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10.2 PALEOOKOLJE, RAZVOJ TAL TER OHRANJENOST ARHEOLOŠKEGA ZAPISA IN GROBNIH PRIDATKOV NA PEZDIRČEVI NJIVI

10.2 PALAEOENVIRONMENT, SOIL DEVELOPMENT, AND THE PRESERVATION OF THE ARCHAEOLOGICAL RECORD AND GRAVE GOODS AT PEZDIRČEVA NJIVA

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UVOD

Ohranjenost arheološkega zapisa in grobnih pridatkov na Pezdirčevi njivi je mogoče ustrezno razumeti le v širšem kontekstu paleookolja in razvoja tal na najdišču. Sedimentacijski, pedogeni in antropogeni procesi, ki so se na lokaciji odvijali pred nastankom grobišča, med njegovim nastajanjem in po njem, so bistveno vplivali na položaj grobov v okviru talnih horizontov ter na stopnjo njihove ohranjenosti in preoblikovanosti.

Ostaline preteklih človekovih dejavnosti na Pezdirčevi njivi obsegajo poleg erodiranih gomil tudi vkope, polnila in grobne pridatke mlajšehalštatskodobnih in viniških grobov, ki so ohranjeni izključno v B-horizontih (glej tu poglavja 2, 4 in 10.1). V pričujoči študiji smo si zato zastavili cilj rekonstruirati paleookolje in razvoj tal na območju grobišča. Hkrati smo želeli pojasniti, kako je specifična dinamika naravnih in antropogenih procesov skozi čas oblikovala takšen stratigrafski zapis, kakršen je bil dokumentiran med arheološkimi izkopavanji.

V prvem delu prispevka primerjamo pelodni zapis za širše območje Gribelj[1] (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009) s pedološkimi podatki s Pezdirčeve njive in razpravljamo, kako se navedena tipa paleookoljskih indikatorjev med seboj razlikujeta in dopolnjujeta.

V drugem in tretjem delu prispevka opisujemo teoretična modela, zasnovana na treh tipih integriranih podatkov: pedostratigrafiji najdišča (glej poglavje 10.1, sl. 2), fizikalno-kemijskih in mikromorfoloških

[1] Griblje ležijo približno pet kilometrov gorvodno od Podzemlja in so na pedološki karti Slovenije, podobno kot tla na najdišču, opredeljena kot izprana tla (Luvisol) ali distrična rjava tla (Dystric Cambisol).

INTRODUCTION

The preservation of the archaeological record and grave goods at Pezdirčeva njiva can only be fully understood within the broader context of the palaeoenvironmental history and soil development at the site. Sedimentary, pedogenic, and anthropogenic processes occurring before, during, and after the formation of the cemetery played a decisive role in shaping the vertical and horizontal positions of the graves within the soil horizons, as well as in determining the extent to which they were preserved, altered, or transformed over time.

Traces of past human activity at Pezdirčeva njiva include eroded barrows, as well as pits, fills, and grave goods associated with Late Hallstatt and Vinica-type burials, all of which are preserved exclusively within the B horizons (see Chapters 2, 4, and 10.1 in this volume). The aim of this study was therefore to reconstruct the palaeoenvironmental conditions and soil development within the cemetery area. At the same time, we sought to explain how, over time, the specific dynamics of natural and anthropogenic processes shaped the stratigraphic record as it was documented during archaeological excavations.

The first section of this paper compares the pollen record from the wider Griblje area[1] (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009) with soil data from Pezdirčeva njiva, and discusses how these two types of palaeoenvironmental indicators both differ from and complement each other.

[1] Griblje lies approximately five kilometres upstream from Podzemelj and, like the soils at the site, is classified on the Soil Map of Slovenia as leached soil (Luvisol) or dystric brown soil. (Dystric Cambisol)

lastnostih tal (glej poglavje 10.1, tab. 1–3; sl. 5–11) ter geomorfni analizi pobočnih procesov (glej poglavje 10.1, sl. 13). Z modelom razvoja tal pojasnjujemo rast in diferenciacijo posameznih talnih horizontov skozi holocen (*sl. 2*), z modelom pedostratigrafske zgodovine grobišča pa razlagamo preoblikovanje in ohranjenost arheološkega zapisa ter artefaktov na najdišču (*sl. 3*).

Takšen celoviti pristop omogoča poglobljeno razumevanje naravnih dejavnikov in njihovega vpliva na arheološke kontekste na Pezdirčevi njivi skozi čas. Prispevek s tem vzpostavlja nova metodološka izhodišča za interpretacijo grobišč v širšem okviru okoljskih sprememb ter hkrati ponazarja pomen interdisciplinarnih pristopov pri pojasnjevanju kompleksne dinamike naravnih in antropogenih procesov na arheoloških najdiščih.

POSKUS REKONSTRUKCIJE PALEOOKOLJA NA OBMOČJU GROBIŠČA

V primerjavi z drugimi paleokoljskimi indikatorji, zlasti pelodom, so tla manj občutljiva za posamezne podnebne dogodke in spremembe, kar še posebej velja za obdobje holocena, ko so bila klimatska nihanja manj ekstremna kot v predhodnih geoloških obdobjih (Holliday 2004, 190). Kljub temu lahko na podlagi fizikalnih, kemičnih in bioloških lastnosti tal, ki odražajo lastnosti matične podlage, podnebnih razmer, reliefa ter na lokaciji prisotne flore in favne, v širokih potezah orišemo vpliv paleookolja na tla Pezdirčeve njive.

Analiza morfoloških, mikromorfoloških in pedoloških lastnosti evtričnih rjavih tal (Eutric Cambisol) na najdišču kaže na zveznost eluvialno-iluvialnih ter oksidacijsko-redukcijskih procesov v naravnih tleh (kontrolna talna profila P5–P6; glej poglavje 10.1, tab. 1, 3, sl. 1, 2, 5). To nakazuje daljšo časovno kontinuiteto teh procesov, verjetno skozi večji del holocena, v obdobjih z zadostno količino padavin (predvidoma vsaj 800 mm na leto; prim. Lipar et al. 2024).

Situacija na Pezdirčevi njivi se bistveno razlikuje od razmer na nekaterih grobiščih v srednje- in vzhodnoevropskem puhličnem pasu, kjer so bili pod raziskanimi gomilami dokumentirani černozjomi, nasutja gomil pa so bila sčasoma preoblikovana v podzole (na primer Hejcman et al. 2013; Kabala et al. 2019). Opisani fenomen odraža podnebne in vegetacijske spremembe, ki so v poznem holocenu vodile do zaraščanja nekdanjih obdelovalnih in pašnih površin znotraj odprtih hrastovih ali mešanih gozdov z gostejšimi, bolj zaprtimi bukovimi gozdovi z manjšim deležem trav in zeli. Zaradi sprememb v vegetacijskem pokrovu so se v tleh začeli odvijati intenzivni procesi izpiranja, ki so povzročili degradacijo izjemno rodovitnih černozjomov

The second and third sections of the paper propose two theoretical models based on three types of integrated data: the site's pedostratigraphy (see Chapter 10.1, Fig. 2 in this volume), the physical–chemical and micromorphological properties of the soil (see Ch. 10.1, Tabs. 1–3; Figs. 5–11), and the geomorphological analysis of slope processes (see Ch. 10.1, Fig. 13). The paper reconstructs the growth and differentiation of individual soil horizons throughout the Holocene using a soil development model (*Fig. 2*), and interprets the reshaping and preservation of the archaeological record and artefacts at the site through a pedostratigraphic history model of the cemetery (*Fig. 3*).

This comprehensive approach allows us to develop a deeper understanding of natural factors and their influence on archaeological contexts at Pezdirčeva njiva over time. In doing so, the paper establishes new methodological vantage point for interpreting cemeteries within the broader framework of environmental change, while simultaneously highlighting the importance of interdisciplinary approaches in explaining the complex dynamics of natural and anthropogenic processes at archaeological sites.

TOWARDS A RECONSTRUCTION OF THE PALAEOENVIRONMENT AT PEZDIRČEVA NJIVA

Compared to other palaeoenvironmental indicators, particularly pollen, soil is less sensitive to short-term climatic events and fluctuations. This is especially evident in the Holocene, when climatic variability was less pronounced than in preceding geological periods (Holliday 2004, 190). Nevertheless, it is possible to broadly reconstruct the influence of the palaeoenvironment on the soils of Pezdirčeva njiva by examining their physical, chemical, and biological properties, which in turn reflect the characteristics of the parent material, climatic conditions, relief, and the flora and fauna present at the site.

Analysis of the morphological, micromorphological, and pedological properties of the eutric brown soils (Eutric Cambisol) at the site demonstrates the continuity of eluviation–illuviation and oxidation–reduction processes in natural soils (control soil profiles P5–P6; see Ch. 10.1, Tabs. 1, 3; Figs. 1, 2, 5). This indicates that these processes persisted over an extended period, likely throughout much of the Holocene, during periods of sufficient rainfall (conceivably at least 800 mm per year; cf. Lipar et al. 2024).

The situation at Pezdirčeva njiva differs significantly from that documented at some cemeteries within the central and eastern European loess belt, where Chernozems have been recorded beneath barrows, while the mound deposits themselves were gradually transformed into Podzols (e.g. Hejcman et al. 2013; Kabala et al. 2019). This phenomenon reflects climatic and vegetational changes ter nastanek izpranih in obeljenih podzolov (Kabala et al. 2019, 96–98).

Lastnosti tal na Pezdirčevi njivi, pogojene z drugačnim talnim tipom in klimatskimi razmerami na obravnavanem območju, kažejo drugačno dinamiko razvoja v holocenu, zaznamovanega z daljšo kontinuiteto pedogenih procesov. Na podlagi analiz sklepamo, da se eluvialno-iluvialni ter oksidacijsko-redukcijski procesi v času nastanka grobišča niso bistveno razlikovali od današnjih (glej poglavje 10.1, tab. 1, 3, sl. 1–2, 5).

Pelodni zapis s približno pet kilometrov oddaljenega mokrišča v Gribljah kaže oscilacije lokalne vegetacije z izmenjujočimi se fazami bolj odprte in bolj zaprte gozdne krajine skozi holocen (*sl. 1*). Po koncu zadnjega glaciala je na širšem območju vzorčenja uspeval odprt mešani gozd (lipa, leska, hrast, breza, bor), ki so ga med 7900 in 6600 cal BCE zaradi vlažnejšega podnebja nadomestili gosti bukovi gozdovi. V nadaljnjem pelodnem zapisu so zabeležena tri izrazitejša obdobja odpiranja bukovih gozdov. Prvič med 6600 in 6000 pr. n. št. verjetno zaradi bolj suhega podnebja ali človekovega vpliva, čeprav arheoloških najdišč iz tega obdobja še ne poznamo. Drugič med 4400 in 3700 pr. n. št., v času srednjega neolitika in eneolitika, ko se v pelodnem zapisu prvič pojavijo antropogeni indikatorji, vključno z žiti in pelodom rastlin, značilnih za pašnike, polja in ruderalne površine. In tretjič med 2800 in 1000 pr. n. št., v času bronaste in začetka železne dobe, ko je v zapisu znova zaznano povečanje deleža žit, zeli in oglja (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009).

