13,73		54	1,6	0,2		10
	Btg1	30–40		5,7		4,2	67,5	28,3		5,75	0,85	0,08	0,03	14,23		47	0,7	0,2		8
		40–57		5,8		4,6	66,5	28,9		5,49	0,99	0,09	0,03	14,19		47	0,5	<0,1		8
	Btg2	57–64		5,8		6,6	58,4	35		7,22	1,23	0,11	0,03	14,17		61	0,5	<0,1		8
		64–80		6		6,8	54,9	38,3		6,39	1,06	0,1	0,03	14,16		54	0,5	0,4		8
	Btg3	80–109		6		7,3	57,1	35,6		5,91	0,94	0,09	0,03	14,41		49	0,3	0,2		5

← *Tab. 1:* Izbrane fizikalne in kemijske lastnosti tal v profilih P1–P6. Z zvezdico (*) označeni horizonti B v profilih tal P1 in P2 predstavljajo ohranjene spodnje dele polnil grobnih jam. Zaradi poodložitvenih procesov homogenizacije ti na podlagi morfoloških značilnosti in večine analiziranih parametrov izkazujejo predvsem lastnosti, značilne za pedogenetske procese, zato so v tej študiji obravnavani tudi kot talni horizonti.
Tab.1: Selected physical and chemical properties of soils in profiles P1–P6. B horizons marked with an asterisk (*) in soil profiles P1 and P2 represent preserved lower parts of grave pit fills. Due to post-depositional homogenisation processes, these horizons exhibit morphological characteristics and most analysed parameters typical of pedogenetic processes and are therefore also treated as soil horizons in this study.

potrjujejo tudi fragmenti krst in manjši leseni elementi različnih artefaktov, ohranjeni v nekaterih grobovih na najdišču (glej tu, poglavje 3, Katalog).

MIKROMORFOLOŠKA ANALIZA TAL NA NAJDIŠČU

Mikromorfološka analiza 12 zbruskov (*sl. 2*), v katerih so zajeti horizonti tal v zahodnem delu grobišča (profil P4, zbruski PZD 189–PZD 192) ter v dveh kontrolnih profilih P5 in P6 (zbruski PZD 219–PZD 222, PZD 259–PZD 262) (*sl. 1*), kaže, da so na mikroskopski ravni na najdišču in v njegovi okolici najmočneje izraženi znaki, povezani s poljedelstvom, eluvialno-iluvialnimi procesi ter procesi oglejevanja. V manjšem obsegu zaznamo tudi znake koluvialnih procesov.

Debelina humusno akumulativnih A-horizontov (*tab. 2–3 , sl. 2, 6*: a, b; *7*) v profilih tal P4–P6 se giblje od 20 do 40 cm. Prevladujoča mikrostruktura A-horizontov je kanalna, kar pomeni, da v sistemu makropor prevladujejo pore, ki so vezane na delovanje koreninskega sistema in favne tal. V zbruskih jih prepoznamo po cilindrični ali cevasti obliki, gladkih stenah in zaobljenih zaključkih (Stoops 2021, 65; Verecchia, Trombino 2021, 36–37). A-horizont je v vseh treh profilih tal dobro porozen, količina makropor v zbruskih se giblje okrog 15 %. Horizont ima teksturo meljaste ilovice, razmerje med grobo in fino mineralno frakcijo pri meji 20 μm je ali 35 : 65 (PZD 219), ali 30 : 70 (PZD 189, PZD 259), kar pomeni, da je večina gradiva v tleh (65–70 %) manjša od 20 μm. Fina frakcija ima v presevni svetlobi z navzkrižnima polarizatorjema (+ nik) lisasto dvolomno strukturo, ki je povzročena z naključno razporeditvijo enakostraničnih do rahlo podolgovatih domen orientirane gline znotraj fine frakcije. Domene orientirane gline se med seboj ne dotikajo (glej Stoops 2021, 96).

Organska snov v velikostnih frakcijah melja in peska se v A-horizontu pojavlja v treh oblikah: kot razkrojeni ostanki rastlinskih tkiv in organov rdečkastih in rjavih odtenkov z razpoznavno celično strukturo, kot amorfna organska snov rdečkastih in rjavih odtenkov, v kateri posamične celice niso več razpoznavne, ter kot zogleneli rastlinski ostanki črne barve (glej Babel 1975; Stoops 2021, 88–89).

At a depth of 77–97 cm in profile P2, a marked increase in organic matter content (2.1%) was detected, which is associated with the lower fill of Grave 18A (*Tab. 1; Figs. 1–2, 5*). The same layer also exhibited a pronounced increase in the C/N ratio (24), substantially higher than typical values for fields, meadows, and recent or buried A horizons, which usually average around 10 (Brezigar et al. 2020). The high C/N ratio is likely a consequence of the grave having contained wood – possibly a coffin – and the slower decomposition rate of lignin and cellulose (cf. Hejcman et al. 2013, 187). The presence of preserved coffin fragments and smaller artefacts with wooden elements in several graves at the site further supports this interpretation (see Chapter 3, *Catalogue,* in this volume).

MICROMORPHOLOGICAL ANALYSIS OF SOILS AT THE SITE

Micromorphological analysis of 12 thin sections (*Fig. 2*) capturing soil horizons in the western part of the cemetery (P4: PZD 189–PZD 192) and two control soil profiles, P5 and P6 (PZD 219–PZD 222; PZD 259–PZD 262) (*Fig. 1*), shows that the most prominent microscopic features at the site and in its surroundings are associated with agriculture, eluviation-illuviation, and gleying processes. Indicators of colluvial processes are also present, although they are less pronounced.

The humus-accumulative A horizons (*Tabs. 2–3, Figs. 2, 6*: a–b; *7*) in soil profiles P4–P6 range in thickness from 20 to 40 cm. Their dominant microstructure is channel type, characterised by a macropore system in which voids formed by root activity and soil fauna predominate. In thin sections, these pores are identifiable by their cylindrical or tubular shape, smooth walls, and rounded terminations (Stoops 2021, 65; Verecchia, Trombino 2021, 36–37). In all three soil profiles, the A horizon is well-porous, with macropores comprising some 15% of the thin section area. The topsoil has a silty loam texture, with the ratio between the coarse and fine mineral fractions at the 20 μm threshold either 35:65 (PZD 219) or 30:70 (PZD 189, PZD 259), indicating that 65–70% of the material is finer than 20 μm. Under cross-polarised light (XPL), the fine fraction (*i.e.*, b-fabric) exhibits a stipple-speckled birefringent fabric resulting

Tab. 2: Izbrane mikromorfološke lastnosti tal v profilih P4–P6: struktura, fina frakcija in tipi talnih agregatov.

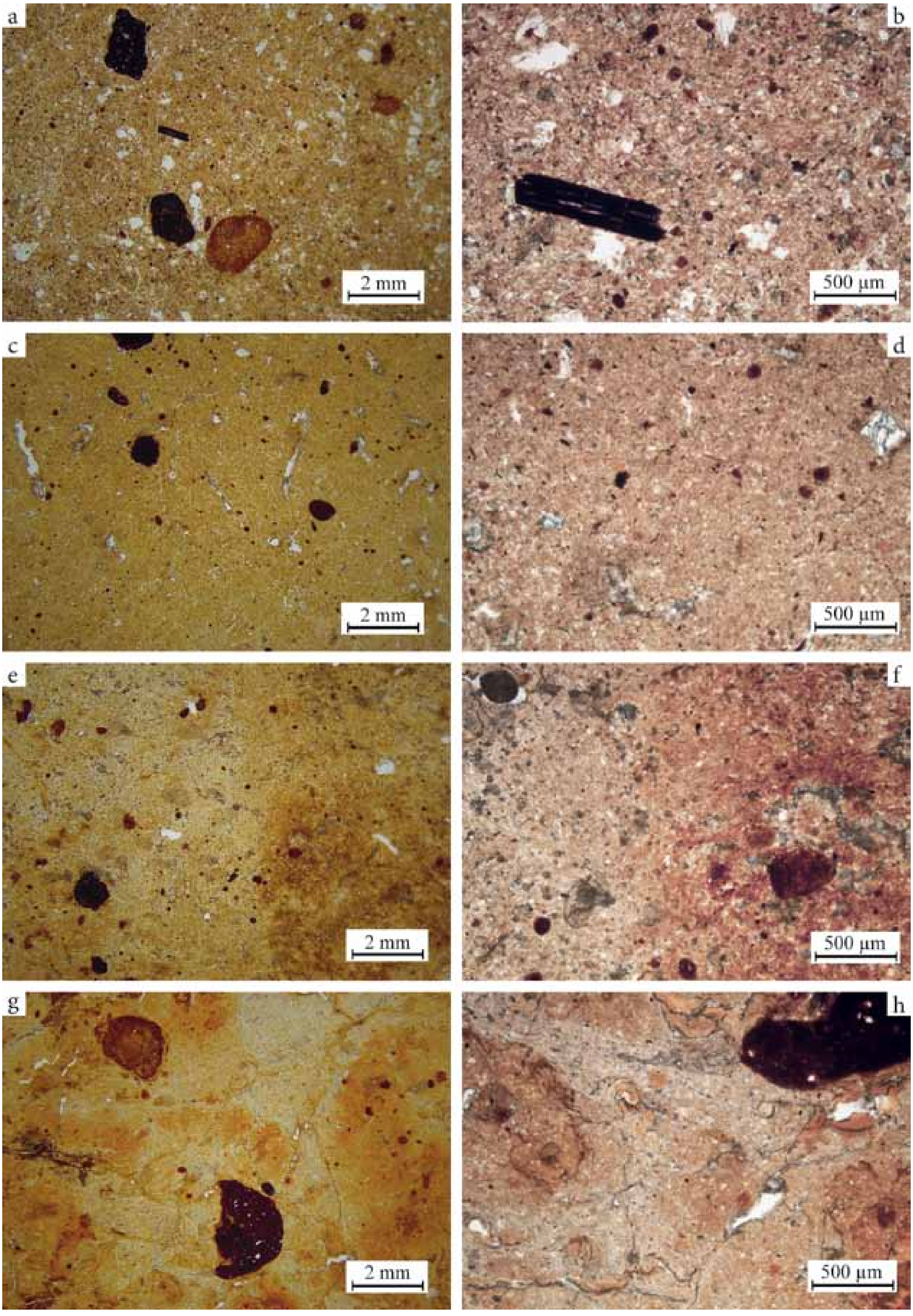
Št. profila / Talni horizont	Mikrom. blok	Tekstura	Struktura		Poroznost	Fina frakcija			Tipi talnih agregatov			
			Mikrostruktura	Razmerje groba : fina frakcija (20 µm)		Barva gradiva (II nik)	Dvolomna struktura (+ nik)	Barva gradiva (poševno vpadajoča svetloba)	Tip 1	Tip 2	Tip 3	Tip 4
Profil 4 A2, A3	PZD 189, 190	org. meljasta ilovica	kanalna	30:70	■■	rdečkasto rumena, močno pikasta	lisasta	močno rjava	■■■■■■	+		+
Profil 4 AB	PZD 190	org. meljasta ilovica	kanalna, lokalno pore nepravilnih oblik	25:75	■■■	rdečkasto rumena, rjavkasto rumena, močno pikasta	lisasta, mozaična	močno rjava, rumenkasto rjava	■■■■■	■■■■		+
Profil 4 B	PZD 191	meljasta ilovica	kanalna	25:75	■■■	rumena, rjavkasto rumena, rahlo pikasta	naključno strijasta	rumenkasto rjava	■	■■■■■■		+
Profil 4 Bg	PZD 192	meljasto glinena ilovica	kanalna, lokalno razpoke	20:80	■■	rumena, rjavkasto rumena, rdečkasto rumena, rahlo pikasta	naključno strijasta	rumenkasto rjava, močno rjava	■		■■■■■■	+
Profil 5 A	PZD 219	org. meljasta ilovica	kanalna	35:65	■■■	rdečkasto rumena, močno pikasta	lisasta	močno rjava	■■■■■■	■	■	
Profil 5 BA	PZD 220	meljasta ilovica	kanalna	25:75	■■■	rumena, rdečkasto rumena, močno pikasta	mozaična, naključno strijasta	rumenkasto rjava, močno rjava	■■■■	■■■■■	■	
Profil 5 Bg1	PZD 221	meljasta ilovica	kanalna, lokalno kamrice	25:75	■■■	rumena, rjavkasto rumena, rahlo pikasta	mozaična, naključno strijasta	rumenkasto rjava	■■	■■■■■■		+
Profil 5 Bg2	PZD 221, 222	meljasta ilovica - meljasto glinena ilovica	poliedrična, prizmatična, lokalno kanali	25:75, 20:80	■■	rumena, rjavkasto rumena, rdečkasto rumena, rumenkasto rdeča, rahlo pikasta	naključno strijasta	rumenkasto rjava, močno rjava, rumenkasto rdeča	■		■■■■■■	+
Profil 6 A2	PZD 259	org. meljasta ilovica	kanalna	30:70	■■■	rdečkasto rumena, močno pikasta	lisasta	močno rjava	■■■■■■		■	+
Profil 6 Btg1	PZD 260, 261	meljasto glinena ilovica	kanalna, lokalno kamrice	25:75	■■■	rumena, rdečkasto rumena, močno pikasta	lisasta	rumenkasto rjava, močno rjava	■■■		■■■■■■	+
Profil 6 Btg2	PZD 261, 262	meljasto glinena ilovica	poliedrična, prizmatična, lokalno kanali	20:80	■■	rumena, rjavkasto rumena, rahlo pikasta	mozaična, naključno strijasta	rumenkasto rjava	■■		■■■■■■	+
Profil 6 Btg3	PZD 262	meljasto glinena ilovica	kanalna, lokalno razpoke	20:80	■■■	rumena, rjavkasto rumena, rdečkasto rumena, rumenkasto rdeča, rahlo pikasta	naključno strijasta, vzporedno strijasta	rumenkasto rjava, močno rjava, temno rdečkasto rjava, rumenkasto rdeča, temno rdečkasto rjava			■■■■■■	

Pogostost (prirejeno po Bullock et al. 1985, 23, 112):
+ v sledovih (<1%); ■ zelo redek (1–5%); ■■ občasen (6-15%); ■■■ mnog/pogost (16–30%); ■■■■ številen (31–50%); ■■■■■ prevladujoč (51–70%); ■■■■■■ zelo prevladujoč (> 71%).

