Nauportus - an Early Roman trading post at Dolge njive in Vrhnika
The results of geophysical prospecting using a variety of independent methods

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Izvleček

Zgodnjerimska postojanka na Dolgih njivah je del Navporta, vikusa na mestnem ozemlju Akvileje. Arheološko najdišče je bilo preiskano z geofizikalnimi metodami, ki temeljijo na različnih in neodvisnih fizikalnih principih: geoelektrično upornostno metodo, metodo električne prevodnosti, magnetno metodo in georadarsko metodo. Rezultati so podani na osnovi komplementarnosti teh metod ob upoštevanju podatkov starejših arheoloških izkopavanj, ki smo jih uporabili že na samem začetku za oblikovanje ustrezne strategije raziskav. Rezultate geofizikalnih raziskav smo združili s tlorisi predhodnih izkopavanj, analiza rezultatov georadarskega sondiranja je omogočila prikaz arhitekturnih ostankov na 3D način. Pridobljen je bil nov tloris postojanke, ki je bila utrjena z obzidjem s stolpi in obrambnim jarkom. Tretjino notranje površine je zavzemal trg, okoli katerega so bila razporejena skladišča (*horrea*) s stebrišči in taberne. Na trgu je stalo svetišče obhodnega tipa. Primerjavo za arhitekturo postojanke najdemo predvsem v republikanskih naselbinah Italije in v rimskih pristaniščih. Ponovno smo analizirali kronologijo drobnih najdb, ki kažejo na nastanek postojanke v predavgustejskem ali v zgodnjeavgustejskem obdobju ter upad v 1. st. po Kr.

Ključne besede: Slovenija, *Nauportus* - Vrhnika, Dolge njive, zgodnjerimska doba, vikus, geofizikalne raziskave, magnetna metoda, geoelektrična upornostna metoda, metoda električne prevodnosti, georadarska metoda, tloris, utrdba, trg, skladišča, taberne, obhodno svetišče, pristanišče, kronologija, trgovina, promet

Abstract

The Early Roman trading post at Dolge njive formed a part of Nauportus - a *vicus* on the town territory of Aquileia. The site was investigated using various geophysical methods: geoelectric resistivity, electrical conductivity, magnetometry, and Ground Penetrating Radar (GPR). The results are presented in view of the complementarity of these methods. The data from earlier archaeological excavations were used to plan an appropriate and effective research strategy. The results from geophysical prospecting were combined with the ground plans resulting from former excavations and a new ground plan of the trading post was engendered. A 3D portrayal of the architectural remains was enabled by georadar sounding. The site was fortified with a defence wall and towers as well as a defence ditch. One third of the interior surface was covered by the market place, which was surrounded by storehouses (*horrea*) with a portico and *tabernae*. An ambulatory type temple was also found here. Similar architecture is known primarily from Republican settlements in Italy and from Roman ports. The chronology of the small finds was reviewed and the results place the origins of the site in the Pre-Augustan or Early Augustan periods, and its decline in the 1st century AD.

Keywords: Slovenia, Nauportus - Vrhnika, Dolge njive, Early Roman period, 1st century BC, *vicus*, geophysical prospecting, magnetic method, geoelectric resistivity method, conductivity method, Ground Penetrating Radar method, ground plan, defence wall, market place, storehouse, *tabernae*, temple with an ambulatory, port, chronology, trade, traffic

Introduction 220
History of investigations of the Roman settlement at Dolge njive 220
Geophysical prospecting 222
Description and explanation of the architectural remains 233
Chronology of the settlement on the basis of small finds 254
Interpretation of the architecture 261
Conclusion 265

INTRODUCTION

One of the most important old routes connecting the Italian peninsula with the central Danube region crossed the passes in the contact region of the Julian Alps and the Dinaric Alps. Its decline down to the Ljubljana basin began at Vrhnika. Here, at the sources of the Ljubljanica river, lies the beginning of an old navigable route travelling eastwards along the Ljubljanica, Sava and Drava rivers.

The settlement of Nauportus arose proximate to the river sources, in the area of present-day Vrhnika. Nauportus is known already from classical literary sources, as well as from significant Early Roman epigraphic monuments. The settlement attained the status of *vicus* in the territory of Aquileia from the middle of the 1st century BC onwards (Šašel 1966; Šašel Kos 1990; Šašel Kos 1998; Šašel Kos 2000, 294-297; Šašel Kos 2002).