Na podlagi pelodne analize za širše območje Gribelj (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009) lahko za dolgoživeče gradišče na Kučarju (Dular et al. 1995; Grahek, Kovač 2020) sklepamo, da je pokrajino okoli gradišča od pozne bronaste do mlajše železne dobe sestavljal mozaik mešanih listnatih gozdov, pašnikov, polj in ruderalnih površin. Ob rekonstruiranem zaporedju horizontov A–AB–B–Bt na Pezdirčevi njivi (*sl. 2:* t7) predvidevamo, da je bila na lokaciji pred nastankom grobišča najverjetneje travniška vegetacija z dobro razvitim horizontom A. Razvoj tal v gozdu namreč praviloma vodi v oblikovanje sorazmerno plitvih horizontov O in A, kakršnih na najdišču nismo zaznali. Čeprav v tleh na lokaciji ni bil prepoznan časovno zanesljiv signal, ki bi pričal o trenutku prehoda iz gozda v travnik, pa je skozi celotno globino talne sekvence prisotno mikrooglje (glej tu poglavje 10.1), kar bi lahko morda povezali tudi s krčenjem gozda in odpiranjem pokrajine ob poselitvi Kučarja.

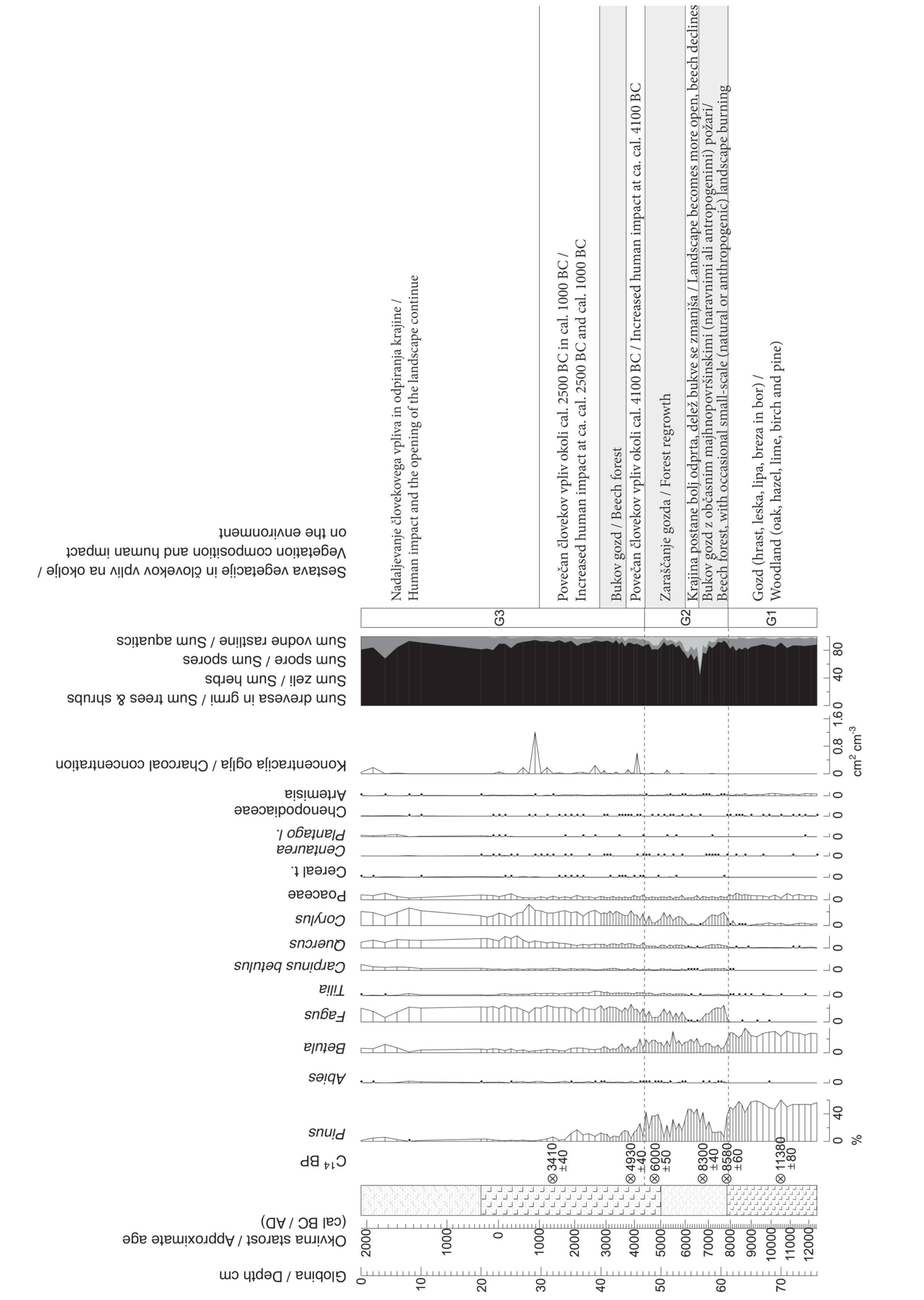
Mikrooglje je bilo kot indikator krčenja in namenskega požiganja rastja v več fazah ugotovljeno tudi v palinološkem zapisu iz Gribelj, kjer odraža več – tudi starejših – ciklov antropogenih posegov v krajino (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009). Na Pezdirčevi njivi teh faz (ali naravnih požarov) nismo mogli z gotovostjo prepoznati, saj mikrooglje z najdišča

during the Late Holocene, which led to former arable land and pastures within open oak or mixed forests becoming overgrown by denser beech forests with a lower proportion of grasses and herbs. These changes in vegetation cover resulted in intensive leaching processes within the soils, leading to the degradation of highly fertile Chernozems and the subsequent formation of leached and bleached Podzols (Kabala et al. 2019, 96–98).

Conditioned by the distinct soil type and climatic conditions of the examined area, the soils at Pezdirčeva njiva display a different developmental dynamic during the Holocene, one characterised by the prolonged continuity of pedogenic processes. Based on our analyses, we postulate that the eluviation–illuviation and oxidation–reduction processes occurring during the period of the cemetery's formation did not differ significantly from those observed today (see Ch. 10.1, Tabs. 1, 3; Figs. 1–2, 5).

The pollen record from the wetland in Griblje, approximately five kilometres away, shows oscillating phases of denser and more open forest landscapes in local vegetation throughout the Holocene (*Fig. 1*). Following the end of the Last Glacial Period, the wider area was covered by open mixed forest (lime, hazel, oak, birch, pine), which was replaced by dense beech forests between 7900 and 6600 BCE under wetter climatic conditions. The subsequent pollen record reveals three distinct phases of beech forest opening: the first between 6600 and 6000 BCE, probably due to a drier climate or human activity, although no archaeological sites from this period are currently known; the second between 4400 and 3700 BCE, during the Middle Neolithic and Eneolithic, when anthropogenic indicators – including cereals and pollen of grassland, arable, and ruderal species – first appear; and the third between 2800 and 1000 BCE, during the Bronze Age and the beginning of the Iron Age, when a resurgence of cereals, herbs, and charcoal was recorded (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009).

Based on pollen analysis of the wider Griblje area (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009), we hypothesise that between the Late Bronze Age and Late Iron Age, the landscape surrounding the enduring Kučar hillfort (Dular et al. 1995; Grahek, Kovač 2020) comprised a mosaic of mixed deciduous forests, pastures, fields, and ruderal areas. According to the reconstructed sequence of A–AB–B–Bt horizons at Pezdirčeva njiva (*Fig. 2:* t7), we infer that prior to the establishment of the cemetery, the area was most likely covered by grassland vegetation with a well-developed A horizon, as the relatively shallow O and A horizons typically formed under forest soil development were not observed at the site. Although no chronologically reliable signal indicates a transition of the soils at the site from forest to grassland, the presence of microcharcoal throughout the soil sequence (see Ch. 10.1, Tab. 3) may point to deforestation and landscape clearance associated with the settlement of Kučar.



Sl. 1: Griblje (GR3). Pelodni diagram (%) za izbrane taksone (M. Andrič, prirejeno po Mason, Andrič 2009, sl. 2).
Fig. 1: Griblje (GR3). Pollen diagram (%) for selected taxa (M. Andrič, adapted from Mason, Andrič 2009, fig. 2).

ni bilo radiokarbonsko datirano, v okviru talne sekvence pa je tudi zelo mobilno (prim. Conedera et al. 2009; Turner et al. 2010).

Razvoj vegetacije in tal v holocenu odraža v primeru Pezdirčeve njive različno močan vpliv podnebja, reliefa, matične podlage[2] ter človeka na oba paleookoljska indikatorja. Zgodovina vegetacijskega pokrova na širšem območju Gribelj v holocenu je zaznamovana z nihanji med bolj zaprto in bolj odprto gozdno krajino (*sl. 1*). Na takšno dinamiko vegetacije so v starejšem holocenu vplivale predvsem podnebne spremembe, v mlajšem holocenu pa zlasti človek z različno intenzivnimi posegi v prostor. Ker gre v obravnavanem primeru za razmeroma nizko ležečo pokrajino brez izrazitih višinskih razlik, relief ni imel bistvene vloge pri oblikovanju preteklih rastlinskih združb (prim. z Julijskimi Alpami: Andrič et al. 2020; Caf et al. 2023). Podobno velja tudi za vpliv tal na vegetacijo. Tla na širšem območju Kučarja so si po geokemijski sestavi sorodna (prim. poglavje 10.1, sl. 3; glej tudi Turniški, Grčman (*v pripravi*), zato sklepamo, da so bila manj pomemben dejavnik v razvoju vegetacije.

Na prostoru grobišča predvidevamo progresivno rast tal s postopno diferenciacijo posameznih talnih horizontov v holocenu (*sl. 2*). Pedološki parametri kažejo, da so bila tla manj občutljiva za podnebne spremembe kot vegetacija, kar se odraža v kontinuiteti eluvialno-iluvialnih in oksidacijsko-redukcijskih procesov skozi večji del holocena. Nasprotno pa sta za vegetacijo manj pomembna matična podlaga in relief imela ključno vlogo pri holocenskem razvoju tal na najdišču. V zadnji fazi je na tla pomembno vplival tudi človek, vendar so bili antropogeni vplivi zaznani pozneje kot v pelodnem zapisu iz Gribelj, saj so zajemali le signal s prostora grobišča ter z nad njim ležečega gradišča na Kučarju.

Uporaba palinoloških podatkov iz Gribelj (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009) tako omogoča natančnejšo rekonstrukcijo vegetacijskega pokrova na širšem območju najdišča, kar samo s pedološkimi analizami ne bi bilo mogoče doseči. Integracija obeh tipov paleookoljskih podatkov hkrati razkriva komplementarnost pelodnega in pedostratigrafskega zapisa ter omogoča celovitejše razumevanje paleookolja, v katerem je nastal arheološki zapis na Pezdirčevi njivi.

RAZVOJ TAL NA NAJDIŠČU

Tla na najdišču zaznamuje policiklična pedogeneza, ki je opredeljena kot specifična oblika razvoja tal, v okviru katere tla doživijo več zaporednih ciklov razvoja v različnih klimatskih razmerah in na več različnih lokacijah (Holliday 2004, 77; Schaetzl, Anderson 2005, 338–339).

[2] V primeru vegetacije razpravljamo o vplivu tal, v primeru tal pa o vplivu matične podlage.