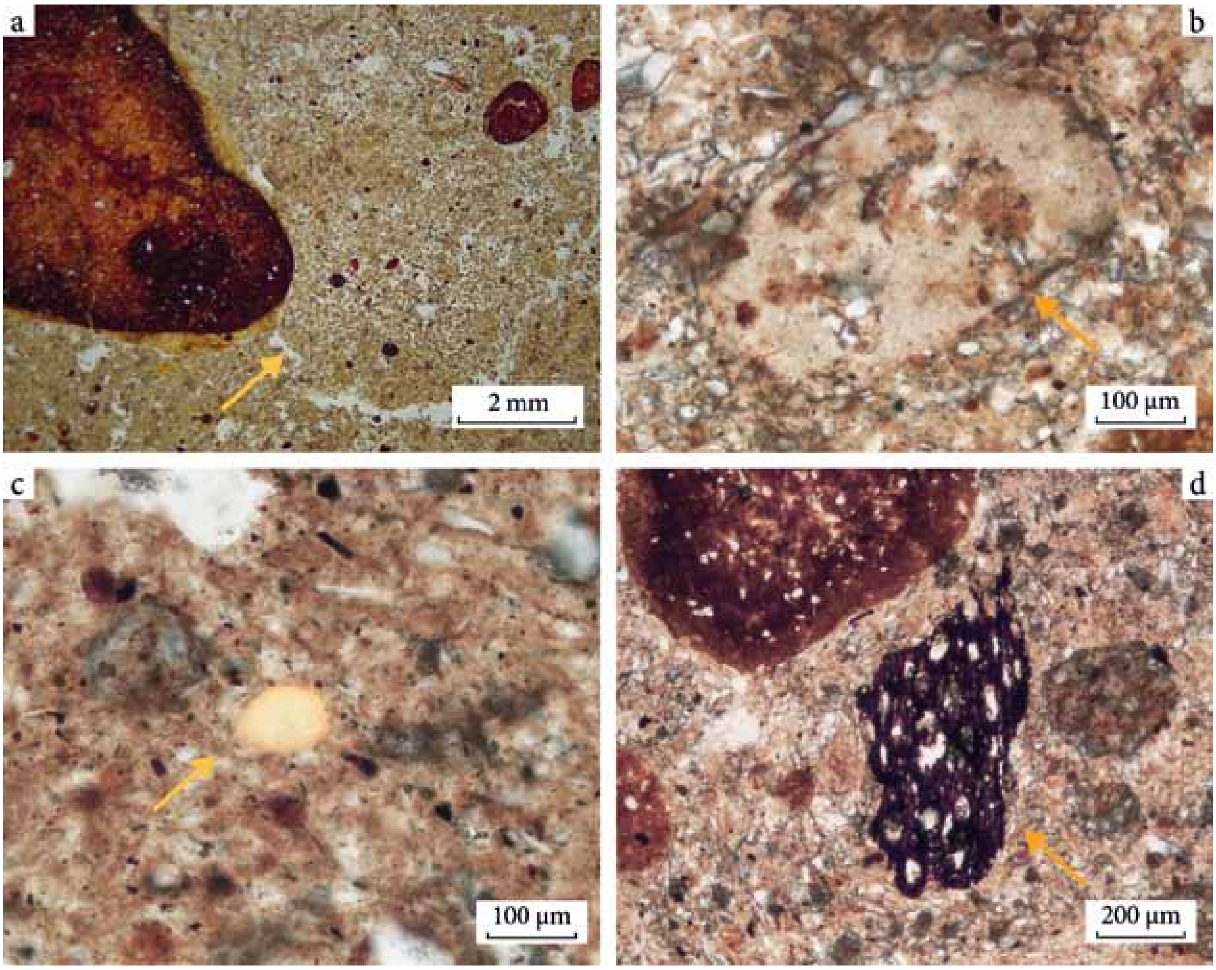
Tab.2: Selected micromorphological properties of soils in profiles P4–P6: structure, fine fraction, and types of soil aggregates.

Profile no. / Soil Horizon	Monolith	Texture	Structure		Porosity	Fine Material			Soil Aggregate Types			
			Microstructure	c:f (20 µm) Ratio		Nature of the material (PPL)	Birefringence fabric (XPL)	OIL	SAT 1	SAT 2	SAT 3	SAT 4
Profile 4 A2, A3	PZD 189, 190	organic silt loam	channel	30:70	■■	reddish yellow, heavily dotted	stipple-speckled	strong brown	■■■■■■	+		+
Profile 4 AB	PZD 190	organic silt loam	channel with local vughy	25:75	■■■	reddish yellow, brownish yellow, heavily dotted	stipple-speckled, mosaic-speckeld	strong brown, yellowish brown	■■■■■	■■■■		+
Profile 4 B	PZD 191	silt loam	channel	25:75	■■■	yellow, brownish yellow, lightly dotted	random-striated	yellowish brown	■	■■■■■■		+
Profile 4 Bg	PZD 192	silty clay loam	channel with local fissure	20:80	■■	yellow, brownish yellow, reddish yellow, lightly dotted	random-striated	yellowish brown, strong brown	■		■■■■■■	+
Profile 5 A	PZD 219	organic silt loam	channel	35:65	■■■	reddish yellow, heavily dotted	stipple-speckled	strong brown	■■■■■■	■	■	
Profile 5 BA	PZD 220	silt loam	channel	25:75	■■■	yellow, reddish yellow, heavily dotted	mosaic-speckled, random-striated	yellowish brown, strong brown	■■■■	■■■■■	■	
Profile 5 Bg1	PZD 221	silt loam	channel with local chamber	25:75	■■■	yellow, brownish yellow, lightly dotted	mosaic-speckled, random-striated	yellowish brown	■■	■■■■■■		+
Profile 5 Bg2	PZD 221, 222	silt loam - silty clay loam	angular blocky to prismatic with channel	25:75, 20:80	■■	yellow, brownish yellow, reddish yellow, yellowish red, lightly dotted	random-striated	yellowish brown, strong brown, yellowish red	■		■■■ ■■■	+
Profile 6 A2	PZD 259	organic silt loam	channel	30:70	■■■	reddish yellow, heavily dotted	stipple-speckled	strong brown	■■■■■■		■	+
Profile 6 Btg1	PZD 260, 261	silty clay loam	channel with local chamber	25:75	■■■	yellow, reddish yellow, heavily dotted	stipple-speckled	yellowish brown, strong brown	■■■		■■■■■■	+
Profile 6 Btg2	PZD 261, 262	silty clay loam	angular blocky to prismatic with channel	20:80	■■	yellow, brownish yellow, lightly dotted	mosaic-speckled, random-striated	yellowish brown	■■		■■■■■■	+
Profile 6 Btg3	PZD 262	silty clay loam	channel with local fissure	20:80	■■■	yellow, brownish yellow, reddish yellow, yellowish red, red, lightly dotted	random-striated, paralell striated	yellowish brown, strong brown, dark reddish brown, yellowish red, dark reddish brown			■■■■■■	

Frequency class refers to % area (following Bullock et al. 1985: 23, 112):
+ trace amount (<1%); ■ very few (1-5%); ■■ few (6-15%); ■■■ frequent (16-30%); ■■■■ common (31-50%); ■■■■■ dominant (51-70%); ■■■■■■ very dominant (> 71%).



→ *Sl. 6/ Fig. 6*



Sl. 7: Mikromorfološke lastnosti humusno kumulativnih A-horizontov na najdišču: (a) mrvičasti agregati (rumena puščica), značilni za površinske horizonte z visoko stopnjo biološke aktivnosti (horizont A2, talni profil P6); (b) fosfatizirana amorfna organska snov (oranžna puščica), vezana na mineralizacijo organske snovi v gnoju (horizont A2, profil tal P6); (c) fosfatna nodula (rumena puščica), vezana na proces gnojenja njivskih površin (horizont A, profil tal P5); (d) dobro ohranjeni večji fragment oglja (oranžna puščica) z ohranjeno celično strukturo (horizont A1, profil tal P4). (a)–(d): II nik.
Fig. 7: Micromorphological features of the humus-accumulative A horizons at the site: (a) crumb aggregates (yellow arrow), typical of surface horizons with high biological activity (horizon A2, soil profile P6); (b) phosphatised amorphous organic matter (orange arrow), linked to the mineralisation of organic matter in manure (horizon A2, soil profile P6); (c) phosphate nodule (yellow arrow), associated with the manuring of arable surfaces (horizon A, soil profile P5); (d) well-preserved large charcoal fragment (orange arrow) with distinct cellular structure (horizon A1, soil profile P4). (a)–(d): PPL.

← *Sl. 6:* Talni horizonti s Pezdirčeve njive pod stereomikroskopom (levi stolpec) in optičnim mikroskopom (desni stolpec): (a, b) horizont A, profil tal P4; (c, d) horizont B, profil tal P4; (e, f) horizont Bg, profil tal P4; (g, h) horizont Btg2, profil tal P6. (a–g): II nik.
Fig. 6: Soil horizons from Pezdirčeva njiva under a stereomicroscope (left column) and a petrographic microscope (right column): (a, b) horizon A, soil profile P4; (c, d) horizon B, soil profile P4; (e, f) horizon Bg, soil profile P4; (g, h) horizon Btg2, soil profile P6. (a–g): PPL.

Št. profila / horizont tal Profile no. / Soil Horizon	Mikrom. blok / Monolith	Organska snov / Organic Matter					Novotvorbe / Pedofeatures				
		Sveže korenine / Fresh Roots	Drobci gnoja / Dung fragments	Amorfna organska snov / Amorphous organic matter	Fragm. rastlin. tkiv / Uncharred Plant Material	Oglje / Charred Plant Material	Prevleke por / Clay Coatings	Fe-Mn nodule / Fe-Mn Nodules	Fe-Mn zabarvanje / Fe-Mn Staining	Fosfatne nodule / Phosphate Nodules	Iztrebki / Excrements
Profil 4 A2, A3	PZD 189, 190	+	+	■	■	■	□	□□□		□	□□
Profil 4 AB	PZD 190	+			+	+	□	□□□	□		□
Profil 4 B	PZD 191				+	+	□□	□□□	□□□□		□
Profil 4 Bg	PZD 192	+	+	■	■	■	□□	□□□		□	□□
Profil 5 A	PZD 219	+		■	■	■	□	□□□			□□
Profil 5 BA	PZD 220	+	+		+	+	□□	□□□	□□		□□
Profil 5 Bg1	PZD 221				+	+	□□	□□□□	□□□□		□□
Profil 5 Bg2	PZD 221, 222	+		■	■	■	□	□□□		□	□□□
Profil 6 A2	PZD 259	+		■	■	■	□	□□□		□	□□
Profil 6 Btg1	PZD 260, 261	+		+	+	+	□□	□□□□	□□		□□
Profil 6 Btg2	PZD 261, 262				+	+	□□□	□□□□	□□□□□		□□
Profil 6 Btg3	PZD 262				+	+	□□□	□□□	□□□□□		□

Pogostost (prirejeno po Bullock et al. 1985, 23, 112): 1 – organska snov: glej legendo v *Tab. 2*; 2 – Novotvorbe:
□ redek (< 2 %); □□ občasen (2–5 %); □□□ mnog/pogost (6–10 %); □□□□ številen (11–20 %); □□□ zelo številen (> 20 %)
Frequency class refers to % area (following Bullock et al. 1985): 1 – Organic matter: see legend in *Tab. 2*; 2 – Pedofeatures:
□ rare (< 2%); □□ occasional (2–5%); □□□ many (6–10%); □□□□ abundant (11–20%); □□□□□ very abundant (> 20%)

Tab. 3: Izbrane mikromorfološke lastnosti tal v profilih P4–P6: organska snov in novotvorbe.
Tab.3: Selected micromorphological properties of soils in profiles P4–P6: organic matter and pedofeatures.

Med naštetimi tipi je v zbruskih najbolje zastopano oglje (*sl. 7:* d), sledijo amorfna organska snov in razkrojeni ostanki rastlinskih tkiv. V profilih P4 (PZD 189) in P5 (PZD 219) so bili prepoznani tudi fosfatizirani agregati amorfne organske snovi (0,15–0,5 mm), ki so v presevni svetlobi z navzkrižnima polarizatorjema (+ nik) izotropni in ki najverjetneje predstavljajo ohranjene drobce gnoja (*tab. 3, sl. 7:* b*; 8*). V vseh treh profilih so v sledovih prisotne tudi fosfatne nodule bledo rumene barve, ki so v presevni svetlobi z navzkrižnima polarizatorjema (+ nik) izotropne (*tab. 3, sl. 7:* c; *8:* e–f). Njihove morfološke lastnosti kažejo, da gre najverjetneje za nodule apatita. V nekaterih primerih je očitno, da so nekatere nastale ob mineralizaciji gnoja (*sl. 8:* e–f).