The palynological record from Griblje also contains microcharcoal, indicating multiple phases of vegetation clearance and purposeful burning, which reflect several anthropogenic interventions in the landscape, including earlier ones (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009). However, at Pezdirčeva njiva, we were unable to identify these phases – or to distinguish them from natural fire events – with certainty, as the microcharcoal from the site has not been radiocarbon dated and is also highly mobile within the soil sequence (cf. Conedera et al. 2009; Turner et al. 2010).

At Pezdirčeva njiva, vegetation and soil development during the Holocene reflect the varying influences of climate, relief, parent material,[2] and human activity on both palaeoenvironmental indicators. The Holocene vegetation history of the wider Griblje area is characterised by fluctuations between denser and more open forested landscapes (*Fig. 1*). Vegetation dynamics were largely controlled by climatic change during the Early Holocene, whereas in the Late Holocene they became increasingly shaped by human agency through interventions of varying intensity. Since the study area lies within a relatively low-lying landscape with minimal elevation gradients, topographic relief is unlikely to have exerted a decisive influence on past plant communities (cf. Andrič et al. 2020; Caf et al. 2023). The same reasoning applies to edaphic factors: the soils across the wider Kučar area are geochemically similar (cf. Ch. 10.1, Fig. 3; also Turniški, Grčman (*in prep.*)), suggesting that their influence on vegetation development was of secondary importance.

We hypothesise that soil development in the cemetery area was progressive, with a gradual differentiation of individual horizons throughout the Holocene (*Fig. 2*). Pedological parameters indicate that soils were less responsive to climatic change than vegetation, as evidenced by the long-term continuity of eluviation–illuviation and redox processes across much of the Holocene. In contrast, parent material and relief – factors that were less significant for vegetation – were decisive in shaping the Holocene trajectory of soil formation at the site. In the final phase, the soil was also strongly influenced by human activity, although anthropogenic signals appear later here than in the pollen record from Griblje and primarily reflect inputs from the cemetery itself and from the overlying hillfort at Kučar.

The use of palynological data from Griblje (Andrič, Willis 2003; Andrič 2007; Mason, Andrič 2009) therefore enables a more precise reconstruction of vegetation cover in the wider site area, offering insights unattainable through soil analyses alone. The integration of both palaeoenvironmental datasets simultaneously highlights the complementarity of the pollen and pedostratigraphic records and provides a more comprehensive understand-

[2] We consider vegetation in relation to the influence of the soil, while the soil is examined in terms of the influence of its parent material.

Razvoj tal na Pezdirčevi njivi je v nadaljevanju prikazan s teoretičnim modelom (*sl. 2*). V njem je uporabljena barvna shema horizontov naravnih tal iz kontrolnega profila P5, v katerem prevladujejo rumeni odtenki. Za prikaz razvoja horizontov, povezanih z eluvialno-iluvialnimi in oksidacijsko-redukcijskimi procesi, je izbrana barva horizonta Btg3 iz kontrolnega profila P6 z izrazitejšim rdečim odtenkom (prim. poglavje 10.1, sl. 2). Teoretični model predvideva štiri glavne faze razvoja tal, ki se razlikujejo po razmerju med hitrostjo sedimentacijskih in pedogenih procesov na najdišču ter posledično po tipu talnega horizonta, ki se v posamezni fazi razvija in raste (*sl. 2*).[3] Ti procesi so podrobneje opisani v nadaljevanju.

Faza 0 (*sl. 2*) označuje obdobje večkratnih sedimentacijskih dogodkov, ki so se na najdišču zgodili pred holocenom. Ob velikih katastrofičnih dogodkih v pliocenu in pleistocenu je resedimentirano gradivo popolnoma prekrilo in zapolnilo kraške reliefne oblike na območju najdišča (prim. poglavje 10.1, sl. 3). Odloženo gradivo je izviralo iz okoliških karbonatnih okolij. Po geokemijski sestavi je bilo predvidoma podobno izvorni preperini apnenca in dolomita, čeprav natančen izvor gradiva še ni bil podrobneje obravnavan (prim. Bukovac et al. 1983). Resedimentirana zemljina je bila na najdišču verjetno odložena kot premešani, nesortirani in nestratificirani material različnih, za karbonatna okolja značilnih tipov tal in njihovih talnih horizontov. Danes je to gradivo na območju najdišča litostratigrafsko opredeljeno kot kremenov pesek (glej tu, poglavje 10.7, sl. 1), njegova debelina pa predvidoma dosega vsaj nekaj metrov (prim. Bukovac et al. 1983).

Po odložitvi resedimentirane zemljine so se v holocenu, morda pa že v pleistocenu (prim. Kühn 2003; Kabala et al. 2019), začeli pedo-sedimentacijski procesi, ki so privedli do vnovične horizontacije in razvoja evtričnih rjavih tal (Eutric Cambisol) na najdišču. Ker leži Pezdirčeva njiva na izteku Kučarjevega hrbta (glej poglavje 10.1, sl. 13), so tla v holocenu delovala kot depozicijska površina, ki je prejemala površinsko in podpovršinsko vodo, obogateno s karbonati in bazičnimi kationi, ter transportirano gradivo – zlasti material iz horizontov O in A z višjih delov Kučarjevega pobočja (glej poglavje 10.1). Erozijsko-koluvialni procesi so na lokaciji z različno intenzivnostjo odlagali organomineralno gradivo

[3] Ker gre za poenostavljeni prikaz, v fazi t3 (*sl. 2*) ni upoštevan razvoj tal, vezan na prisotnost gozda, ki vodi do nastanka horizontov Ol, Of in Oh. Ob menjavi gozdne vegetacije s travniško so omenjeni horizonti mineralizirali v horizont A, kar pomeni izhodiščno stanje faze t3 v teoretičnem modelu. V modelu prav tako ni predstavljeno namensko nasutje gomil (prim. *sl. 2:* t7), saj gre za mikrolokacijske sedimentacijske dogodke, ki so podrobno obravnavani v modelu pedostratigrafske zgodovine grobišča (*sl.* 3).

ing of the palaeoenvironment within which the archaeological record at Pezdirčeva njiva was formed.

SOIL DEVELOPMENT AT THE SITE

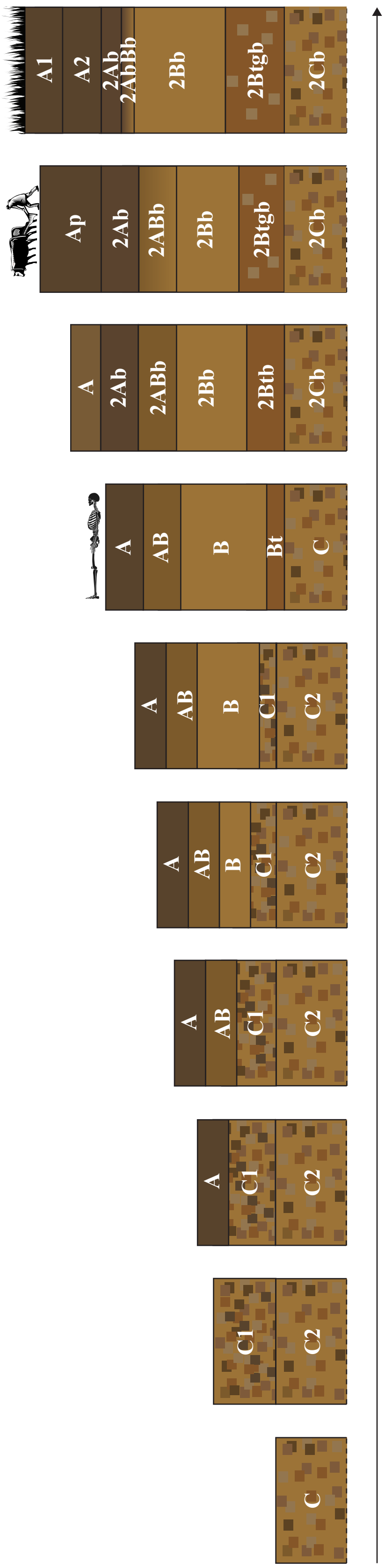
The soils at the site are characterised by polycyclic pedogenesis, a mode of soil formation in which soils undergo multiple successive developmental cycles under varying climatic conditions and in different geomorphological settings (Holliday 2004, 77; Schaetzl, Anderson 2005, 338–339).

In what follows, soil development at Pezdirčeva njiva is illustrated using a theoretical model (*Fig. 2*). This model employs the colour scheme of natural soils from control profile P5, which is dominated by yellowish hues. To represent horizons associated with eluviation–illuviation and redox processes, a more pronounced reddish tone is used for horizon Btg3 from control profile P6 (cf. Ch. 10.1, Fig. 2). The model envisages four main phases of soil development, which differ according to the relationship between the rates of sedimentary and pedogenic processes at the site and, consequently, according to the type of soil horizon forming and thickening in each phase (*Fig. 2*).[3] These processes are discussed in more detail below.

Phase 0 (*Fig. 2*) marks a period of repeated sedimentation events that occurred at the site prior to the Holocene. During major catastrophic events in the Pliocene and Pleistocene, re-sedimented material completely covered and infilled the karstic landforms at the site (cf. Ch. 10.1, Fig. 3). This material was derived from the surrounding carbonate environments and, although its precise provenance has not yet been examined in detail, it was likely similar in geochemical composition to the parent weathering products of limestone and dolomite (cf. Bukovac et al. 1983). The re-sedimented deposits probably accumulated at the site as a mixed, unsorted, and unstratified assemblage of various soil types and horizons characteristic of carbonate environments. Today, this deposit is lithostratigraphically classified as quartz sand (cf. Ch. 10.1, Fig. 1), reaching a thickness of at least several metres (cf. Bukovac et al. 1983).

Following the deposition of re-sedimented soils, pedo-sedimentary processes, which may have begun as early as the Pleistocene (cf. Kühn 2003; Kabala et al. 2019)

[3] The theoretical model serves as a simplified representation, with the development of soils associated with forest vegetation – which leads to the formation of the Ol, Of, and Oh horizons – not taken into account in phase t3 (*Fig. 2*). When forest vegetation was replaced by grassland, these horizons mineralised into horizon A, which represents the starting point of phase t3. The model also does not include the deliberate construction of barrows (cf. *Fig. 2*: t7), as these represent microlocational sedimentation events that are discussed in detail in the model of the pedostratigraphic history of the cemetery (*Fig. 3*).



FAZA 0 / PHASE 0

Resedimentacija /
Re-sedimentation

Zemljina iz širše okolice Kučarja, ki je nastajala na karbonatnih matičnih podlagah.
Nestratificirano, nesortirano gradivo različnih talnih horizontov.
Transport in odložitev/sedimentacija gradiva na lokaciji v času pliocena (*t1*) in pleistocena (*t2*) ob velikih katastrofičnih dogodkih.

Soil from the wider Kučar area, formed on carbonate parent materials.
Unstratified, unsorted material from different soil horizons.
Transport and deposition/sedimentation of material at the site during the Pliocene (*t1*) and Pleistocene (*t2*) in the course of major catastrophic events.

FAZA 1 / PHASE 1

Razvoj tal na resedimentiranem gradivu, rast horizonta B /
Soil genesis on the re-sedimented material, the B horizon thickening

Hitrost sedimentacije < hitrost pedogeneze.

t3: nastanek humusno akumulativnega horizonta (A).
t3–t7: koluvijalni doprinos pri nastanku tal, ki pa ni viden kot samostojna plast.
t3–t7: rast horizonta B navzgor in sočasno poglabljanje navzdol.
t4–t7: postopno pretvarjanje spodnjega dela horizonta A v horizont B.
t5: diferenciacija mineralnega horizonta (B).
t7: eluvijalno-iluvijalni procesi (t. j. vertikalni procesi izpiranja po horizontih navzdol) sprožijo diferenciacijo horizontov B in Bt, ki se nadaljuje tudi v fazah t8–t10.
t7: nastanek grobišča na Pezdirčevi njivi.

Sedimentation rate < pedogenesis rate.

t3: formation of the humus-accumulative horizon (A).
t3–t7: colluvial contribution to soil formation, not visible as a separate layer.
t3–t7: upbuilding of the B horizon and its simultaneous deepening.
t4–t7: gradual transformation of the lower part of the A horizons into the B horizons.
t5: differentiation of the mineral horizon (B).
t7: eluvial–illuvial processes (i.e., vertical leaching through the horizons) trigger the differentiation of the B and Bt horizons, which continues through phases t8–t10.
t7: formation of the Pezdirčeva njiva cemetery.

FAZA 2 / PHASE 2

Pokop tal /
Soil burial

Hitrost sedimentacije > hitrost pedogeneze.

t8: sedimentacijski dogodek, nastane pokopani humusno akumulativni horizont (2Ab).

Sedimentation rate > pedogenesis rate.

t8: A sedimentation event, forming a buried humus-accumulative horizon (2Ab).

FAZA 3 / PHASE 3

Razvoj tal ob dolgotrajni kmetijski rabi, rast horizonta A / Soil development under long-term agricultural use, the A horizon thickening

Hitrost sedimentacije = hitrost pedogeneze.

t9: homogeniziranje in bogatitev z organskim materialom ornice (Ap).
t9: uničenje/erozija gomil s poljedelsko rabo.
t10: diferenciacija humusno akumulativnih horizontov v A1 in A2 zaradi zatravitve opuščenih poljedelskih površin (Ap).

Sedimentation rate = pedogenesis rate.

t9: homogenisation and enrichment with organic material within the plough layer (Ap).
t9: destruction/erosion of barrows through agricultural use.
t10: differentiation of humus-accumulative horizons into A1 and A2 due to grassland cover on former arable land (Ap).

Sl. 2: : Teoretični model razvoja tal na najdišču.
Fig. 2: Theoretical site-specific soil formation model.

ter tako povzročali rast tal navzgor, ponekod pa tudi nastanek pokopanih horizontov A.

V fazi 1 (*sl. 2*), ki obsega večji del holocena, je bila za tla značilna hitrost sedimentacije manjša od hitrosti pedogeneze. Takšno razmerje med obema tipoma procesov je povzročilo rast B-horizonta navzgor ter v manjšem obsegu tudi njegovo sočasno poglabljanje navzdol (prim. Birkeland 1984, 184; Johnson 1985, 30; Schaetzl, Anderson 2005, 324–325, 458–460; Johnson et al. 2005, 34; Gruškovnjak 2019, sl. 11).

V fazi t3 je vegetacija obogatila vrhnji del resedimentiranega gradiva (C1) z endogeno organsko snovjo, kar je skupaj z bioturbacijo in biološkim kroženjem snovi povzročilo nastanek humusno akumulativnega A-horizonta.

V fazah t4–t7 je sledil stalni nizkoenergijski koluvialni doprinos s pobočja Kučarja, ki pa v pedostratigrafskem zapisu ni viden kot samostojna plast. Zaradi kopičenja endogenega organskega gradiva in odlaganja eksogenega organomineralnega koluvialnega gradiva se je horizont A sčasoma odebelil za več kot 10–20 cm, torej čez cono koreninskega razrasta travne ruše, v kateri je biološko kroženje snovi v tleh najintenzivnejše. Spodnji deli horizonta A so bili zato postopno prek prehodnega horizonta AB izvzeti iz kroženja snovi, saj so bili v njih vnosi organske snovi manjši od njenih izgub.

Horizont B je v fazi 1 zaradi površinskega dodajanja gradiva rasel navzgor ter se hkrati zaradi vertikalno delujočih pedogenih procesov, še zlasti preperevanja mineralov, strukturiranja talnih agregatov in izpiranja, v manjšem obsegu poglabljal tudi navzdol v resedimentirano gradivo (C1) iz faze 0. Zaradi vertikalno potekajočih eluvialno-iluvialnih procesov je v preodebeljenem horizontu B v fazi t7 prišlo do diferenciacije na B- in z izprano glino bogatejši Bt-horizont, ki se je nadaljevala tudi v fazah t8–t10.

Faza t7 verjetno predstavlja naravni pedostratigrafski zapis na lokaciji v času nastanka grobišča na Pezdirčevi njivi. V takratnem okoljskem kontekstu tal je prišlo do namenskega nasutja mlajšehalštatskodobnih gomil in pozneje razširitve grobišča s planimi viniškimi grobovi (prim. *sl. 3:* F1.1–F1.2).

Faza 2 (*sl. 2*) označuje krajše obdobje v razvoju tal, v katerem se sprva nadaljuje poglabljanje B- in Bt-horizontov navzdol, nato sledi pokop tal. Ta sprememba nastane, ker je hitrost sedimentacije večja od hitrosti pedogeneze. Višjeenergijsko odlaganje koluvialnega gradiva, ki je v fazi t8 pokopalo nekdanjo hodno površino in ustvarilo pokopani A-horizont, je dokumentirano v talnem profilu P1 ter arheoloških referenčnih profilih A–B in C–D v vzhodnem delu grobišča (poglavje 10.1, sl. 1–2, glej tudi poglavje 2, sl. 2.8). V navedenih profilih so nad 2Ab ležeči humusno akumulativni horizonti svetlejše barve kot pokopani A-horizont. Takšna situacija kaže,

but certainly by the Holocene, led to renewed horizonation and the development of eutric brown soils (Eutric Cambisol) at the site. Since Pezdirčeva njiva lies on the footslope of Kučar (cf. Ch. 10.1, Fig. 13), the soils functioned during the Holocene as a depositional surface that received surface and subsurface waters enriched in carbonates and basic cations, as well as transported material, particularly from the O and A horizons of the upper sections of Kučar's slope (cf. Ch. 10.1). Erosional–colluvial processes of varying intensity deposited organo-mineral material at the site, causing upward soil accretion and the sporadic formation of buried A horizons.

In Phase 1 (*Fig. 2*), which spans most of the Holocene, the rate of sedimentation was lower than the rate of pedogenesis. This imbalance led to upbuilding of the B horizon and, to a lesser extent, its top-down thickening (cf. Birkeland 1984, 184; Johnson 1985, 30; Schaetzl, Anderson 2005, 324–325, 458–460; Johnson et al. 2005, 34; Gruškovnjak 2019, Fig. 11).

In phase t3, vegetation enriched the upper part of the re-sedimented deposit (C1) with endogenous organic matter, which, together with bioturbation and biological cycling, led to the formation of a humus-accumulative A horizon.

Phases t4–t7 were characterised by continued low-energy colluvial input from the Kučar slope, which is not, however, discernible in the pedostratigraphic record as a discrete layer. The combined accumulation of endogenous organic matter and the sedimentation of exogenous organo-mineral colluvial material caused the A horizon to thicken by more than 10–20 cm, extending beyond the root zone of the grass cover where biological cycling is most intense. The lower parts of the A horizon were therefore gradually excluded from active nutrient cycling through the development of a transitional AB horizon, as organic inputs diminished while losses increased.

Due to surface additions of material, the B horizon accreted upwards during Phase 1, while also deepening into the re-sedimented substrate (C1 from Phase 0) under the influence of vertically acting pedogenic processes, particularly mineral weathering, soil aggregation, and leaching. Through vertical eluviation–illuviation processes, this thickened B horizon eventually differentiated into a B horizon and a clay-enriched Bt horizon, a transformation that continued during phases t8–t10.

Phase t7 probably represents the site's natural pedostratigraphic record at the time when the cemetery at Pezdirčeva njiva was established. Within the environmental soil context of this period, Late Hallstatt barrows were deliberately constructed, followed by the subsequent expansion of the cemetery with flat Vinica-type graves (cf. *Fig. 3*: F1.1–F1.2).

Phase 2 (*Fig. 2*) marks a shorter period of soil development, initially characterised by the continued da pri pokopu ni šlo za hiter sedimentacijski dogodek, temveč za daljši proces, v okviru katerega melanizacija površinskega horizonta ni dohajala hitrosti sedimentacije (prim. Schaetzl, Anderson 2005, 459; Johnson et al. 2005, 34; Buol et al. 2011, 340; Gruškovnjak 2019, 34–36).

Ker je pokopani horizont A v profilu P1 nad viniškim grobom 50 in ker so bili v njem odkriti večji fragmenti poznolatenske in antične keramike (glej poglavje 2, sl. 2.9), sklepamo, da horizont 2Ab označuje več sto let trajajoče obdobje razmeroma stabilnega površinskega horizonta, verjetno zaradi načrtnega vzdrževanja prostora grobišča. Opisana pedostratigrafska zveza med horizontom Ab in viniškim grobom omogoča relativno datacijo pokopa tal v čas *po nastanku* planega, latenskega dela grobišča. Večji fragmenti antične keramike v omenjenem horizontu pa nakazujejo, da se je pokop zgodil v času antike ali pozneje.

Zadnjo fazo razvoja tal na najdišču, tj. fazo 3 (*sl. 2*), zaznamuje vnovična sprememba razmerja med hitrostjo sedimentacije in pedogeneze, ki sta v tej fazi uravnoteženi. Takšna sprememba se je zgodila zaradi dolgotrajne novoveške, morda pa že srednjeveške poljedelske rabe tal na lokaciji (glej poglavje 10.1). Ciklično oranje in gnojenje v tej fazi sta povzročila homogenizacijo in obogatitev ornice (Ap) z organskim materialom ter rast humusno akumulativnega horizonta navzgor (prim. Schaetzl, Anderson 2005, 458–459; Johnson 1985, 30; Buol et al. 2011, 339; Gruškovnjak 2019, 34–36).

Zaradi bioturbacije in vplivov oranja se v fazah t9–t10 (*sl. 2*) začneta zabrisovanje in postopna degradacija pokopanih horizontov, zlasti 2ABb in 2Ab, kar je dobro razvidno v talnem profilu P1. V tem profilu so tla, pokopana v antiki ali pozneje (2Ab), še vedno dobro melanizirana, medtem ko je organska snov večje frakcije že do toliko mineralizirana, da ne odraža več povišane vsebnosti organske snovi (glej poglavje 10.1, tab. 1, sl. 1–2, 5).

Podobni procesi degradacije pokopanih A-horizontov so bili dokumentirani na številnih najdiščih, verjetno kot posledica upada števila živih organizmov v tleh po pokopu (Holliday 2004, 285–286). Pri eksperimentalnem nasutju v kraju Overton Down v Združenem kraljestvu je bilo na primer ugotovljeno, da se je vsebnost organskega ogljika v pokopanem A-horizontu pod nasutjem v 33 letih po pokopu zmanjšala za kar 29 % (Crowther et al. 1999).