V A-horizontih so tudi redke prašnate glinene prevleke (< 1 %). Te (*sl. 9:* a) predstavljajo tip teksturnih novotvorb, ki se pojavlja na površini makropor. Pod mikroskopom jih prepoznamo po njihovem "prašnatem" videzu, ki je posledica teksturne heterogenosti prevlek (Deák et al. 2017, 241). Od hidromorfnih novotvorb so prisotne do 6 mm velike nodule Fe/Mn (7 %). Količina organo-mineralnih iztrebkov bradavičastih oblik, ki jih tvorijo deževniki, dosega v zbruskih do 3 %.

Debelina prehodnih AB- in BA-horizontov (*tab. 2–3*) v profilih P4–P6 se giblje od 10 do 35 cm (*sl. 2*). Prevladujoča mikrostruktura je kanalna. Lokalno so prisotne tudi nepodolgovate pore nepravilnih oblik (še zlasti v spodnji polovici PZD 190) in kamrice, za katere je značilno, da povezujejo kanalne in ravninske pore ter predstavljajo največji tip v zbruskih zastopanih por (glej tudi Stoops 2021, 65; Verecchia, Trombino 2021, 36–37). Analizirani horizonti so dobro porozni, količina makropor v zbruskih se giblje od 15 % (PZD 220) do 25 % (PZD 190). Horizonti imajo teksturo meljaste ilovice (PZD 190, 220) do meljasto glinaste ilovice (PZD 260–PZD 261), količina fine frakcije (< 20 µm) v gradivu pa je še večja kot v humusno kumulativnih horizontih in dosega 75 %. Fina frakcija ima v presevni svetlobi z navzkrižnima polarizatorjema (+ nik) lisasto, mozaično ali strijasto dvolomno strukturo. Za mozaično dvolomno strukturo (PZD 190, PZD 220) je značilno, da se domene orientirane gline v fini frakciji dotikajo (Stoops 2021, 96). Pri strijasti dvolomni strukturi (PZD 190, PZD 220) se podolgovate, vsaj 30 µm dolge domene orientirane gline najpogosteje sekajo v naključnem vzorcu (Stoops 2021, 96).

Organska snov v velikostnih frakcijah melja in peska se tudi v prehodnih horizontih pojavlja v treh oblikah: kot razkrojeni ostanki rastlinskih tkiv in organov, kot amorfna organska snov ter kot zogleneli rastlinski ostanki. Med naštetimi tipi organske snovi je najbolje zastopano oglje, sledi amorfna organska snov, razkrojenih ostankov rastlinskih tkiv je primerjalno najmanj. V profilu tal P4 (PZD 190) so bili ugotovljeni tudi posamični drobci gnoja, v profilih P4 (PZD 190) in P6 (PZD 260) so v sledovih prisotne tudi fosfatne nodule.

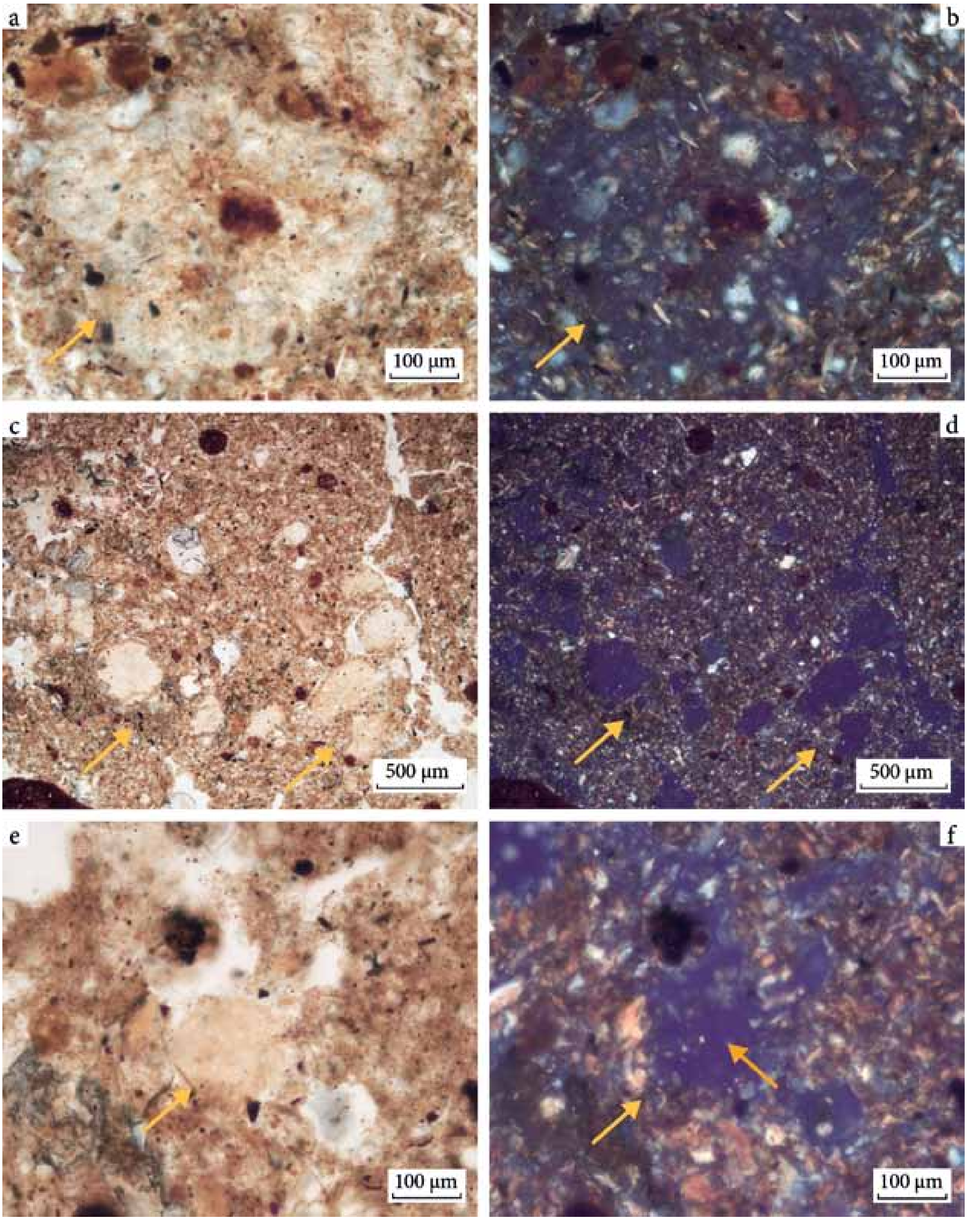
from the random distribution of equidimensional to slightly elongated domains of oriented clay. These domains do not touch one another (see Stoops 2021, 96).

Organic matter in the silt and sand fractions occurs in three forms within the A horizon: (1) as decomposed plant tissues and organs in reddish to brownish colours with recognisable cellular structures; (2) as amorphous organic matter in reddish to brownish colours in which individual cells are no longer discernible; and (3) as black carbonised plant remains (see Babel 1975; Stoops 2021, 88–89).

In the thin sections, charcoal is the most common (*Fig. 7:* d), followed by amorphous organic matter and decomposed plant tissues. In profiles P4 (PZD 189) and P5 (PZD 219), phosphatised aggregates of amorphous organic matter (0.15–0.5 mm) were also identified, which are isotropic under crossed polarisers (XPL) and most likely represent preserved manure aggregates (*Tab. 3, Figs. 7*: b; *8*). In all three profiles, pale yellow phosphate nodules – also isotropic under cross-polarised light – occur in trace amounts (*Tab. 3, Figs. 7*: c; *8:* e–f). Judging by their morphological properties, these are most likely apatite nodules, with some formed during the mineralisation of manure (*Fig. 8: e–f*).

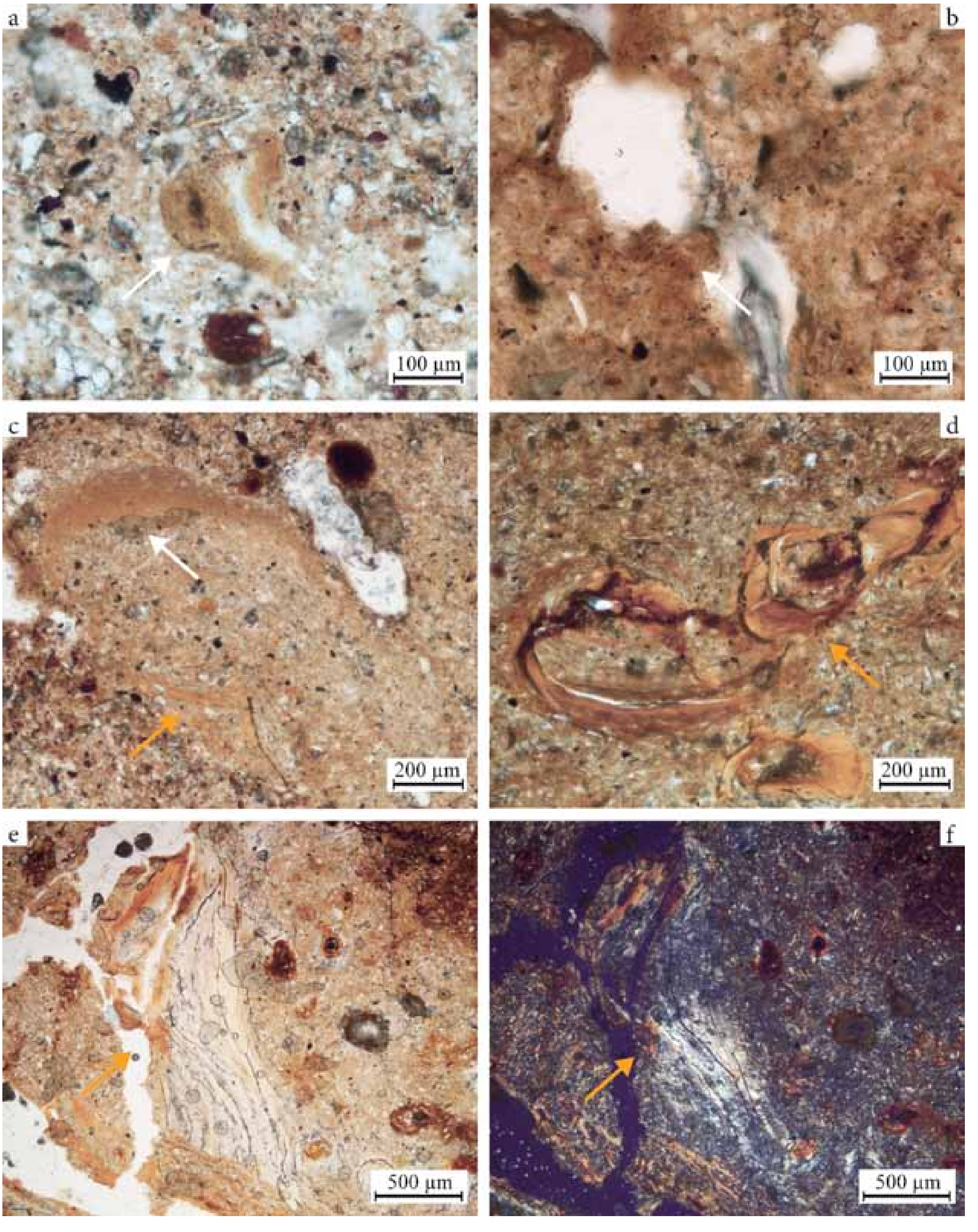
The A horizons also contain rare dusty clay coatings (< 1%). These (*Fig. 9:* a) are a type of textural pedofeature occurring on macropore surfaces. Under the microscope, they are distinguishable by their "dusty" appearance resulting from their textural heterogeneity (Deák et al. 2017, 241). The hydromorphic pedofeatures include Fe-Mn nodules up to 6 mm in size (7%). Organo-mineral, mammillated earthworm faecal pellets make up as much as 3% of the thin sections.

The thickness of transitional AB and BA horizons (*Tabs. 2–3*) in profiles P4–P6 ranges from 10 to 35 cm (*Fig. 2*). Channel microstructure predominates. Vughs of irregular shape occur in places (particularly in the lower half of PZD 190), as do chambers, which characteristically connect large channels with planar voids and represent the largest pore type observed in the thin sections (see also Stoops 2021, 65; Verecchia, Trombino 2021, 36–37). The analysed horizons are well-porous, with macropores making up between 15% (PZD 220) and 25% (PZD 190) of the thin section area. Their texture ranges from silty loam (PZD 190, 220) to silty clay loam (PZD 260–PZD 261), with the proportion of the fine fraction in the material (<20 µm), which reaches 75%, higher than in the humus-accumulative horizons. Under crossed polarisers (XPL), the fine fraction exhibits stipple-speckled, mosaic-speckled, or striated birefringent fabrics. Domains of oriented clay in mosaic-speckled fabric (PZD 190, PZD 220) are typically in contact with one another (Stoops 2021, 96). In striated birefringent fabric (PZD 190, PZD 220), elongated domains of oriented clay of at least 30 µm in length most often intersect in a random pattern (Stoops 2021, 96).