V fazi t9 (*sl. 2*) pride na Pezdirčevi njivi do uničenja gomil zaradi poljedelske rabe (prim. *sl. 3:* F3.1 in poglavje 10.1, sl. 12), v zadnji fazi t10 pa se v nekaterih delih najdišča (talni profili P2–P4, P6; glej poglavje 10.1, tab. 1, sl. 1–2, 5) pojavi diferenciacija humusno kumulativnega horizonta na horizonta A1 in A2, kar

downward deepening of the B and Bt horizons, followed by the burial of soils as a consequence of the sedimentation rate exceeding the rate of pedogenesis. High-energy colluvial deposition during phase t8, which buried the former ground surface and created the buried A horizon, was documented in soil profile P1 and in archaeological reference profiles A–B and C–D in the eastern part of the cemetery (Ch. 10.1, Figs. 1–2; see also Ch. 2, Fig. 2.8 in this volume). In these profiles, the humus-accumulative horizons above 2Ab are lighter in colour than the buried A horizon itself. This indicates that burial was not the result of a rapid depositional event, but rather a prolonged process during which melanisation of the surface horizon could not keep pace with sediment accumulation (cf. Schaetzl, Anderson 2005, 459; Johnson et al. 2005, 34; Buol et al. 2011, 340; Gruškovnjak 2019, 34–36).

Since the buried A horizon in profile P1 was located above Vinica-type Grave 50 and contained larger fragments of Late La Tène and Roman period pottery (cf. Ch. 2, Fig. 2.9), we infer that 2Ab represents a surface horizon that remained stable for several centuries, probably as a result of deliberate cemetery maintenance. The pedostratigraphic relationship between the Ab horizon and the Vinica-type grave allows us to place the relative timing of the soil burial after the establishment of the flat La Tène section of the cemetery. Furthermore, the presence of substantial fragments of pottery from the Roman period within this horizon suggests that the burial took place during Roman period or later.

The final stage of soil development at the site, Phase 3 (*Fig. 2*), is characterised by a balance between sedimentation and pedogenesis. This shift resulted from long-term post-Medieval, and possibly already Medieval, soil cultivation at the site (cf. Ch. 10.1). During this phase, cyclical ploughing and manuring homogenised and enriched the ploughsoil (Ap) with organic matter, leading to the upward cumulisation of the humus-accumulative horizon (cf. Schaetzl, Anderson 2005, 458–459; Johnson 1985, 30; Buol et al. 2011, 339; Gruškovnjak 2019, 34–36).

Bioturbation and ploughing during phases t9–t10 (*Fig. 2*) led to a loss of horizon expression in the buried horizons, particularly 2ABb and 2Ab, as is clearly evident in soil profile P1. In this profile, soils buried in Roman period or later (2Ab) remain well melanised, although larger organic fractions have mineralised to the extent that they no longer register as elevated organic content (see Ch. 10.1, Tab. 1, Figs. 1–2, 5).

Similar degradation processes affecting buried A horizons have been documented at numerous sites and are likely the result of a post-burial decline in soil biota (Holliday 2004, 285–286). For example, at the experimental mound at Overton Down in the United Kingdom, the organic carbon content beneath the fill of a buried A horizon decreased by 29% within 33 years of burial (Crowther et al. 1999).

kaže na preoblikovanje nekdanjih poljedelskih površin (A2) v travniške (A1) (prim. *sl. 3:* F3.2).

Razvoj tal na Pezdirčevi njivi je tako potekal v več zaporednih fazah, ki odražajo spreminjajoča se razmerja med sedimentacijskimi, pedogenimi in antropogenimi procesi v holocenu. Rekonstruirana pedostratigrafska slika kaže, da so tla na najdišču ohranila sledove večtisočletne dinamike, ki je pomembno vplivala na ohranjenost arheološkega zapisa in grobnih pridatkov na Pezdirčevi njivi. Oboje podrobneje pojasnjujemo v nadaljevanju.

PEDOSTRATIGRAFSKA ZGODOVINA GROBIŠČA

Teoretični model pedostratigrafske zgodovine (*sl. 3*) pojasnjuje preoblikovanje ter ohranjenost arheološkega zapisa in grobnih pridatkov na najdišču. Umeščen je v kontekst razvoja tal na lokaciji (*sl. 2:* faze 1–3), iz katerega je razvidno, da sta na grobišču dva pedostratigrafska kompleksa.[4]

Starejši kompleks sestavljajo A-, AB- in diferencirani B-horizonti, razviti na resedimentiranem pliokvartarnem gradivu (*sl. 2:* t1–t7). Mlajši kompleks vključuje horizonte Ap ter A1 in A2 nad pokopanim humusno akumulativnim horizontom (2Ab), ki označuje sedimentacijski dogodek in litološko diskontinuiteto (*sl. 2:* t8–t10). Primerjalno gledano so bili vsi horizonti nad pokopanimi tlemi razviti na drugem gradivu – mešanici endogenega organskega gradiva ter eksogenega materiala, povezanega s koluvialnim doprinosom s Kučarja ter z gnojenjem njivskih in travniških površin.

Na tem mestu je treba poudariti, da je v modelu upoštevan še tretji pedostratigrafski kompleks – gomile (*sl. 3*). Njihovo nasutje je obravnavano kot antropogeni sedimentacijski dogodek, ki povzroči diskontinuiteto v pedogenih procesih v tleh na najdišču. Zaradi delno drugačnih morfoloških in fizikalno-kemijskih lastnosti zemljine v plaščih gomil, povzročenih s premeščanjem, mešanjem in nasipavanjem z glino bogatega zemljenega gradiva na hodni površini grobišča, so začeli tlotvorni procesi v gomilah potekati z drugačno hitrostjo in intenzivnostjo kot v pokopanih tleh pod gomilo ali v nepokopanem delu tal (prim. *sl. 3:* F1.1). Te razlike upra-

[4] Pedostratigrafski kompleks sestavljajo vsi talni horizonti, razviti na isti matični podlagi. Ko v talnem profilu pride do litološke diskontinuitete, povzročene s sedimentacijskim dogodkom, je treba vse horizonte nad odloženim sedimentom ali nad najvišjim pokopanim horizontom (najpogosteje horizontom Ab) obravnavati kot drug pedostratigrafski kompleks, razvit na drugačni matični podlagi (*sl. 2;* prim. Courty et al. 1989, 31–33, Fig. 3.3; Schaetzl, Anderson 2005, 37; Goldberg, Macphail 2006, Fig. 2.1; Gruškovnjak 2019, sl. 12).

In phase t9 (*Fig. 2*), the barrows at Pezdirčeva njiva were levelled through agricultural activity (cf. Fig. 3: F3.1; Ch. 10.1, Fig. 12). In the final phase, t10, the humus-accumulative horizon in certain sections of the site (soil profiles P2–P4, P6; cf. Ch. 10.1, Tab. 1, Figs. 1–2, 5) differentiated into horizons A1 and A2, reflecting the transformation of former agricultural surfaces (A2) into grassland (A1) (cf. *Fig. 3*: F3.2).

Soil development at Pezdirčeva njiva therefore proceeded through several successive phases, each reflecting shifting balances between sedimentary, pedogenic, and anthropogenic processes during the Holocene. The reconstructed pedostratigraphic sequence shows that the soils at the site preserve traces of millennia-long dynamics that profoundly influenced the preservation of the archaeological record and grave goods at Pezdirčeva njiva. A more detailed discussion of both follows below.

PEDOSTRATIGRAPHIC HISTORY OF THE CEMETERY

The theoretical model of pedostratigraphic history (*Fig. 3*) explains the processes underlying the transformation and preservation of the archaeological record and grave goods at the site. It is situated within the broader framework of soil development (*Fig. 2*: Phases 1–3), which demonstrates the presence of two pedostratigraphic complexes at the cemetery.[4]

The older pedostratigraphic complex consists of A, AB, and differentiated B horizons developed on resedimented Plio–Quaternary deposits (*Fig. 2*: t1–t7). The younger complex comprises Ap, A1, and A2 horizons overlying a buried humus-accumulative horizon (2Ab), which marks a sedimentary event and a lithological discontinuity (*Fig. 2*: t8–t10). In comparison, all horizons above the buried soils developed from different material – namely, a mixture of endogenous organic matter and exogenous sediments derived from colluvial inputs from Kučar as well as from the manuring of field and meadow soils.

It is also important to note that the model considers a third pedostratigraphic complex – the barrows (*Fig. 3*). Their construction represents an anthropogenic sedimentary event that introduces a discontinuity in pedogenic processes within the soils at the site. Owing to the distinct morphological and physico-chemical properties of the

[4] A pedostratigraphic complex comprises all soil horizons that have formed from the same parent material. When a sedimentary event produces a lithological discontinuity in a soil profile, all horizons above the deposited sediment, or above the uppermost buried horizon (most commonly horizon Ab), must be regarded as a separate pedostratigraphic complex that has formed from a different parent material (*Fig. 2*; cf. Courty et al. 1989, 31–33, Fig. 3.3; Schaetzl, Anderson 2005, 37; Goldberg, Macphail 2006, Fig. 2.1; Gruškovnjak 2019, Fig. 12).

vičujejo obravnavo gomilnih nasutij kot samostojnega pedostratigrafskega kompleksa.

V skladu s pedološkimi standardi označevanja so pred imena vseh horizontov, ki spadajo v isti kompleks, dodane enake arabske številke, kompleksi pa so oštevilčeni zaporedno od zgoraj navzdol z upoštevanjem, da pred prvega ne dodajamo številke 1 (prim. Schaetzl, Anderson 2005, 37). V modelu sta vzporedno prikazani pedostratigrafski situaciji, vezani na mlajšehalštatskodobne gomile in grobove (levi in v nekaterih fazah tudi srednji stolpec) ter na viniške plane grobove (desni stolpec). Rimske številke označujejo antropogene sedimentacijske plasti: nasute gomile (I), polnila mlajšehalštatskodobnih grobov (II, III) in polnila viniških grobov (IV). Na podlagi tukaj opisanih pedoloških konceptov in konvencij je v nadaljevanju predstavljen vpliv pedo-sedimentarnih procesov na preoblikovanje ter ohranjenost arheološkega zapisa in artefaktov na najdišču.

Pedološki podatki za talna profila P2 in P3 (poglavje 10.1, tab. 1, sl. 1–2, 5) kažejo, da so bile v fazi F1.1 (*sl. 3*, glej tudi *sl. 2:* t7) prek nekaterih mlajšehalštatskodobnih grobov (II, III) namensko nasute zemljene gomile, bogate z glino. Ta visokoenergijski sedimentacijski dogodek je pokopal tla (horizonti 2Ab, 2ABb, 2Bb) in grobove pod gomilami (II, III), kar je upočasnilo tlotvorne procese v obeh tipih kontekstov. Čeprav so bili pokopani in nepokopani talni horizonti (A, AB, B) na istih globinah ter so zvezno prehajali drug v drugega (*sl. 3:* F.1.1), so začeli pedogenetski procesi na najdišču potekati z dvema različnima hitrostma: v nepokopanih tleh s hitrostjo, običajno za evtrična rjava tla (Eutric Cambisol, dokumentirana na najdišču (glej poglavje 10.1), ter bistveno počasneje v pokopanih tleh in grobovih pod gomilnimi nasutji, ki so "zapečatila" tla in arheološki zapis pod njimi.