Sl. 8: Fosfatizirana amorfna organska snov (a–d) in fosfatne nodule (e in f), vezane na mineralizacijo organske snovi v gnoju. V nekaterih fosfatnih nodulah (f, oranžna puščica) se pojavljajo posamični sferuliti (tj. sferično oblikovani kalcitni minerali, ki se tvorijo v črevesju drobnice in goveda; glej Canti, Brochier 2017). (a) in (b) horizont A2, profil tal P4; (c) in (d) horizont A2, profil tal P4; (e) in (f) horizont Bg1, profil tal P5. (a), (c) in (e): II nik; (b), (d) in (f): + nik.

Fig. 8: Phosphatised amorphous organic matter (a–d) and phosphate nodules (e, f), associated with the mineralisation of organic matter in manure. In some phosphate nodules (f, orange arrow), individual spherulites are present (i.e., spherically shaped calcite minerals formed in the intestines of sheep/goats and cattle; see Canti, Brochier 2017). (a, b) horizon A2, soil profile P4; (c, d) horizon A2, soil profile P4; (e, f) horizon Bg1, soil profile P5. (a, c, e): PPL; (b, d, f): XPL.



Sl. 9: V tleh na najdišču so znotraj makropor prisotni trije glavni tipi glinenih prevlek: prašnate glinene prevleke, ki so eden najpomembnejših znakov poljedelske rabe tal (a, b, c – bela puščica); čiste glinene prevleke, tvorjene z vertikalnimi procesi izpiranja gline po profilu navzdol (c in d – oranžna puščica); in kompleksne glinene prevleke, ki so nastajale skozi daljše časovno obdobje in ki so morda vezane na večje klimatske spremembe in zato tudi predholocenske procese v tleh (e in f – oranžna puščica; prim. Kühn et al. 2003). (a) horizont A3, profil tal P4; (b) in (c) horizont B, profil tal P4; (d) horizont Bg, profil tal P4; (e) in (f) horizont Btg3, profil tal P6. (a)–(e): II nik; (f): + nik.

Fig. 9: In the soils at the site, three main types of clay coatings are present within macropores: dusty clay coatings, one of the most important indicators of agriculture (a, b, c – white arrow); pure clay coatings, formed by vertical clay eluviation down the profile (c, d – orange arrow); and complex clay coatings, formed over longer periods and possibly linked to major climatic changes, and thus also to pre-Holocene soil processes (e, f – orange arrow; compare Kühn et al. 2003). (a) horizon A3, soil profile P4; (b, c) horizon B, soil profile P4; (d) horizon Bg, soil profile P4; (e, f) horizon Btg3, soil profile P6. (a–e): PPL; (f): XPL.

V prehodnih horizontih je količina prašnatih prevlek v makroporah relativno večja v primerjavi z A-horizonti, pojavljati se začnejo tudi čiste glinene prevleke (*tab. 3, sl. 9*). V nasprotju s prašnatimi je za čiste glinene prevleke značilno, da gre za teksturno homogen tip prevlek, v katerem je odložena le glinena frakcija (Kühn et al. 2010, 224). V zbruskih so tudi številne nodule Fe-Mn (7 %), količina organo-mineralnih iztrebkov bradavičastih oblik dosega do 3 %.

Debelina mineralnih horizontov B, Bg in Btg (*tab. 2–3, sl. 6:* c–g; *9, 10*) v profilih P4–P6 se giblje od 60 do 79 cm. V zgornjih delih mineralnih horizontov prevladuje kanalna mikrostruktura (na primer PZD 191, PZD 221). Lokalno so prisotne tudi kamrice in mikrostruktura razpok (Bullock et al. 1985; Verecchia, Trombino 2021, 38–39), za katero je značilno pojavljanje redkih ravninskih por in kanalov v teksturno finem matriksu, ki nakazujejo začetek tvorjenja poliedričnih agregatov (na primer PZD 192). V spodnjih delih mineralnih horizontov se z višjim deležem gline spremeni tudi mikrostruktura, ki se v najnižje vzorčenih horizontih največkrat giblje med poliedrično in prizmatično. Medtem ko so za poliedrično mikrostrukturo značilni oglati strukturni agregati, so za prizmatično mikrostrukturo značilni po vertikalni osi razpotegnjeni agregati, ki spominjajo na prizme (Stoops 2021, 59; Verecchia, Trombino 2021, 28). Mineralni horizonti so v nekaterih delih slabše porozni kot A- in AB-horizonti, količina makropor se v zbruskih močno razlikuje, in sicer od 10 % (PZD 192) do 25 % (PZD 220, 221). Slabša poroznost vodi do pogostejšega in daljšega zastajanja vode ter zato izrazitejših znakov oglejevanja (*sl. 10:* a, c). Horizonti imajo teksturo meljaste ilovice (PZD 191, 221) do meljasto glinaste ilovice (PZD 192, 222, 261–262), količina fine frakcije (< 20 μm) v gradivu pa je še večja kot v višje ležečih horizontih in se giblje od 75 % (PZD 191, 221) do 80 % (PZD 192, 222, 261–262). Fina frakcija ima v presevni svetlobi z navzkrižnima polarizatorjema (+ nik) mozaično ali strijasto dvolomno strukturo. Pri strijasti dvolomni strukturi (PZD 190, 220) se podolgovate, vsaj 30 μm dolge domene orientirane gline ali sekajo v naključnem vzorcu ali pa so vzporedno orientirane (na primer PZD 262; Stoops 2021, 96–97).

Količina organske snovi v velikostnih frakcijah melja in peska je opazno manjša kot v humusno akumulativnih in prehodnih horizontih. Pojavlja se le še v sledovih; še vedno so najštevilčnejši zogleneli rastlinski ostanki. V profilu tal P5 (PZD 221) so bili prepoznani tudi posamični drobci gnoja (*tab. 3, sl. 8:* f). Fosfatne nodule niso bile zaznane.

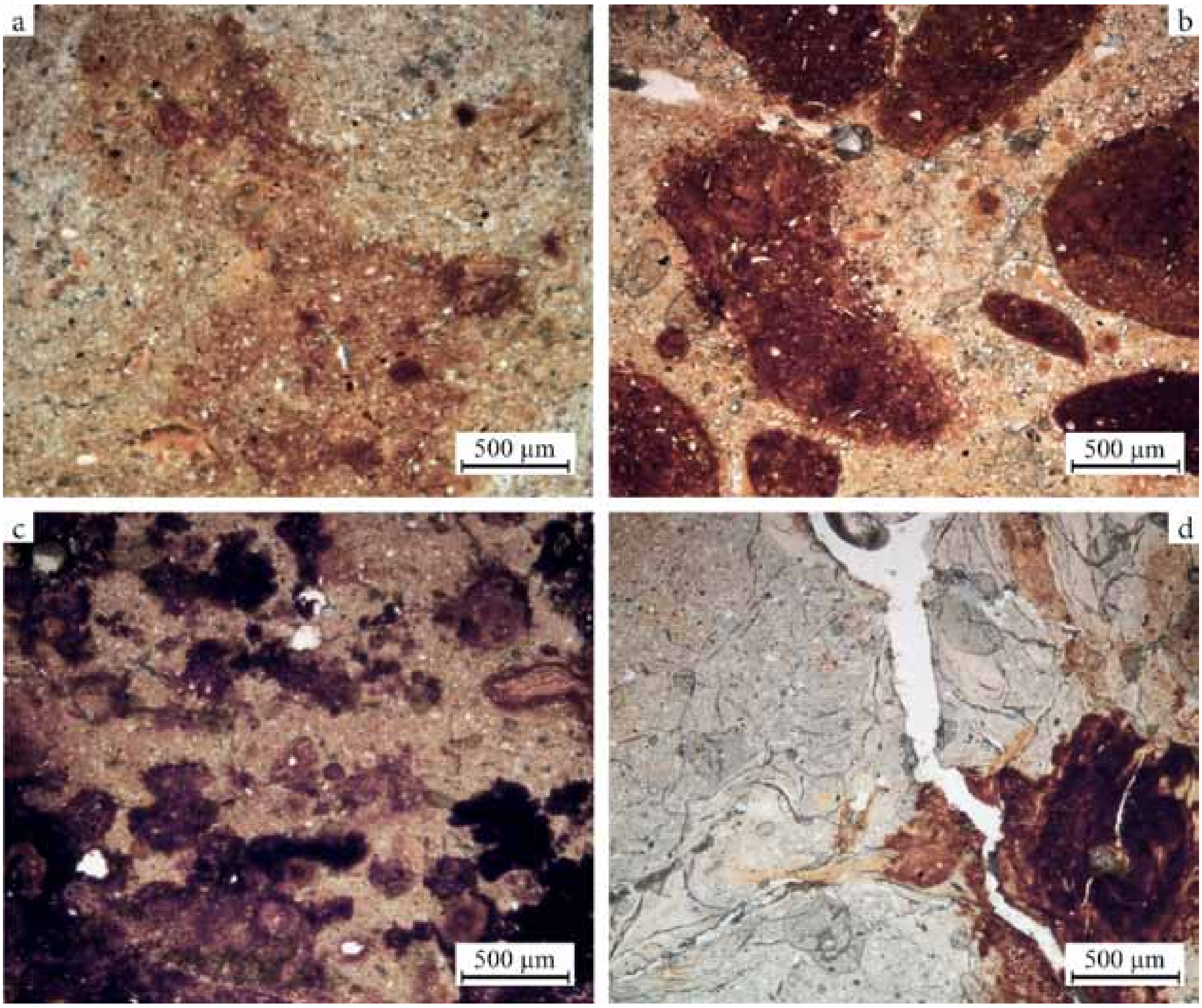
V mineralnih horizontih se z globino veča količina čistih glinenih prevlek, medtem ko količina prašnatih prevlek upada. Prisotne se tudi kompleksne glinene prevleke, za katere sta značilna plastenje in nastanek serije več tanjših lamin ali debelejših prevlek znotraj makropor (*sl. 9:* b–f; glej tudi Stoops 2021, 109). Medtem

Silt- and sand-sized organic matter also occurs in three forms within the transitional horizons: decomposed remains of plant tissues and organs, amorphous organic matter, and carbonised plant remains. Among the three types, charcoal is the most frequent, followed by amorphous organic matter, while decomposed remains of plant tissue are relatively scarce. Soil profile P4 (PZD 190) also turned up individual manure fragments, while profiles P4 (PZD 190) and P6 (PZD 260) also contained traces of phosphate nodules.

Compared to the A horizons, the quantity of dusty clay coatings in the transitional horizons is slightly higher and includes incipient occurrences of pure clay coatings (*Tab. 3; Fig. 9*). In contrast to dusty coatings, pure clay coatings are texturally homogeneous and composed solely of clay fraction (Kühn et al. 2010, 224). The thin sections also contain numerous Fe-Mn nodules (7%), while organo-mineral, mammillated earthworm faecal pellets account for up to 3%.

The thickness of mineral B, Bg, and Btg horizons (*Tabs. 2–3, Figs. 6:* c–g; *9, 10*) in profiles P4–P6 varies between 60 and 79 cm. The upper parts of the mineral horizons are dominated by channel microstructure (e.g. PZD 191, PZD 221). Sporadically, chambers appear as does crack microstructure (Bullock et al. 1985; Verecchia, Trombino 2021, 38–39), characterised by rare planar pores and channels in a fine-textured matrix, indicating the onset of polyhedral aggregate formation (e.g. PZD 192). In the lower parts of mineral horizons, increased clay content also alters microstructure. In the lowest sampled horizons, the latter most often shifts between blocky and prismatic. While blocky microstructure is characterised by angular structural aggregates, prismatic microstructure consists of vertically protracted prism-like aggregates (Stoops 2021, 59; Verecchia, Trombino 2021, 28). In places, mineral horizons are less porous than horizons A and AB; macropore content in thin section ranges widely from 10% (PZD 192) to 25% (PZD 220, 221). Lesser porosity leads to more frequent and longer-lasting water retention and thereby to more pronounced signs of gleying. (*Fig. 10:* a, c). The horizon textures range from silty loam (PZD 191, 221) to silty clay loam (PZD 192, 222, 261–262) with fine fraction quantities (< 20 μm) ranging from 75% (PZD 191, 221) to 80% (PZD 192, 222, 261–262), values that are even higher than those in the overlying horizons. Under crossed polarised light (XPL), the fine fraction shows a mosaic or striated birefringent fabric. In the case of striated birefringent fabric (PZD 190, 220), elongated, at least 30 μm-long domains of oriented clay intersect in a random pattern or are oriented parallel to each other (e.g. PZD 262; Stoops 2021, 96–97).