Na podlagi stratigrafsko izpričanih posutij plaščev v primeru gomil 48 in 5 v Stični (Gabrovec et al. 2006, priloge 1–2, 4; Gabrovec 2008, 36) predvidevamo, da so v fazi F1.2 (*sl. 3*) gravitacijski in koluvialni procesi sprožili počasno posedanje in erozijo gomil na Pezdirčevi njivi. Ti procesi so se nadaljevali tudi v fazi F1.3. Premeščeno gradivo gomilnih plaščev je bilo odloženo na obodu gomil, kjer je bilo z bioturbacijo vključeno v horizont A (*sl. 3:* F1.2). V tej fazi se je grobišče razširilo s planimi viniškimi grobovi (IV), ki so bili skoncentrirani na severnem in južnem robu grobišča (glej tu, pogl. 4). Podobno kot pri starejšeželeznodobnih grobovih so bile tudi v tem primeru grobne jame izkopane dovolj globoko, da so njihovi spodnji deli segali v horizont B (prim. *sl. 3:* F1.1–F1.2).

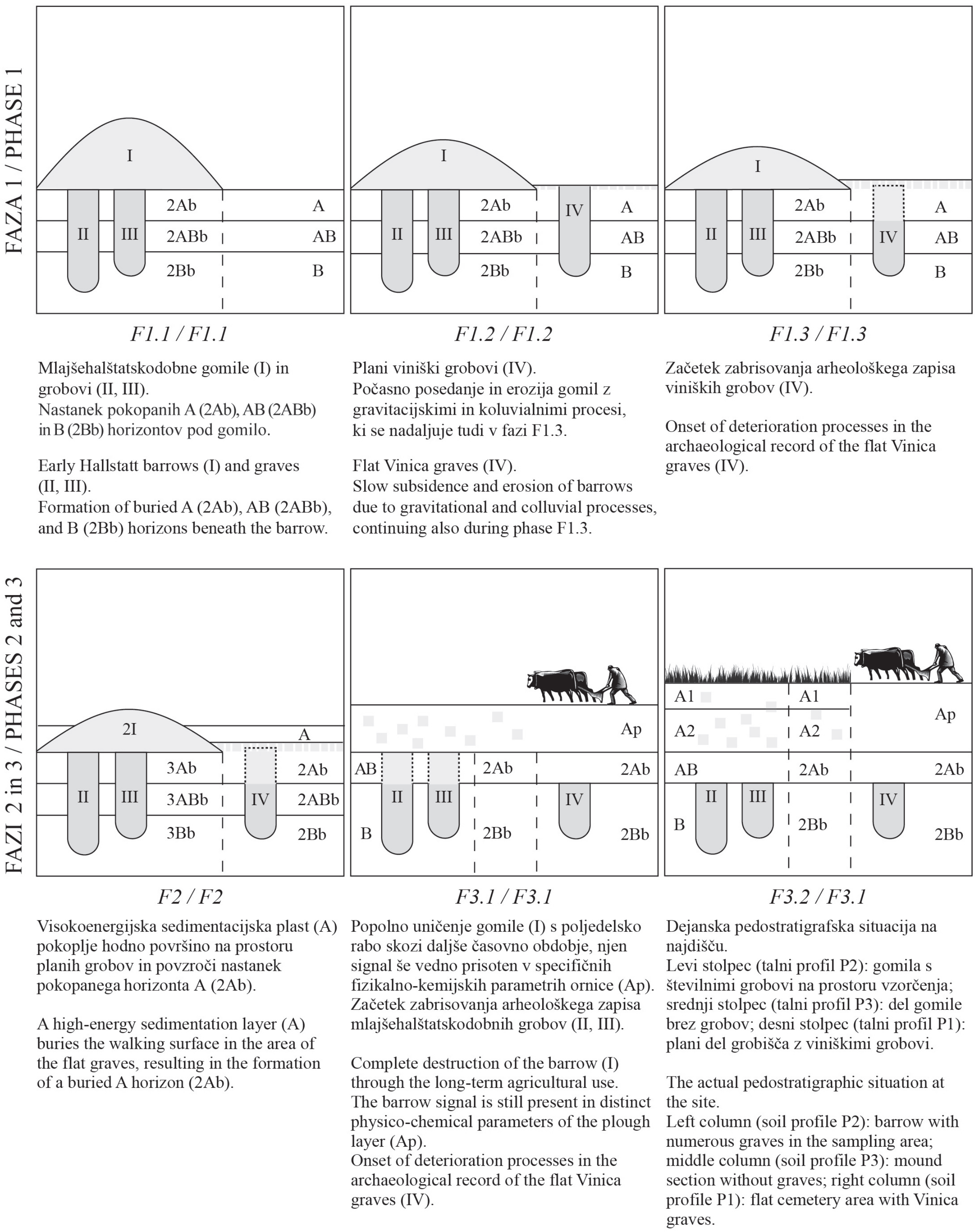
V fazi F1.3 (*sl. 3*) je bioturbacija, tj. mehansko in biološko delovanje rastlin in živali, še zlasti koreninskega sistema in mezofavne, ki premešča zemljeno gradivo v vse smeri – navzgor, navzdol in lateralno (Johnson et al.

mound material – produced by the relocation, mixing, and heaping of clay-rich soils on the cemetery walking surface – soil-forming processes within the mounds began to unfold at a different rate and intensity than in the buried soils beneath them or in the unburied soils (cf. *Fig. 3*: F1.1). These contrasts justify treating the mound deposits as an independent pedostratigraphic complex.

According to soil science marking conventions, identical Arabic numerals are placed before all horizon designations belonging to the same complex, and the complexes are numbered consecutively from top to bottom, with the first complex not marked with the numeral 1 (cf. Schaetzl, Anderson 2005, 37). The model presents two parallel pedostratigraphic sequences: one associated with the Late Hallstatt-period barrows and graves (left column, and in some phases the central column) and another associated with the subsequent flat Vinica-type graves (right column). Roman numerals denote anthropogenic sedimentary units: constructed mound (I), fills of Late Hallstatt graves (II, III), and fills of Vinica-type graves (IV). Building on these conventions, the following section examines the impact of pedo-sedimentary processes on the transformation and preservation of the archaeological record and artefacts at the site.

Pedological data from soil profiles P2 and P3 (Ch. 10.1, Tab. 1, Figs. 1–2, 5) indicate that in Phase F1.1 (*Fig. 3*; cf. also *Fig. 2*: t7), clay-rich mounds were deliberately heaped over certain Late Hallstatt graves (II, III). This high-energy sedimentation event buried the soils (horizons 2Ab, 2ABb, 2Bb) together with the graves beneath the mounds, thereby slowing soil-forming processes in both type of contexts. Although the buried and unburied soil horizons (A, AB, B) occurred at equivalent depths and graded continuously into one another (*Fig. 3*: F1.1), pedogenic processes at the site began to proceed at two distinct rates: in the unburied soils, they advanced at a pace typical of the eutric brown soils (Eutric Cambisol documented at the site (see Ch. 10.1), whereas in the buried soils and graves beneath the mound deposits, they progressed much more slowly due to the "sealing" effect of the overburden, which impeded further pedogenesis and contributed to the preservation of the archaeological record.

Based on stratigraphically documented subsidence observed in the case of Barrows 48 and 5 at Stična (Gabrovec et al. 2006, Appendices 1–2, 4; Gabrovec 2008, 36), we infer that in Phase F1.2 (*Fig. 3*), gravitational and colluvial processes may likewise have contributed to the gradual subsidence and erosion of the mounds at Pezdirčeva njiva. These processes continued into Phase F1.3. Material displaced from the mound fill was redeposited along their peripheries, where it was incorporated into A horizon through bioturbation (*Fig. 3*: F1.2). At this stage, the cemetery was extended by the introduction of flat Vinica-type graves (IV), concentrated along



Sl. 3: Teoretični model grobišča v kontekstu razvoja tal na najdišču.
Fig. 3: Theoretical model of the cemetery in relation to soil development at the site.

2005, 38–40), začelo na območju planih viniških grobov zabrisovati zgornje dele vkopov in homogenizirati polnila grobnih jam v A-horizontu nepokopanih tal.

its northern and southern margins (see Chapter 4 in this volume). As with the Early Iron Age graves, these burial pits were dug to a sufficient depth for their lower parts to extend into B horizon (cf. *Fig. 3*: F1.1–F1.2).

Na dnu grobnih jam v B-horizontih sta se hkrati začeli degradacija kosti in korozija kovinskih artefaktov.

Stratigrafija in grobni pridatki mlajšehalštatskodobnih grobov pod gomilnimi nasutji so bili v tej fazi (*sl. 3:* F1.3) primerjalno manj izpostavljeni preoblikovanju s pedogenimi procesi. Pokopani talni horizonti in arheološki konteksti v njih so bili namreč bolj odmaknjeni od površja in zato izolirani v biološko in kemično stabilnejšem okolju. Zaradi večje relativne globine je bila (mikro)biološka aktivnost v teh kontekstih upočasnjena, temperaturne razlike ter nihanja v vlažnosti in vsebnosti kisika pa manj izraziti, kar je upočasnilo zabrisovanje stratigrafskega zapisa, korozijo kovin in raztapljanje apatita v kosteh.

Faza F2 (*sl. 3*, glej tudi *sl. 2:* t8) označuje krajše obdobje v zgodovini grobišča, ko je višjeenergijski koluvij, predvidoma v antiki ali pozneje, pokopal hodno površino in ustvaril pokopani humusno akumulativni horizont (2Ab) na območju planih viniških grobov (glej poglavje 10.1). Od te faze lahko na najdišču sledimo dvema različno starima in na različen način pokopanima A-horizontoma: starejšemu, ki je nastal z namenskim nasutjem gomil in ki je ohranjen v talnem profilu P3 v vzhodnem delu grobišča pod eno od mlajšehalštatskodobnih gomil (*sl. 3:* 3Ab; glej tudi poglavje 10.1, tab. 1, sl. 1–2, 5), ter mlajšemu, ki je bil oblikovan z naravnim koluvijem s Kučarja v času antike ali pozneje in ki je ohranjen v talnem profilu P1 v severnem delu grobišča nad viniškim grobom 50 (*sl. 3:* 2Ab; glej tudi poglavje 10.1, *tab. 1, sl. 1–2, 5*).

Da gre dejansko za različno stara in različno dobro ohranjena pokopana humusno akumulativna horizonta, potrjuje primerjava pedoloških podatkov za oba, vključno z njuno debelino ter deležem gline in organske snovi (poglavje 10.1, tab. 1, sl. 1–2, 5). Organska snov je bolje ohranjena v horizontu Ab pod gomilo, medtem ko je v profilu P1 nad viniškim grobom 50 vidna le še kot melanizirajoči pigment, ki daje tej plasti značilno temno barvo, tipično za pokopane A-horizonte.

Tako izrazita razlika med pokopanima A-horizontoma (*sl. 3:* F2) je nastala zaradi različne narave gradiva, s katerim sta bila pokopana. Pri talnem profilu P3 je bil horizont Ab prekrit z debelejšo plastjo zemljine s povišanim deležem gline in relativno majhnim deležem organske snovi, medtem ko je bil pri talnem profilu P1 pokopan s tanjšo plastjo koluvialnega gradiva s Kučarja, v kateri je prevladoval material iz horizontov O in A, bogatih z organsko snovjo (glej poglavje 10.1, sl. 13).