Compared to the humus-accumulative and transitional horizons, the quantity of organic matter in the silt- and sand-sized fractions is markedly lower and occurs only in trace amounts; however, charred plant residues remain the most abundant. Soil profile P5 (PZD



Sl. 10: Na videz horizonta Btg močno vplivajo eluvialno-iluvialni in oksidacijsko-redukcijski procesi, ki v horizontih s težjo teksturo in slabšo prepustnostjo vodijo do nastanka: (a) zabarvanja talnega matriksa z železovimi in manganovimi (hidr)oksidi; (b) in (c) razvoja železovih in manganovih (hidr)oksidnih nodul v naslednjem koraku; ter (d) razbarvanja talnega matriksa, kjer prevladujejo redukcijske razmere (a), (c) in (d): horizont Btg3, profil tal P6; (b): horizont Btg2, profil tal P6. (a)–(d): II nik.
Fig. 10: The appearance of the Btg horizon is strongly influenced by eluviation-illuviation and oxidation-reduction processes, which, in horizons with heavier texture and reduced water permeability, result in: (a) soil matrix staining with Fe-Mn oxides; (b, c) the subsequent development of Fe–Mn (hydr)oxide nodules; and (d) soil matrix bleaching under prevailing reducing conditions. (a, c, d) horizon Btg3, soil profile P6; (b) horizon Btg2, soil profile P6. (a–d): PPL.

ko je količina organomineralnih iztrebkov v mineralnih horizontih v primerjavi s humusno akumulativnimi in prehodnimi horizonti primerjalno najmanjša, pa je količina novotvorb Fe-Mn največja. Poleg nodul Fe-Mn je v horizontih zaznati tudi skorje Fe-Mn in zabarvanje matriksa s Fe-Mn (hidr)oksidi (*sl. 10:* a–c).

V mikromorfoloških vzorcih so bili na podlagi barve v presevni svetlobi pri vzporednih nikolih (II nik) in v poševno lomljeni svetlobi ter tudi na podlagi teksture dvolomne strukture fine frakcije ter količine organske snovi in novotvorb Fe-Mn dokumentirani štirje tipi agregatov tal, ki se pojavljajo zunaj matičnih horizontov (*tab. 1, sl. 11*). Agregati tipa 1, ki jih tvori zemljina

221) contained individual dung fragments (*Tab. 3; Fig. 8:* f). Phosphate nodules were not detected.

In mineral horizons, the quantity of pure clay coating increases with depth, while the quantity of dusty coatings decreases. Complex clay coatings also appear, featuring characteristic layering and formation of several thinner laminations or thicker coatings within macropores (*Fig. 9:* b–f; see also Stoops, 2021, 109). While the mineral horizons contain fewer organo-mineral faecal pellets than the humus-accumulative and transitional horizons, they exhibit the highest abundance of Fe-Mn pedofeatures. In addition to Fe-Mn nodules, these horizons also feature

A-horizontov, so rdečkasto rumeni v presevni svetlobi pri vzporednih nikolih (II nik), močno rjavi v poševno lomljeni svetlobi ter močno pikasti zaradi organskega materiala in nodul Fe-Mn v fini frakciji (< 20 μm).

Agregati tipa 2, ki jih tvori zemljina B-horizontov, so rumeni do rjavkasto rumeni v presevni svetlobi pri vzporednih nikolih (II nik), rumenkasto rjavi v poševno lomljeni svetlobi ter rahlo pikasti zaradi organskega materiala in nodul Fe-Mn v fini frakciji (< 20 μm) (*sl. 11:* b).

Agregati tipa 3, ki jih tvori zemljina z glino bogatih Bg- in Btg-horizontov, so barvno najbolj heterogeni. Lahko so rumeni, rjavkasto rumeni, rdečkasto rumeni ali rumenkasto rdeči v presevni svetlobi pri vzporednih nikolih (II nik), rumenkasto rjavi, močno rjavi ali rumenkasto rdeči v poševno lomljeni svetlobi ter rahlo pikasti zaradi organskega materiala in nodul Fe-Mn v fini frakciji (< 20 μm) (*sl. 11:* c–d).

Agregati tipa 4 so rumeni v presevni svetlobi pri vzporednih nikolih (II nik) in rumenkasto rjavi v poševno lomljeni svetlobi. Organski material in nodule Fe-Mn v fini frakciji (< 20 μm) so v teh agregatih prisotni le v sledovih, zanje pa je značilna višja koncentracija gline, kot jo zasledimo v *in situ* horizontih tal, zato bi morda lahko predstavljali koluvialni doprinos zemljine, ki izvira s Kučarja (*sl. 11:* a, e–f).

RAZPRAVA

GEOARHEOLOŠKI ZNAKI GOMIL NA PEZDIRČEVI NJIVI

Ker na Pezdirčevi njivi gomile niso bile topografsko dokumentirane, smo njihov morebitni obstoj preverjali z geoarheološkimi analizami. Osredotočili smo se na prepoznavanje specifičnih fizikalno-kemijskih in mikromorfoloških parametrov, ki bi lahko pričali o prisotnosti bolj ali manj uničenih gomilnih plaščev ter ohranjenih pokopanih tal pod gomilami.

Pri terenskem opisu morfoloških lastnosti posameznih horizontov tal na štirih lokacijah znotraj grobišča (profili tal P1–P4) so bila pokopana tla (2Ab) dokumentirana v profilih tal P1 in P3 (*sl. 1–2*). V P1 leži 2Ab nad viniškim grobom 50 v severnem delu najdišča, v P3 pa pod domnevno razorano mlajšehalštatskodobno gomilo v vzhodnem delu grobišča (*sl. 1–2*). Izbrane pedološke lastnosti obeh horizontov, še zlasti njuna debelina, pH, delež gline in organske snovi (*tab. 1, sl. 2, 5*), kažejo razlike med plastema, kar bi lahko odražalo – enako kot njuna relativna starost – razliko v njunem nastanku.[4]

Morfološke lastnosti posameznih horizontov tal na treh lokacijah na območju domnevnih gomil (profili tal P2–P4) niso pokazale sledov gomilnih plaščev v pedostratigrafski sekvenci (*sl. 1–2*). Laboratorijska analiza pe-

[4] O tej problematiki podrobneje razpravljamo v poglavju 10.2 (glej poglavje 10.2, sl. 2 in 3).

Fe-Mn crusts and matrix staining with Fe-Mn (hydr) oxides (*Fig. 10:* a–c).

In the micromorphological samples, four types of soil aggregates occur outside their parent horizons. They were identified based on their colour in transmitted light under plane-polarised light (PPL) and obliquely incident light, as well as on their texture, the birefringent fabric of the fine fraction, and the amount of organic matter and Fe-Mn pedofeatures present (*Tab. 1; Fig. 11*).

Type 1 aggregates, consisting of material from the A horizon, appear reddish-yellow in plane polarised light (PPL), dark brown in obliquely incident light (OIL), and strongly speckled due to organic material and Fe-Mn nodules in the fine fraction (< 20 μm).

Type 2 aggregates, composed of material from the B horizon, appear yellow to yellowish-brown in plane polarised light (PPL), yellowish-brown in obliquely incident light (OIL), and are slightly speckled due to organic material and Fe-Mn nodules in the fine fraction (< 20 μm) (*Fig. 11*: b).

Type 3 aggregates, consisting of clay-rich material from the Bg and Btg horizons, are the most heterogeneous in colour. Under plane-polarised light (PPL), they range from yellow and yellowish-brown to reddish-yellow and yellowish-red; under obliquely incident light (OIL), they appear yellowish-brown, dark brown, or yellowish-red, and are slightly speckled due to the presence of organic material and Fe-Mn nodules in the fine fraction (< 20 μm) (*Fig. 11:* c–d).

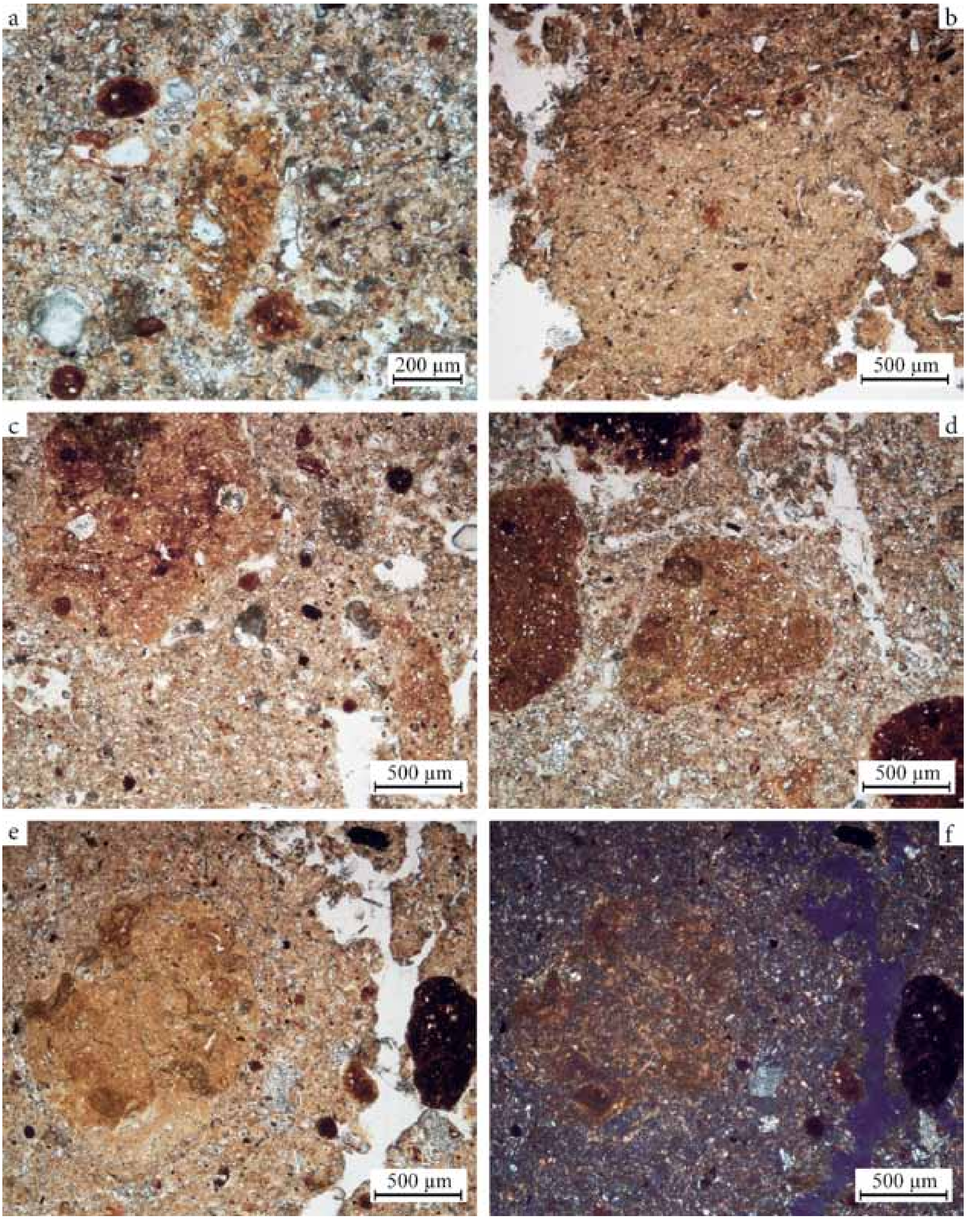
Type 4 aggregates are yellow in plane polarised light (PPL) and yellowish-brown in obliquely incident light (OIL). Organic material and Fe–Mn nodules in the fine fraction (< 20 μm) occur only in trace amounts, while the clay content is higher than that of the *in situ* soil horizons. They may therefore represent a colluvial input originating from Kučar (*Fig. 11*: a, e–f).

DISCUSSION

GEOARCHAEOLOGICAL INDICATORS OF BARROWS AT PEZDIRČEVA NJIVA

Since barrows at Pezdirčeva njiva were not documented topographically, we investigated their potential existence through geoarchaeological analyses. Our focus was on identifying specific physico-chemical and micromorphological parameters that could indicate the presence of mound fills in various states of destruction, as well as the existence of buried soils beneath them.

Morphological properties of soil horizons at four locations within the cemetery (soil profiles P1–P4) suggested buried soils (2Ab) in profiles P1 and P3 (*Figs. 1–2*). In profile P1, horizon 2Ab is located above the Vinica-type Grave 50 in the northern part of the site, while in profile P3, it occurs beneath a presumably ploughed-out Late



Sl. 11: Različni tipi talnih agregatov se zaradi bioturbacije, oranja in koluvialnih procesov pojavljajo zunaj matičnih horizontov: (a) agregat tipa 4 v horizontu A2 (profil tal P4); (b) agregat tipa 2 v horizontu A3 (profil tal P4); (c) in (d) agregati tipa 3 v horizontu A2 (profil tal P6); (e) in (f) agregati tipa 4 v horizontu Btg1 (profil tal P6). (a)–(e): II nik; (f): + nik.
Fig. 11: Different types of soil aggregates occur outside their parent horizons due to bioturbation, ploughing, and colluvial processes: (a) Type 4 aggregate in horizon A2, profile P4; (b) Type 2 aggregate in horizon A3, profile P4; (c, d) Type 3 aggregates in horizon A2, profile P6; (e, f) Type 4 aggregates in horizon Btg1, profile P6. (a–e): PPL; (f): XPL.

doloških parametrov v profilih P1–P6 pa kaže nekatera odstopanja, ki bi lahko bila dokaz nekdanje prisotnosti nasutih gomil in hkrati znak intenzivnih antropogenih procesov, ki bi lahko postopno vodili do popolnega uničenja gomilnih plaščev. Spreminjanje vsebnosti gline z globino v P2 in P3, ki sta bila kot edina med vzorčenimi profili tal locirana znotraj domnevnih gomil (*sl. 1*), namreč ne sledi naravnim trendom, dokumentiranim v preostalih profilih (P1, P4–P6). Za slednje sta značilna nižji delež gline v zgornjih horizontih (< 20 %) ter postopno naraščanje vsebnosti gline z globino kot posledica iluvialnih procesov. Dober primer takega trenda vidimo v kontrolnem profilu P6, približno 20 m proč od zahodnega roba grobišča, v katerem se procesi izpiranja kažejo v zveznem naraščanju vsebnosti gline z globino od 17,3 % v horizontu A1 do 38,3 % v horizontu Btg2 (*tab. 1, sl. 5*).