Ker je bil gomilni plašč debelejši in teksturno težji, je vplival na pretok padavinske vode skozi talni profil, zmanjšal prezračenost in znižal mikrobno aktivnost, kar je upočasnilo mineralizacijo organske snovi in omogočilo boljšo ohranitev humusa v pokopanem A-horizontu. Čeprav je Ab v profilu P3 starejši in je bil pokopan v mlajšehalštatski dobi, je pokop upočasnil

In Phase F1.3 (*Fig. 3*), bioturbation – i.e. mechanical and biological activity by plants and animals, particularly associated with root systems and mesofauna, which moves sediment upwards, downwards, and laterally (Johnson et al. 2005, 38–40) – began to blur the upper parts of the grave cuts and homogenise their fills within A horizon of the unburied soils. At the same time, bone degradation and the corrosion of metal artefacts commenced in the basal parts of the burial pits within B horizon.

During this phase, the stratigraphy and grave goods of the Late Hallstatt burials beneath the mound deposits were comparatively less affected by transformation through pedogenic processes (*Fig. 3*: F1.3). Located deeper below the surface, the buried soils and the archaeological contexts they contained were isolated within a biologically and chemically more stable environment. Their greater relative depth reduced (micro)biological activity and temperature fluctuations, while also moderating changes in moisture and oxygen content. As a result, pedogenic overprinting of stratigraphy, metal corrosion, and bone apatite dissolution progressed more slowly.

Phase F2 (*Fig. 3*; cf. also *Fig. 2*: t8) marks a shorter period in the cemetery's history, during which higher-energy colluvial deposition – probably occurring in Roman period or later – buried the walking surface and resulted in the formation of a buried humus-accumulative horizon (2Ab) in the area of the flat Vinica-type graves (see Ch. 10.1). From this phase onward, two buried A horizons of different ages and modes of burial can be traced at the site: the earlier, created by deliberate barrow construction and preserved in profile P3 in the eastern part of the cemetery beneath one of the Late Hallstatt barrows (*Fig. 3*: 3Ab; cf. Ch. 10.1, Tab. 1, Figs. 1–2, 5); and the later, formed by natural colluvial input from Kučar during Roman period or later, preserved in profile P1 in the northern part of the cemetery above Vinica-type grave 50 (*Fig. 3*: 2Ab; see also Ch. 10.1, Tab. 1, Figs. 1–2, 5).

Comparative pedological data – including horizon thickness, clay content, and organic matter – confirm that these are indeed buried A horizons of different ages and states of preservation (Ch. 10.1, Tab. 1, Figs. 1–2, 5). Organic matter is better preserved in the Ab horizon beneath the barrow, whereas in profile P1 above Vinica-type grave 50, it is present only as a melanising pigment, imparting the characteristic dark colour typical of buried A horizons.

The marked differences between these two buried horizons (*Fig. 3*: F2) result from the contrasting nature of the deposits that covered them. In soil profile P3, horizon Ab was buried beneath a thicker, clay-rich mound fill containing relatively sparse organic matter, whereas in profile P1 it was overlain by a thinner colluvial layer derived from Kučar, dominated by material originating from organic-rich O and A horizons (see Ch. 10.1, Fig. 13).

pedogene spremembe. Nasprotno pa je mlajši Ab v profilu P1, ki je nastal predvidoma v antiki ali pozneje, zaradi večje biološke aktivnosti, bolj oksidativnih razmer in neupočasnjene mineralizacije v krajšem času doživel izrazitejšo degradacijo.

V fazi F3.1 (*sl. 3,* glej tudi *sl. 2:* t9) je sledilo popolno uničenje gomil zaradi dolgotrajne, morda že srednjeveške in nato novoveške poljedelske rabe tal na najdišču. V tej fazi so bili gomilni plašči progresivno erodirani toliko, da niso bili več topografsko ali stratigrafsko prepoznavni (poglavje 10.1, sl. 12). Čeprav je bila z glino bogata zemljina, uporabljena za nasutja gomil, premeščena in premešana znotraj ornice (Ap), se je teksturni signal gomilnega plašča kljub temu ohranil v humusno akumulativnih horizontih do različnih globin.[5]

Uničenje gomil z oranjem je privedlo do nove pedostratigrafske situacije, v kateri je prišlo do neposrednega stika med površinskim humusno kumulativnim horizontom A – v tem primeru ornice (Ap) – in pokopanim horizontom 2Ab na območju gomil (*sl. 3:* F3.1). S tem so bili mlajšehalštatskodobni grobni konteksti "odpečateni" in prvič po nasutju gomil bolj izpostavljeni specifičnim tlotvornim dejavnikom.

Zabrisovanje arheološkega zapisa in degradacija artefaktov v mlajšehalštatskodobnih grobovih zaradi bioturbacije, eluvialno-iluvialnih in redoks procesov sta se pospešila šele v tej fazi in torej bistveno pozneje kot pri viniških grobovih. V slednjih so ti procesi namreč neprekinjeno potekali že od faze F1.3 (prim. *sl. 3:* F1.3, F3.1), zato je arheološki zapis planih viniških grobov bistveno bolj zabrisan, artefakti v grobovih pa precej slabše ohranjeni (glej tu poglavji 5.3 in 10.3).

V fazi F3.2 (*sl. 3*) se je zgodila zadnja pedostratigrafska sprememba, ko se je v nekaterih delih grobišča (talni profili P2–4, P6, glej poglavje 10.1, tab. 1, sl. 1–2, 5) odvila diferenciacija humusno kumulativnega horizonta na horizonta A1 in A2. To kaže na preoblikovanje nekdanjih poljedelskih površin (A2) v travniške (A1).

Faza F3.2 ustreza dejanski pedostratigrafski situaciji na grobišču, kakršna je bila ugotovljena med geoarheološkim vzorčenjem treh talnih profilov (P1–P3). V levem stolpcu prikazani profil P2 ustreza stanju v osrednjem delu grobišča, kjer so bili znotraj oboda gomile številni, drug poleg drugega vkopani grobovi in kjer pokopani horizont A ni bil ohranjen. V srednjem stolpcu je prikazan profil P3 v vzhodnem delu grobišča z mlajšehalštatskodobnim pokopanim A-horizontom (2Ab) pod eno od gomil, v desnem stolpcu koloni pa profil P1 v severnem delu najdišča z ohranjenim mlajšim, predvidoma v antiki ali pozneje pokopanim A-horizontom (2Ab) nad viniškim grobom 50.

5 Predvidevamo, da je signal erodiranih gomil na obeh lokacijah prisoten tudi v obliki specifičnega geokemijskega signala, kar nameravamo preveriti v prihodnje.

Since the barrow fill was thicker and texturally heavier, it reduced water percolation through the soil profile, decreased aeration, and lowered microbial activity. These conditions slowed the mineralisation of organic matter and allowed for better preservation of humus in the buried A horizon. Horizon Ab in profile P3 was buried during the Late Hallstatt period and is therefore earlier; nevertheless, burial significantly slowed its pedogenic transformation. Conversely, the younger horizon Ab in profile P1, which probably formed in Roman period or later, experienced more intense biological activity, more oxidative conditions, and accelerated mineralisation, leading to more pronounced degradation within a shorter time span.

In Phase F3.1 (*Fig. 3*; cf. also *Fig. 2*: t9), the mounds were completely levelled as a result of long-term soil cultivation, possibly beginning in the Mediaeval period and continuing into the post-Mediaeval era. During this phase, the mound fills were progressively eroded until they became topographically and stratigraphically unidentifiable (Ch. 10.1, Fig. 12). Although the clay-rich sediments of the mound deposits were relocated and incorporated into the ploughsoil (Ap), the textural signal of the original mound material remained detectable within the humus-accumulative horizons at various depths.[5]

The destruction of the barrows through ploughing created a new pedostratigraphic situation in which the surface humus-accumulative horizon A in the former mound areas – in this case, the ploughsoil (Ap) – came into direct contact with the buried horizon 2Ab (*Fig. 3*: F3.1). As a result, the Late Hallstatt grave contexts became "unsealed" and, for the first time since the construction of the barrows, were more directly exposed to specific soil-forming processes.

The disturbance of the archaeological record and the degradation of artefacts in the Late Hallstatt graves, driven by bioturbation, eluviation–illuviation, and redox processes, began to accelerate only in this phase. This occurred much later than in the Vinica-type graves, where these processes had been active continuously since Phase F1.3 (cf. *Fig. 3*: F1.3, F3.1). As a result, the archaeological record of the Vinica-type graves is considerably more disturbed, and their artefacts are markedly less well preserved (see Chs. 5.3 and 10.3).

In Phase F3.2 (*Fig. 3*), the final pedostratigraphic change occurred, when in certain parts of the cemetery (soil profiles P2–P4, P6; see Ch. 10.1, Tab. 1, Figs. 1–2, 5) the humus-accumulative horizon differentiated into horizons A1 and A2. This transformation indicates that former arable surfaces (A2) were converted into grassland (A1).

Phase F3.2 corresponds to the present pedostratigraphic situation at the cemetery, as documented through

5 We posit that at both locations, the imprint of the eroded mounds is also reflected in distinct geochemical signals, which we seek to examine in future research.

Predstavljeni model pedostratigrafske zgodovine grobišča na Pezdirčevi njivi (*sl. 3*) jasno ponazarja, da arheološki zapis po nastanku ne ostaja statičen, temveč se dinamično spreminja zaradi dolgotrajnega in večplastnega prepletanja naravnih in antropogenih procesov na najdišču. Najpomembnejši dejavniki, ki so bistveno vplivali na ohranjenost izvornega stratigrafskega zapisa in artefaktov v grobovih, so visokoenergijski, antropogeni in naravni sedimentacijski dogodki, tj. namenska nasutja gomil in koluvialni pokop tal z gradivom s Kučarja, bioturbacija, eluvialno-iluvialni in redoks procesi ter spremembe v rabi prostora skozi čas.

Pedogeni procesi, ki so vplivali na zapis in artefakte, so bili odvisni tako od bioloških in fizikalno-kemijskih lastnosti talnih horizontov, v katere je bil arheološki zapis umeščen, kot tudi od lastnosti talnih horizontov, ki so ležali nad plastmi z arheološkimi ostanki. Enako pomemben dejavnik za ohranjenost zapisa in artefaktov je bila dolžina izpostavljenosti različnim pedogenim dejavnikom, ki so vključevali mehanske poškodbe ter (mikro)biološke, hidrološke in fizikalno-kemijske procese. Rahlo kisla tla, velika količina padavin, odsotnost karbonatov in zmanjšana vsebnost kalcijevih kationov so tiste pedogene lastnosti tal na najdišču, ki so skupaj z naravnimi in antropogenimi sedimentacijskimi dogodki določile, v kolikšnem obsegu so bili arheološki zapis in artefakti ohranjeni ali preoblikovani v različnih delih grobišča. Model tako uspešno pojasnjuje navidezni paradoks, da so mlajši, plani viniški grobovi in njihovi pridatki ter pokopana tla nad njimi slabše ohranjeni kot mlajšehalštatskodobna pokopana tla in grobovi z artefakti pod gomilami.

SKLEPNE UGOTOVITVE

Analiza paleookolja, razvoja tal in pedostratigrafske zgodovine najdišča je pokazala, da je ohranjenost arheološkega zapisa in artefaktov na Pezdirčevi njivi rezultat večtisočletnega dinamičnega prepletanja naravnih in antropogenih procesov po nastanku grobišča. Na preoblikovanje stratigrafskega zapisa so odločilno vplivali visokoenergijski naravni in antropogeni sedimentacijski dogodki, bioturbacija, eluvialno-iluvialni in redoks procesi ter spremembe v rabi prostora. Specifične lastnosti lokalnih tal – rahlo kisla reakcija, odsotnost karbonatov in zmanjšana vsebnost kalcijevih kationov – so poleg naštetih pedogenih procesov še dodatno vplivale na hitrost razgradnje organskih in anorganskih materialov v grobovih.