Na lokaciji P2, ki leži znotraj domnevne gomile v osrednjem delu grobišča (*sl. 1*), je po drugi strani vsebnost gline v zgornjem horizontu A1 višja (25,1 %) kot v pod njim ležečem A2-horizontu (18,5 %), kar bi lahko pojasnili z ostankom razoranega gomilnega plašča. Zaradi povišane vsebnosti gline bi morda lahko sklepali, da je bil plašč gomile nasut iz lokalnih, z glino bogatejših mineralnih zemljin B-horizontov in da se je zaradi dolgotrajne poljedelske rabe ohranil le še kot teksturni signal v površinskem horizontu (*tab. 1, sl. 5*; glej tudi Prijatelj et al. (*v pripravi*)).

V profilu P3, ki leži znotraj gomile v vzhodnem delu grobišča (*sl. 1*), sta z glino obogateni obe humusno akumulativni plasti A1 in A2. Ker v nasprotju s P2 preideta v mineralne horizonte brez vmesne plasti z manjšim deležem gline (< 20 %), bi jih lahko pojasnili z – v tem primeru – debelejšim in/ali bolj v globino primešanim ostankom gomilnega plašča, kar se je odrazilo v doprinosu glinene frakcije znotraj obeh humusno akumulativnih horizontov (*tab. 1, sl. 5*).

Razlika v debelini z mineralnim gradivom obogatenih površinskih horizontov, kakršna je bila zaznana pri profilih tal P2 in P3, bi lahko bila pogojena z različnimi parametri. Uporabljeni gradbeni material, položaj v gomili, način oranja, dolžina poljedelske rabe, koluvialni doprinos in tudi interakcije naštetih dejavnikov bi lahko vsi potencialno vplivali na to, v kolikšnem obsegu teksturna razlika v A-horizontu ali več A-horizontih dejansko odraža signal razoranega gomilnega plašča. Naj ponazorimo z nekaj hipotetičnimi primeri. Ob nasutju je plašč najdebelejši v središču gomile, proti obodu pa se tanjša. Oranje premešča gradivo plašča lateralno, zaradi česar je v trenutku, ko je gomila popolnoma erodirana s površja, večja količina gradiva premaknjena na obod (*sl. 12*). Tam, kjer je ostanek razoranega plašča debelejši, se bo teksturni signal predvidoma ohranil dlje. Dolžina poljedelske rabe prav tako vpliva na moč teksturnega signala: dlje ko se orje, bolj se razorani plašč horizontalno raznaša po njivski površini v smeri oranja. S tem seveda

Hallstatt mound in the eastern part of the cemetery (*Figs. 1–2*). Select characteristics of both horizons – particularly their thickness, pH, clay content, and organic matter content (*Tab. 1; Figs. 2, 5*) – indicate certain differences between the two layers which, like their relative age, may reflect a difference in their formation.[4]

Morphological properties of individual soil horizons at three locations within the putative mound areas (soil profiles P2–P4) revealed no traces of mound fills in the pedostratigraphic sequence (*Figs. 1–2*). However, laboratory analyses of soil parameters in profiles P1–P6 indicate certain anomalies that could be interpreted as evidence of former constructed mounds, as well as signs of intensive anthropogenic processes that may have gradually led to the complete destruction of the mound fills. The depth-relative changes in clay content in profiles P2 and P3 – the only two soil profiles sampled within the putative mound areas (*Fig. 1*) – do not follow the natural trends documented in the other profiles (P1, P4–P6). The latter typically exhibit lower clay content in the upper horizons (< 20%), which then gradually increases with depth as a result of illuvial processes. A clear example of this trend is seen in control profile P6, located approximately 20 m from the western edge of the cemetery, where leaching processes are evident in the continuous increase in clay content from 17.3% in horizon A1 to 38.3% in horizon Btg2 (*Tab. 1; Fig. 5*).

In contrast, in profile P2, located within the putative mound area in the central part of the cemetery (*Fig. 1*), clay content in the upper horizon A1 is higher (25.1%) than in the underlying horizon A2 (18.5%), which could be interpreted as the remnant of a ploughed-down mound fill. The elevated clay content suggests that the mound was composed of locally sourced, clay-rich mineral soil material derived from B horizons and, following prolonged agricultural use, has been preserved only as a textural signal in the surface horizon (*Tab. 1; Fig. 5*; see also Prijatelj et al. (*in preparation*)).

In profile P3, located within the putative mound area in the eastern part of the cemetery (*Fig. 1*), both humus-accumulative horizons A1 and A2 are rich in clay. Since, unlike in profile P2, they transition directly into mineral horizons without an intermediate layer with lower clay content (< 20%), this could be explained by a thicker and/or more deeply mixed remainder of the mound fill in this area, which resulted in an increased input of clay fraction into both humus-accumulative horizons (*Tab. 1; Fig. 5*).

The difference in the thickness of mineral-enriched surface horizons observed in soil profiles P2 and P3 may have depended on several factors. The type of construction material used, the position within the original mound, ploughing methods, the duration of agricultural use, colluvial input, as well as interactions among these variables could all have influenced the extent to which

[4] For a more detailed discussion of this issue, see Chapter 10.2, Figs. 2 and 3.

teksturni signal slabi. V primeru razorane gomile na prostoru s koluvialnim doprinosom bo po drugi strani teksturni signal intenzivnejši, vendar ne bo vezan le na namensko nasuti gomilni plašč, ampak bo hkrati odražal tudi naravni sedimentacijski doprinos.

Koluvialni doprinos na najdišču je mogoče podrobneje opredeliti z geomorfološkim modelom petih elementov pobočja (*sl. 13*) ter s podatki o pH, karbonatih, nasičenosti sorptivnega dela tal z bazičnimi kationi (V-vrednost) in mikromorfološkimi lastnostmi tal (*tab. 1–3, sl. 5, 11:* a, e–f).

Kučar (222 m n. v.) je s približno 100 m višinske razlike razmeroma nizek hrib (*sl. 13:* a–b). Medtem ko pobočja na vzhodni strani dosegajo naklone do 30°, pa je zahodno pobočje nad grobiščem z nakloni, ki zvezno naraščajo od 5° do 20°, najprej dokaj blago, nakar brez brez izrazitih prelomov postopoma preide iz zmerno strmega v strm hrbet (*sl. 13:* a). Analiza petih elementov pobočja (*sl. 12:* c) kaže, da prostor grobišča lahko opredelimo kot iztek Kučarjevega hrbta. Zaradi blagih naklonov od 2° do 4° lahko ta prostor že obravnavamo kot depozicijsko površino, na kateri lahko pričakujemo bogatitev tal s sedimentnim gradivom in materialom iz vodne raztopine ali suspenzije (prim. Schaetzl, Anderson 2005, 482–483; Wysocki et al. 2011, 977–978, 980–983; Schaetzl 2013, 149; Miller, Schaetzl 2015, 139; Marques et al. 2018, 7).

Vpliv površinskih in podpovršinskih voda, ki se lateralno premikajo po pobočju Kučarja navzdol, je bil zaznan v profilih tal P1–P3, ki so imeli v primerjavi s P4–P6 povišane vrednosti pH, karbonatov in bazičnih kationov (*tab. 1, sl. 5*). Opisani trend bogatenja horizontov tal s karbonati in bazičnimi kationi ter posledično višjim pH je izrazit zlasti v vzhodnem in osrednjem delu najdišča, ne pa tudi v zahodnem.

V profilih P4–P6 so bili pod mikroskopom prepoznani agregati tipa 4 (*sl. 11:* a, e–f), ki jih ne moremo vzporejati z nobenim od na lokacijah izpričanih horizontov tal. Zanje je značilna višja koncentracija gline, ki je tudi mikromorfološko drugačna od gline, dokumentirane znotraj tal na najdišču: medtem ko je prva izjemno čista in intenzivno rumene barve, je druga bolj rdečkasta in pogosto zabarvana s Fe-Mn (hidr) oksidi (*tab. 2, sl. 10–11*). Ker so agregati tipa 4 prisotni v vseh treh horizontih tal (A, AB in B), sklepamo, da bi lahko omenjeno gradivo bilo indic konstantnega, nizkoenergijskega koluvialnega doprinosa drugačnega tipa zemljine s Kučarja (glej tudi poglavje 10.2; sl. 2–3).

Ob upoštevanju tukaj opisanih geomorfnih procesov si znova oglejmo z mineralnim gradivom obogatene površinske horizonte v profilih tal P2 in P3. Kombinacija geomorfološke lokacije (*sl. 13*), mikromorfoloških znakov (*sl. 11;* a, e–f) ter znakov bogatitve tal s površinskimi in podpovršinskimi vodami s Kučarja (*tab. 1, sl. 5*) kaže, da koluvialni doprinos predstavlja naravno sedimentacijsko ozadje, značilno za celoten prostor naj-

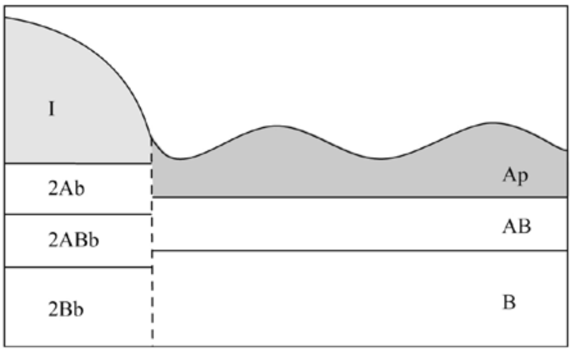
textural differences within one or more A horizons reflect a ploughed-down mound fill. This can be illustrated with the following hypothetical scenarios: when a barrow is first constructed, its fill is thickest at the centre and gradually thins toward the outer edge. Ploughing displaces fill material laterally, so by the time the barrow is completely eroded from the surface, much of this material has been redistributed toward the periphery (*Fig. 12*). Where the remaining fill is thicker, its textural signal is expected to persist for a longer period. The strength of this signal is also influenced by the duration of agricultural use: the longer ploughing continues, the more extensively the barrow material is redistributed horizontally across the field in the direction of ploughing, which consequently weakens the textural signal. Conversely, a ploughed mound in an area subject to colluvial input will leave a more pronounced textural signal – one that, however, does not exclusively derive from the intentionally constructed mound but also reflects natural sedimentary contributions.

Colluvial input at the site can be assessed more precisely using the geomorphological five-slope-element model (*Fig. 13*), in combination with data on pH, carbonate content, base saturation of the adsorptive complex (V value), and the micromorphological properties of the soils (*Tabs. 1–3; Figs. 5, 11: a, e–f*).

Kučar (222 m a.s.l.) is a relatively low hill with an elevation difference of approximately 100 m (*Fig. 13:* a–b). While the slopes on the eastern side reach inclinations of up to 30°, the western backslope above the burial ground, with gradients gradually increasing from 5° to 20°, is at first rather gentle and then, without any distinct breaks, gradually transitions from moderately steep to steep terrain (*Fig. 13:* a). Analysis of the five slope elements (*Fig. 12:* c) shows that the area of the burial ground can be defined as the terminus of Kučar's backslope. Due to the gentle inclinations of 2° to 4°, this area can already be regarded as a depositional surface, where soil enrichment with sedimentary material and substances transported in solution or suspension may be expected (cf. Schaetzl, Anderson 2005, 482–483; Wysocki et al. 2011, 977–978, 980–983; Schaetzl 2013, 149; Miller, Schaetzl 2015, 139; Marques et al. 2018, 7).

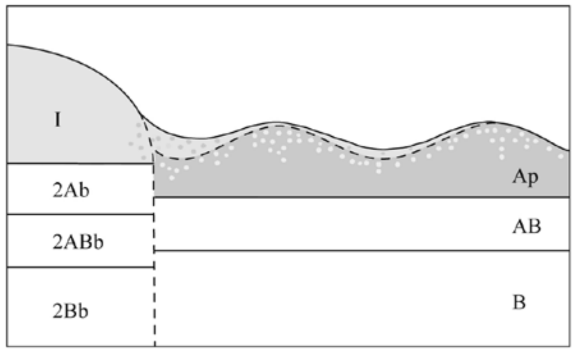
The influence of surface and subsurface waters moving laterally downslope from Kučar was detected in soil profiles P1–P3, which exhibit elevated pH, carbonate content, and base cation values compared to profiles P4–P6 (*Tab. 1; Fig. 5*). This trend – characterised by soil horizons enriched with carbonates and base cations and, consequently, higher pH values – is particularly pronounced in the eastern and central parts of the site, but not in the western part.

Type 4 aggregates (*Fig. 11*: a, e–f) identified in profiles P4–P6 cannot be associated with any of the soil horizons present at the site. They are characterised by a higher clay content that is micromorphologically distinct

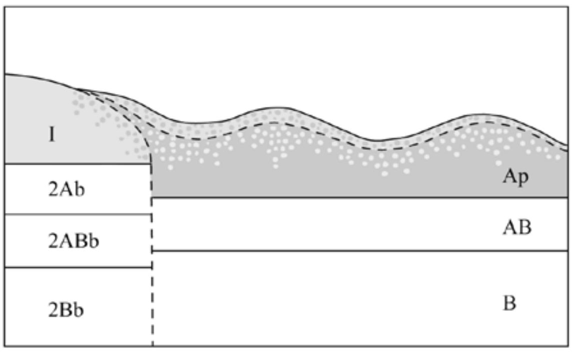


F3.1.1/ Ph3.1.1**
Pojav poljedelskih površin na območju z gomilami. /
Presence of agricultural fields in the area with burial mounds.

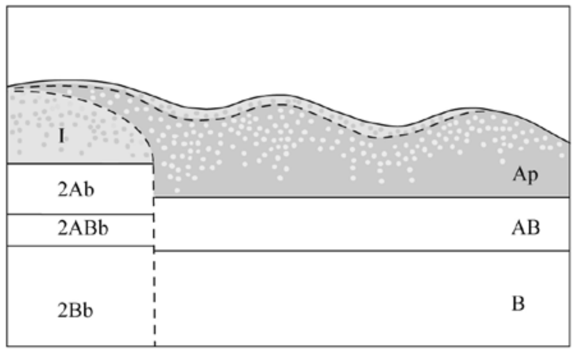
*Glej tudi pogl. 10.2, sl. 3 / See also Chapter 10.2, Fig. 3



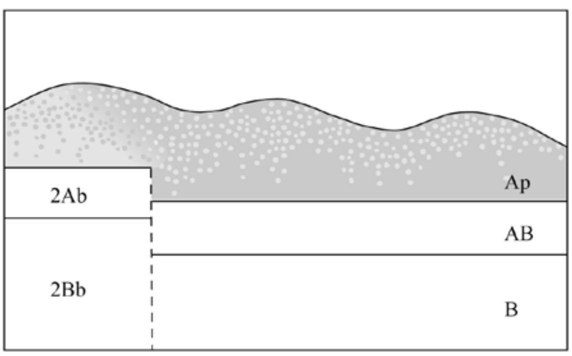
F3.1.2 / Ph3.1.2
Pričetek premeščanja gomilnega plašča z oranjem ter erozijsko koluvijalnimi procesi: večina gradiva se odlaga v negativnih mikrotopografskih oblikah, t. j. v brazdah. /
The onset of mound material dispalcement through ploughing and erosional–colluvial processes: most of the material is deposited in negative microtopographic features, i.e., furrows.



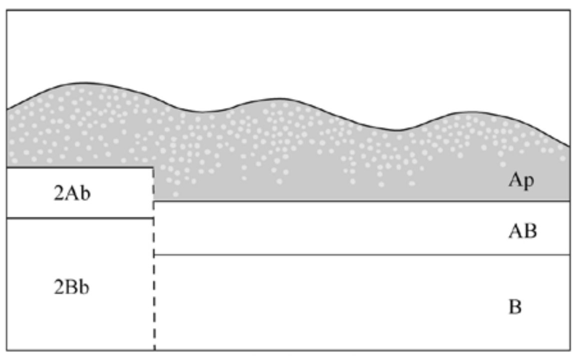
F3.1.3 / Ph3.1.3
Največ premeščenega gradiva je odloženega v neposredni bližini gomile, lateralno se količina gradiva manjša. /
Most of the displaced material is deposited in the immediate vicinity of the mound, with the quantity decreasing laterally.



F3.1.4 / Ph3.1.4
Z vsakim ciklom oranja se gradivo meša in homogenizira znotraj ornice. /
With each ploughing cycle, the material is mixed and homogenized within the topsoil.

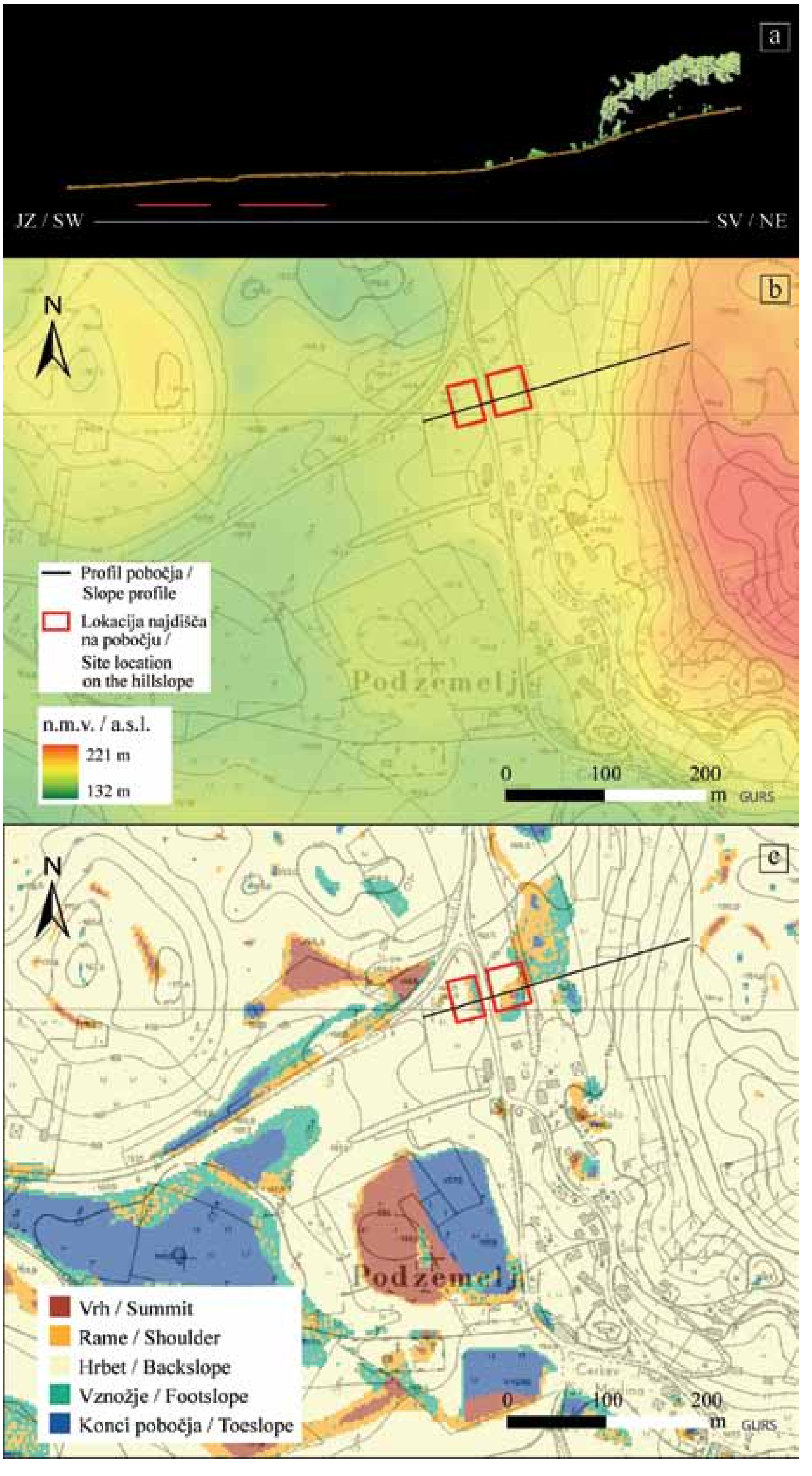


F3.1.5 / P3.1.5
Gomila je izbrisana s površja. /
The mound is erased from the surface.



F3.1.6 / P3.1.6
Podpovršinski ostanki gomile so v celoti homogenizirani z ornico. /
The subsurface remnants of the burial mound are fully homogenized with the topsoil.

Sl. 12: Erozija, premeščanje in odlaganje gradiva gomilnega plašča z oranjem.
Fig. 12: Erosion, transport, and deposition of mound fill material through ploughing.



Sl. 13: Analiza geomorfnih procesov na širšem prostoru najdišča z uporabo modela petih elementov pobočja: (a) transekt prek najdišča v smeri JZ–SV prikazuje postopno naraščanje naklona Kučarjevega hrbta nad najdiščem od blagega (5°) do strmega (20°); (b) digitalni model reliefa (DMR) z resolucijo 0,5 m; (c) klasifikacija petih elementov pobočja za širši prostor najdišča kaže, da je grobišče locirano na izteku hrbta osamelca. (Osnova TTN 5, © GURS)

Fig. 13: Analysis of geomorphic processes in the wider site area using the five-slope-element model: (a) a transect across the site in the SW-NE direction shows the gradual increase in the inclination of Kučar's backslope above the site from gentle (5°) to steep (20°); (b) a digital elevation model (DEM) with a resolution of 0.5 m; (c) classification of the five slope elements in the wider site area indicates that the cemetery is situated on the terminus of the inselberg's backslope. (Basemap: TTN 5, © GURS).

dišča. To pomeni, da bi lahko bila teksturna diferenca v površinskih horizontih profilov tal P2 in P3 vsaj deloma posledica koluvialnega doprinosa.

Po drugi strani primerjava teksturnih trendov med profili P1, P2 in P3 kaže, da ti pri profilih P2 in P3 v največjem obsegu odražajo signal erodiranih gomilnih plaščev. Tako sklepamo, ker je vpliv vode s Kučarja zaznan v vseh treh profilih, medtem ko z mineralnim gradivom obogatene površinske horizonte zasledimo le v profilih P2 in P3, ki sta locirana znotraj domnevnih gomil, ne pa tudi v P1, ki leži na območju viniških grobov. To po našem mnenju vsekakor ne more biti naključje.

Da so lahko bile nasute zemljene gomile s poljedelsko rabo progresivno erodirane in v določenem trenutku popolnoma izbrisane s površja, je bilo izpričano za številna najdišča dolenjske halštatske skupine (prim. Grahek 2004; Križ 2019; Dular 2021). Poljedelska raba tal na širšem območju Pezdirčeve njive je dobro dokumentirana na orotofoto posnetkih vse do leta 2016 (https://ipi.eprostor.gov.si/jv/), v zahodnem delu grobišča pa je potrjena tudi z mikromorfološko analizo gradiva iz profilov tal P4–P6. V teh smo zasledili znake dolgotrajnega poljedelstva, vezanega na prisotnost odprtih, sezonsko neporaščenih njivskih površin, ciklično oranje ter gnojenje z živalskim gnojem, mešanim z gospodinjskim odpadom (*tab. 2–3, sl. 7–9*).

Prašnate glinene prevleke v spodnjem delu humusno akumulativnih ter v prehodnih in mineralnih horizontih so eden najpomembnejših mikromorfoloških znakov poljedelske rabe tal na najdišču. Pod mikroskopom so bile identificirane kot po sestavi heterogene prevleke makropor z različno količino gline, melja, peska in amorfne organske snovi, kar jim daje "prašnat" videz (*sl. 9:* a–c). Takšne pedogene novotvorbe nastajajo v času, ko so njivske površine neporaščene oziroma delno poraščene, vezi v mikrostrukturnih agregatih pa dovolj oslabljene, da lahko vertikalni pretok vode po makroporah sproži delno dezintegracijo agregatov in mobilizacijo delcev različnih frakcij. V nasprotju s čistimi glinenimi prevlekami, ki so vezane na primarno iluviacijo, tj. homogeni in nizkoenergijski, počasni transport gline v koloidni suspenziji po makroporah navzdol (Kühn, 2003, 550; Kühn et al. 2010, 224; Sauzet et al. 2016, 50–51; 2023), je nastanek tega tipa prevlek pojasnjen z mehanično infiltracijo makropor (Kühn et al. 2010; Lewis 2012; Deák et al 2017, 241). Še posebej značilne so za obdelana tla z visoko vsebnostjo melja in nizko vsebnostjo kalcija (Kühn et al. 2010), kar velja tudi za tla na Pezdirčevi njivi (*tab. 1–3*).

Medtem ko številni avtorji poudarjajo, da so strukturne spremembe v tleh, povezane z oranjem, sezonske narave in zato težko sledljive v arheološkem zapisu, saj jih lahko biološki procesi v tleh v 40–200 letih v določenih okoljih popolnoma zabrišejo (na primer Davidson 2002), pa spada Pezdirčeva njiva med tista najdišča, kjer so znaki dolgotrajne obdelave tal dobro ohranjeni.

from the clay documented in the soils at the site: whereas the former is exceptionally pure and intensely yellow, the latter tends to be more reddish and is often stained with Fe-Mn (hydr)oxides (*Tab. 2; Figs. 10–11*). Since Type 4 aggregates are present in all three soil horizons (A, AB, and B), this material likely reflects a continuous, low-energy colluvial influx of soil material originating from Kučar (see also Chapter 10.2; Figs. 2–3 in this volume).

Taking into account the geomorphological processes described above, let us re-examine the clay-enriched surface horizons in soil profiles P2 and P3. The combination of geomorphological setting (*Fig. 13*), micromorphological features (*Fig. 11*: a, e–f), and evidence of soil enrichment through surface and subsurface waters from Kučar (*Tab. 1; Fig. 5*) indicates that the colluvial input forms a natural sedimentary background characteristic of the entire site. This suggests that the textural differences observed in the surface horizons of profiles P2 and P3 may have, at least in part, resulted from colluvial contribution.

On the other hand, a comparison of textural trends in profiles P1, P2, and P3 shows that the textural signals in profiles P2 and P3 are largely indicative of eroded mound fills. This conclusion is based on the observation that, while the influence of water from Kučar is evident in all three profiles, clay-enriched surface horizons were identified only in profiles P2 and P3, both located within the putative mound areas, and not in profile P1, which is situated in the area of the Vinica-type graves. This pattern is unlikely to be coincidental.