Raziskava potrjuje nujnost integracije geoarheoloških metod z arheometričnimi analizami grobnih pridatkov, saj lahko le s celostnim razumevanjem pedosedimentarnih procesov, ki določajo lastnosti tal in s tem okolja, v katero so bili pridatki umeščeni s pokopom, zanesljivo pojasnimo stopnjo njihove ohranjenosti ali

geoarchaeological sampling of three soil profiles (P1–P3). Profile P2, shown in the left column, represents the stratigraphic record in the central section of the cemetery, where numerous graves were cut side by side within the mound perimeter and where the buried A horizon was not preserved. The middle column shows profile P3 in the eastern part of the cemetery, which contains the Late Hallstatt buried A horizon (2Ab) beneath one of the barrows, while the right column shows profile P1 in the northern part of the site, where a younger buried A horizon (2Ab), probably formed in Roman period or later, is preserved above Vinica-type grave 50.

The pedostratigraphic history model of the cemetery at Pezdirčeva njiva (*Fig. 3*) clearly demonstrates that the archaeological record does not remain static after its creation but is subject to dynamic transformations driven by the long-term and multi-layered interplay of natural and anthropogenic processes at the site. The preservation of original stratigraphy and artefacts was most strongly influenced by high-energy sedimentary events – both anthropogenic and natural – including deliberate mound construction, and colluvial soil burial with sediments derived from Kučar, as well as by bioturbation, eluviation–illuviation and redox processes, and changes in land use over time.

Pedogenic processes affecting the archaeological record and artefacts were linked both to the biological and physico-chemical properties of the horizons into which the archaeological contexts were set and to the characteristics of the overlying layers. Distinct soil properties that, together with sedimentary events of both natural and anthropogenic origin, determined the degree to which the archaeological record and artefacts were preserved or transformed in different sections of the cemetery included slight soil acidity, high rainfall, the absence of carbonates, and low concentrations of calcium cations. The proposed model therefore successfully resolves the apparent paradox whereby the younger flat Vinica-type graves, their grave goods, and the overlying buried soil were less well preserved than the buried soils, graves, and associated artefacts beneath the Late Hallstatt barrows.

CONCLUSION

The analysis of the palaeoenvironment, soil development, and pedostratigraphic history of the site demonstrates that the preservation of the archaeological record and artefacts at Pezdirčeva njiva is the product of millennia of complex interactions between natural and anthropogenic processes operating since the establishment of the cemetery. The transformation of the stratigraphic record was decisively shaped by high-energy sedimentary events of both natural and anthropogenic origin, as well as by bioturbation, eluviation–illuviation and redox processes, and changes in land use. In addition to these pedogenic processes, specific properties of the local soils – notably korozije. Takšen pristop je ključen ne le za interpretacijo Pezdirčeve njive, temveč tudi za razumevanje ohranjenosti arheološkega zapisa na drugih grobiščih.

their slightly acidic pH, absence of carbonates, and low concentrations of calcium cations – further accelerated the decomposition of organic and inorganic materials within the graves.

This study, therefore, confirms the necessity of integrating geoarchaeological methods with archaeometric analyses of grave goods. A reliable understanding of their preservation or corrosion can only be achieved through a comprehensive knowledge of the pedo-sedimentary processes that govern the soil properties of the burial environment into which the artefacts were placed. Such an integrated approach is essential not only for interpreting Pezdirčeva njiva but also for understanding the preservation of the archaeological record at other cemetery sites.

ANDRIČ, M. 2007, The Holocene Vegetation Development in Bela krajina (Slovenia) and the Impact of First Farmers on the Landscape. – *The Holocene* 17/6, 63–776. doi: https://doi.org/10.1177/0959683607080

ANDRIČ et al. 2020 = Andrič M., P. Sabatier, W. Rapuc, N. Ogrinc, M. Dolenec, F. Arnaud, U. Von Grafenstein, A. Šmuc 2020, 6600 years of human and climate impacts on lake-catchment and vegetation in the Julian Alps (Lake Bohinj, Slovenia). – *Quaternary Science Reviews* 227, 106043. doi: https://doi.org/10.1016/j.quascirev.2019.106043

ANDRIČ, M., K. J. WILLIS 2003, The Phytogeographical Regions of Slovenia: a Consequence of Natural Environmental Variation or Prehistoric Human Activity? – *Journal of Ecology* 91, 807–821. doi: https://doi.org/10.1046/j.1365-2745.2003.00808.x

BIRKELAND, P. W. 1984, *Soils and Geomorphology*. – New York, Oxford.

BUKOVAC et. al. 1983 = Bukovac, J., M. Poljak, M. Šušnjar, M. Čakalo 1983, *Osnovna geološka karta SFRJ 1 : 100.000, list Črnomelj.* – Beograd.

BUOL et al. 2011 = Buol, S. W., R. J. Southard, R. C. Graham, P. A. Mcdaniel 2011, *Soil Genesis and Classification (6th edition.)*. – Chichester. doi: https://doi.org/10.1016/j.quascirev.2008.11.005

CAF et al. 2023 = Caf, N., P. Sabatier, A. Šmuc, N. Ogrinc, M. Dolenec, W. Rapuc, D. Potočnik, U. Von Grafenstein, M. Andrič 2023, Multi-proxy reconstruction of the Holocene vegetation and land use dynamics in the Julian Alps, north-west Slovenia. – *Journal of Quaternary Science* 38, 107–122. doi: https://doi.org/10.1002/jqs.3461

CONEDERA et al. 2009 = Conedera, M., W. Tinner, C. Neff, M. Meurer, A. F. Dickens, P. Krebs P. 2009, Reconstructing past fire regimes: methods, applications, limits, and open questions. – *Quaternary Science Reviews* 28/5–6, 555– 576. doi: https://doi.org/10.1016/j.quascirev.2008.11.005

COURTY et al. 1989 = Courty, M. A., P. Goldberg, R. Macphail 1989, *Soils and micromorphology in archaeology*. – Cambridge.

CROWTHER et al. 1996 = Crowther, J., R. I. Macphail, G. M. Cruise 1996, Short-term, post-burial change in a humic rendzina soil, Overton Down Experimental Earthwork, Wiltshire, England. – *Geoarchaeology* 11/2, 95–117. doi: https://doi.org/10.1002/(SICI)1520-6548(199603)11:2<95::AID-GEA1>3.0.CO;2-4

DULAR et al. 1995 = Dular, J., S. Ciglenečki, A. Dular 1995, *Kučar. Železnodobno naselje in zgodnjekrščanski stavbni kompleks na Kučarju pri Podzemlju / Kučar. Eisenzeitliche Siedlung und frühchristlicher Gebäudekomplex auf dem Kučar bei Podzemelj*. – Opera Instituti Archaeologici Sloveniae 1. doi: https://doi.org/10.3986/9789610503002

GABROVEC, S. 2008, Stiške gomile / Stična-Grabhügel. – V: *Stična* II/2. *Gomile starejše železne dobe. Razprave / Grabhügel aus der älteren Eisenzeit. Studien*, Katalogi in monografije 38 (2010), 7–60.

GABROVEC et al. 2006 = Gabrovec, S., A. Kruh, I. Murgelj, B. Teržan 2006, *Stična* II/1. *Gomile starejše železne dobe. Katalog / Grabhügel aus der älteren Eisenzeit. Katalog*. – Katalogi in monografije 37.

GOLDBERG, P., R. I. MACPHAIL 2006, *Practical and Theoretical Geoarchaeology*. – Malden, Oxford, Carlton. doi: https://doi.org/10.1017/S0016756809006128

GRAHEK, L., O. KOVAČ 2020, Podzemelj – železnodobno središče v Beli krajini v luči novih raziskav (Podzemelj – an iron Age centre in Bela krajina, in the light of new research. – *Arheološki vestnik* 71, 435–467. doi: https://doi.org/10.3986/AV.71.15

GRUŠKOVNJAK, L. 2019, Kratek teoretski pregled vpliva procesov tvorjenja in geomorfologije tal na arheološki zapis (A short theoretical overview of influences soil formation and soil geomorphology have on the archaeological record). – *Arheo* 36, 7–46.

HEJCMAN et al. 2011 = Hejcman, M., K. Součková, P. Krištuf, J. Peška 2013, What questions can be answered by chemical analysis of recent and paleosols from the Bell Beaker barrow (2500–2200 BC), Central Moravia, Czech Republic? – *Quaternary International* 316, 179–189. doi: https://doi.org/10.1016/j.quaint.2013.06.014

HOLLIDAY, V. T. 2004, *Soils in Archaeological Research*. – Oxford. doi: https://doi.org/10.1093/oso/9780195149654.001.0001

JOHNSON, D. L. 1985, Soil thickness processes. – V: P. D. Jungerius (ur.), *Soils and Geomorphology*, Catena Supplements 6, 29–40.

JOHNSON et al. 2005 = Johnson, D. L., J. E. J. Domier, D. N. Johnson 2005, Animating the biodynamics of soil thickness using process vector analysis: A dynamic denudation approach to soil formation. – *Geomorphology* 67/1–2, 23–46. doi: https://doi.org/10.1016/j.geomorph.2004.08.014

KABALA et al. 2019 = Kabala, C., A. Przybył, M. Krupski, B. Łabaz, J. Waroszewski 2019, Origin, age and transformation of Chernozems in northern Central Europe – New data from Neolithic earthen barrows in SW Poland. – *Catena* 180, 83–102. doi: https://doi.org/10.1016/j.catena.2019.04.014

KÜHN P. 2003, Micromorphology and Late Glacial/Holocene genesis of Luvisols in Mecklenburg-Vorpommern (NE-Germany). – *Catena* 54/3, 537–555. doi: https://doi.org/10.1016/S0341-8162(03)00129-2

LIPAR et al. 2024 = Lipar, M., S. Lojen, M. Breg Valjavec, M. Andrič, A. Šmuc, T. Levanič, J.Tičar, M. Zorn, M. Ferk 2024, Holocene climate variability in Slovenia: A review. – *Acta geographica Slovenica* 64/2. doi: https://doi.org/10.3986/AGS.12798

MASON, P. M. ANDRIČ 2009, Neolithic\Eneolithic settlement patterns and Holocene environmental changes in Bela Krajina (south-eastern Slovenia). – *Documenta Praehistorica* 36, 327–335. doi: https://doi.org/10.4312/dp.36.21

SCHAETZL, R. J., S. ANDERSON 2005, *Soils: Genesis and Geomorphology*. – New York.

TURNER et al. 2010 = Turner, R., N. Roberts, W. J. Eastwood, E. Jenkins, A. Rosen 2010, Fire, climate and the origins of agriculture: micro-charcoal records of biomass burning during the last glacial–interglacial transition in Southwest Asia. *Journal of Quaternary Science* 25/3, 371–386. doi: https://doi.org/10.1002/jqs.1332

TURNIŠKI, R., H. GRČMAN, Soils of the Dinaric Karst in Slovenia: Properties, Pedogenesis and Land Use. – *Geografski vestnik* (v pripravi / in preparation).

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