At numerous sites of the Dolenjska Hallstatt Group, constructed earthen mounds have been documented as having been eroded and, in some cases, entirely erased from the surface through agricultural use (cf. Grahek 2004; Križ 2019; Dular 2021). While agricultural use of soils across the wider Pezdirčeva njiva area is well documented in orthophotos up to 2016 (https://ipi.eprostor.gov.si/jv/), micromorphology of soil profiles P4–P6 also confirms such activity in the western part of the cemetery. These analyses revealed evidence of prolonged cultivation, including open, seasonally bare field surfaces, cyclical ploughing, and fertilisation with animal manure mixed with household refuse (*Tab. 2–3; Figs. 7–9*).

Dusty clay coatings in the lower part of the humus-accumulative horizons and in the transitional and mineral horizons are among the most important micromorphological indicators of agricultural soil use at the site. Under the microscope, they were identified as macropore coatings heterogeneously composed of varying amounts of clay, silt, sand, and amorphous organic matter, which lend them their characteristic "dusty" appearance (*Fig. 9*: a–c). Pedofeatures of this type form when arable surfaces are left bare or only partially vegetated, and the bonds within microstructural aggregates become sufficiently weakened to allow vertical water flow along micropores to mobilise particles of various size fractions. Unlike pure clay coatings associated with primary illuviation – that is, the

Poleg prašnatih glinenih prevlek spadajo med druge ugotovljene znake poljedelstva še oglati, slabo razviti mikrostrukturni agregati v zgornjih horizontih, različni vključki, povezani s procesom gnojenja, ter premeščanje agregatov tal z oranjem (*sl. 7–8, 11*).

Pojavljanje agregatov tipov 1–3 zunaj njihovih matičnih horizontov A, AB in B odraža heterogeno sestavo horizontov tal na najdišču ter kaže na mešanje gradiva z oranjem in bioturbacijo (*tab. 2, sl. 11*). Tako premeščanje niso zabrisali niti intenzivni biološki procesi v tleh, ki težijo k homogenizaciji gradiva (Adderley et al. 2010). Za obdelana tla na Pezdirčevi njivi je značilna tudi posebna obliko agregatov: namesto grudičaste, kakršno najdemo v tleh travišč, imajo agregati oranih tal pogosto oglato mikrostrukturo (Adderley et al. 2010, 571), kar velja tudi za humusno akumulativne in prehodne horizonte na najdišču. Slabša izraženost strukturnih agregatov je najverjetneje posledica tako dolgotrajne obdelave tal, ki slabi njihovo obstojnost, kot tudi specifičnih pedoloških lastnosti tal na najdišču, in sicer razmeroma majhne vsebnosti organske snovi, velikega deleža melja in izpranosti tal. Prisotnost drobcev gnoja, fosfatnih nodul, amorfnega organskega materiala, (mikro)oglja in redkih fragmentov kosti kaže, da so nekdaj na gnoj metali heterogen gospodinjski odpad.

Ob izhodiščnih hipotezah lahko torej sklenemo, da smo z večmetodnim pristopom v osrednjem in vzhodnem delu najdišča zaznali teksturni signal dveh erodiranih gomil ter prepoznali znake dolgotrajne poljedelske rabe. Pod gomilo v vzhodnem delu grobišča (profil P3, horizonta A1, A2) je bil na terenu ugotovljen in nato z laboratorijskimi analizami potrjen 2Ab-horizont, ki je bil pokopan v času nasutja gomile (*tab. 1, sl. 1–2;* glej tudi poglavje 10.2, sl. 2–3). Odsotnost pokopanega A-horizonta pod gomilo v osrednjem delu najdišča je po drugi strani posledica na gosto in drug ob drugem vkopanih grobnih jam, zaradi česar nekdanje hodne površine na točki vzorčenja ob nasutju gomile dejansko ni bilo več (*sl. 1–2*).

Vse kaže, da je bila za gomile na Pezdirčevi njivi rabljena teksturno težja, z glino bogata zemljina mineralnih horizontov, ki je ob poznejšem uničenju gomil s poljedelsko rabo privedla do povečane vsebnosti gline v površinskih A-horizontih. Primerjava obeh erodiranih gomil kaže, da je bil teksturni signal zemljenega plašča bolje ohranjen v vzhodni gomili (P3), kjer je bil prepoznan v horizontu A1 in A2. Da je bil tam teksturni signal viden vse do globine 30 cm, je verjetno povezano s premeščanjem zemljenega nasutja z oranjem, kot predvideva teoretični model, razvit za potrebe te študije (*sl. 12*). Popolno uničenje gomilnega plašča namreč privede do akumulacije večjega deleža premešanega gradiva na gomilnem obodu (*sl. 1, 12*). Z opisanim modelom lahko tudi pojasnimo plitvejši

homogeneous, low-energy, and slow downward transport of clay in colloidal suspension through macropores (Kühn 2003, 550; Kühn et al. 2010, 224; Sauzet et al. 2016, 50–51; 2023) – the formation of dusty clay coatings is explained by the mechanical infiltration of macropores (Kühn et al. 2010; Lewis 2012; Deák et al. 2017, 241). These coatings are particularly characteristic of cultivated soils with high silt and low calcium content (Kühn et al. 2010), which is also the case with the soils at Pezdirčeva njiva (*Tabs. 1–3*).

Numerous authors emphasise that ploughing-related morphological changes in soils are difficult to trace in the archaeological record because they are seasonal in nature and, in certain environments, can be entirely erased within 40–200 years (e.g. Davidson 2002). Nevertheless, clear evidence of prolonged agricultural use has been preserved at Pezdirčeva njiva. In addition to dusty clay coatings, indicators of cultivation identified at the site include angular, poorly developed microstructural aggregates in the upper horizons, various inclusions associated with fertilisation, and the turbation of soil aggregates caused by ploughing (*Figs. 7–8, 11*).

The presence of aggregate Types 1–3 outside their parent A, AB, and B horizons reflects the heterogeneous composition of soil horizons at the site and indicates the mixing of material through ploughing and bioturbation (*Tab. 2; Fig. 11*). Even intense biological activity in the soil, which generally tends toward homogenisation, could not eliminate this type of aggregate redistribution (Adderley et al. 2010). The cultivated soil at Pezdirčeva njiva also exhibits a characteristic aggregate morphology: ploughed soil aggregates often display a subangular blocky microstructure rather than the crumb structure typical of grasslands (Adderley et al. 2010, 571), a pattern observed here in both the humus-accumulative and transitional horizons. Such an expression of structural aggregates is most likely a consequence of prolonged cultivation, which reduces their stability, as well as of the specific pedological characteristics of the site's soils – namely, their relatively low organic matter content, high silt content, and leaching. The presence of dung fragments, phosphate nodules, amorphous organic matter, (micro)charcoal, and occasional bone fragments further suggests that heterogeneous household refuse was once discarded onto dung heaps.

In light of our initial hypotheses, we may therefore conclude that applying a multi-method approach enabled us to detect textural signals of two eroded mounds in the central and eastern parts of the cemetery, while simultaneously identifying evidence of prolonged agricultural use. Beneath the mound in the eastern part of the cemetery (profile P3, horizons A1 and A2), a 2Ab horizon was first identified in the field and later confirmed by laboratory analyses, representing a soil surface buried at the time of mound construction (*Tab. 1; Figs. 1–2*; see also Chapter 10.2; Figs. 2–3). By contrast, the teksturni signal do globine 8 cm v gomili v osrednjem delu grobišča, kjer je bila točka vzorčenja bližje središču gomile (*sl. 1, 12*).

Opisana situacija torej izpolnjuje vse pogoje za potrditev hipoteze o namenskem nasutju gomil na grobišču, saj smo z geoarheološkimi metodami dokazali pokopana tla pod gomilo, erodiran plašč in dolgotrajno poljedelsko rabo na najdišču. Kljub temu pa ne moremo izključiti možnosti, da je bila zaradi stalnega koluvialnega doprinosa mikrotopografija na lokaciji pred gradnjo gomil morda blago valovita in da je bila takšna naravna razgibanost terena izkoriščena pri gradnji gomil ali pokopih.[5]

SKLEPNE UGOTOVITVE

Geoarheološka preiskava nevidnih gomil na Pezdirčevi njivi je potrdila, da lahko sistematična analiza geomorfoloških, fizikalno-kemijskih in mikromorfoloških lastnosti tal razkrije pomembne informacije o arheološki krajini tudi v odsotnosti ohranjenih nadzemnih struktur. Rezultati kažejo, da so na posameznih mestih na grobišču (profila tal P2 in P3) anomalije v teksturni sestavi površinskih horizontov tal, ki odstopajo od naravnih eluvialno-iluvialnih trendov, dokumentiranih v profilih P1 in P4–P6. Ti teksturni odkloni so verjetno posledica s poljedelsko rabo erodiranih, premešanih in premeščenih gomilnih plaščev, ki so se bolje ohranili na obodu uničenih gomil.

Hkrati tudi ni mogoče v celoti izključiti možnosti, da so bile posamezne gomile ali posamezni pokopi umeščeni v naravno bolj razgiban relief, kot to dopušča današnji videz z dolgotrajno agrarno rabo spremenjene kulturne krajine. Z mikromorfološkimi znaki izpričani stalni sedimentacijski doprinos na najdišču opozarja na možnost, da je bil morda relief zaradi koluvialnih procesov v času grobišča bolj valovit kot danes in zato izkoriščen pri pokopih. Mikromorfološke lastnosti dodatno potrjujejo visoko stopnjo antropogene preoblikovanosti tal, kar se kaže v prisotnosti prašnatih glinenih prevlek, fosfatnih nodul, ostankov gnoja in drugih znakov dolgotrajne poljedelske rabe.

Na podlagi izvedene študije ugotavljamo, da interpretacija prazgodovinskih gomilnih grobišč v podobnih okoljih zahteva izjemno previdnost pri razlikovanju med naravnimi elementi reliefa in antropogenimi nasutji. Geoarheološke metode vsekakor omogočajo določeno stopnjo razločevanja med naravnimi in antropogenimi sedimentacijskimi procesi, vendar lahko postane njihova interpretativna moč omejena ob morebitni poznejši intenzivni preoblikovanosti tal.

[5] Prim. tu poglavje 4.5, sl. 4.17.

absence of a buried A horizon beneath the mound in the central part of the site appears to be the result of dense grave-pit clustering in close proximity, which completely truncated the former ground surface (*Figs. 1–2*).

It appears that the barrows at Pezdirčeva njiva were constructed using texturally heavier, clay-rich material derived from mineral horizons. After the barrows were destroyed through agricultural use, this resulted in increased clay content in the surface A horizons. A comparison of the two eroded barrows shows that the textural signal of the earthen mantle was better preserved in the eastern barrow (P3), where it was detected in horizons A1 and A2. In this location, the signal was observable to a depth of 30 cm, a pattern likely linked to the specific mode of barrow fill redistribution by ploughing, as predicted by the theoretical model developed for this study (*Fig. 12*). According to this model, complete destruction of barrow fill leads to the accumulation of a greater proportion of redistributed material at the perimeter of the barrow (*Figs. 1, 12*). The same model can also explain the shallower, 8 cm-deep textural signal observed in the barrow in the central part of the cemetery, where the sampling point was located closer to the centre of the original barrow (*Figs. 1, 12*).

Geoarchaeological methods enabled us to identify a buried soil beneath one of the mounds, evidence of eroded mound fills, and signs of prolonged agricultural use. These results, then, fully support the hypothesis that the mounds at the site were deliberately constructed. Nevertheless, we cannot rule out the possibility that continuous colluvial input had already created a gently undulating microtopography at the location prior to barrow construction, and that such natural terrain was subsequently exploited for the erection of mounds or for burial activity.[5]

CONCLUSION

The geoarchaeological study of the invisible barrows at Pezdirčeva njiva demonstrates that a systematic analysis of geomorphological, physico-chemical, and micromorphological soil properties can yield important insights into the archaeological landscape, even in the absence of preserved above-ground structures. Our results reveal anomalous textural compositions in the surface soil horizons at specific locations within the cemetery (profiles P2 and P3), which deviate from the natural eluviation–illuviation trends documented in profiles P1 and P4–P6. These textural deviations are likely linked to mound fills that became eroded, mixed, and redeposited through agricultural use, with the best-preserved remnants accumulating at the peripheries of the mounds.

At the same time, we cannot entirely discount the possibility that some barrows or burials were fitted into a naturally more irregular relief than the present-day, long-

[5] Cf. Chapter 4.5, Fig. 4.17 in this volume.

term agriculturally modified cultural landscape would suggest. Micromorphological evidence of continuous sedimentary input at the site highlights the possibility that, due to colluvial processes, the relief may have been more undulating at the time the cemetery was established and was subsequently exploited for burial placement. Furthermore, micromorphological features corroborate a high degree of anthropogenic soil transformation, as evidenced by the presence of dusty clay coatings, phosphate nodules, dung residues, and other traces of long-term cultivation.

Based on our study, we conclude that interpreting prehistoric barrow cemeteries in similar environments demands exceptional caution in attempting to distinguish between natural relief elements and anthropogenic constructions. Geoarchaeological methods undoubtedly allow for a certain degree of differentiation between natural and anthropogenic sedimentary processes, but their interpretative value may become limited in cases of subsequent intensive transformation of soils.

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Spletna orodja / Internet tools

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