The position of the Celtic Nauportus dating to the 2nd century BC is not known. The Early Roman settlement was situated in the plain, where the Ljubljanica bends towards the boggy plain of the Ljubljansko barje (*Fig. 1*). A Roman road led between Aquileia and Emona along the western bank of the Ljubljanica through the settlement area at Breg. This part of the settlement, with its origins in the Middle Augustan period, was uninterruptedly occupied through to the 4th century (Horvat 1990; Horvat, Mušič 2007).

The Roman settlement at Dolge njive lay along the eastern bank, inside the hook of the Ljubljanica riverbend. A market place surrounded by storehouses and a defence wall with towers are known from the settlement. The origins of the settlement date to the beginning of the Early Augustan period, with its discontinuation in the mid 1st century AD at the latest (Horvat 1990).

A new ground plan of the settlement at Dolge njive was attained with the geophysical prospecting. This contribution presents the results from the analysis of the functions of the individual buildings, as well as the chronology and the significance of the settlement in its entirety.

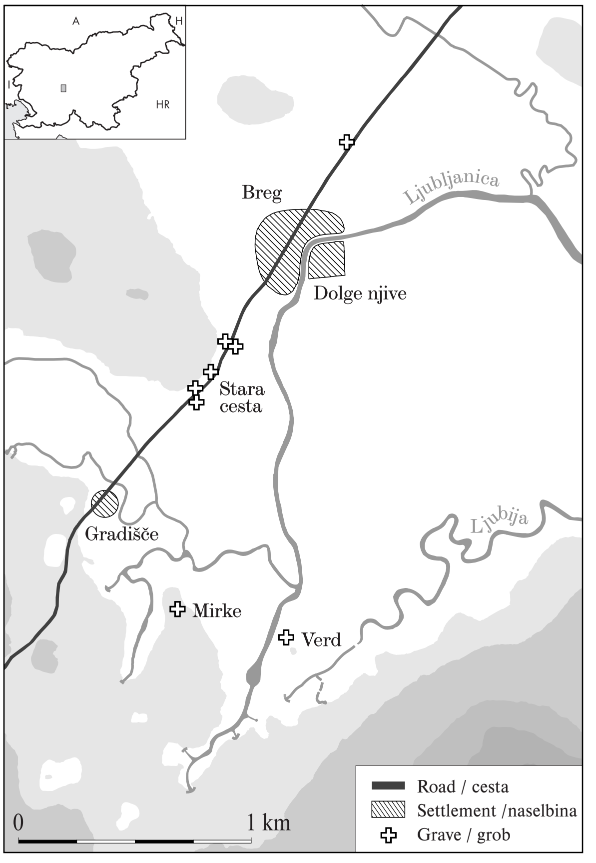

Fig. 1: Nauportus. Positions of archaeological areas.
Sl. 1: Navport. Lega arheoloških območij.

HISTORY OF INVESTIGATIONS OF THE ROMAN SETTLEMENT AT DOLGE NJIVE

The Roman settlement at Dolge njive was first discovered in the mid 19th century (Horvat 1990, 50-57, 171-173).

The Provincial Museum in Ljubljana researched the Ljubljanica riverbed at Dolge njive in 1884. At the time, the preparatory Ferdinand Schulz also excavated three trenches in the area of the Roman settlement: the partition wall in building 2 (c-d), the northeastern area of building 8 and the double wall between buildings 12 and 13 (cf. *Fig. 36;* Horvat 1990, 49-50, 101-103, 108, 172, 207-208, fig. 8).

In 1885 and 1886, under the leadership of Gabrijel Jelovšek, locals dug in the region of areas 4a, 5a-b, 6 and 7. In 1900, S. Jenny investigated the area of the buildings 4a-b and 5b, as well as the northern road (cf. *Fig. 36;* Horvat 1990, 50, 106-108, 172, 209-210).

Walter Šmid / Schmid carried out extensive archaeological excavations at Dolge njive in 1934 and 1936. In face of the limited time and funds, Šmid succeeded in determining the basic outlines of the entire settlement, while the northern and western sides of the settlement underwent more detailed investigation. Following analysis of the modest documentation of the excavations, it is also evident that Šmid trailed only the tops of the walls. The courses of the walls were repeatedly hypothesized, despite the fact that they were

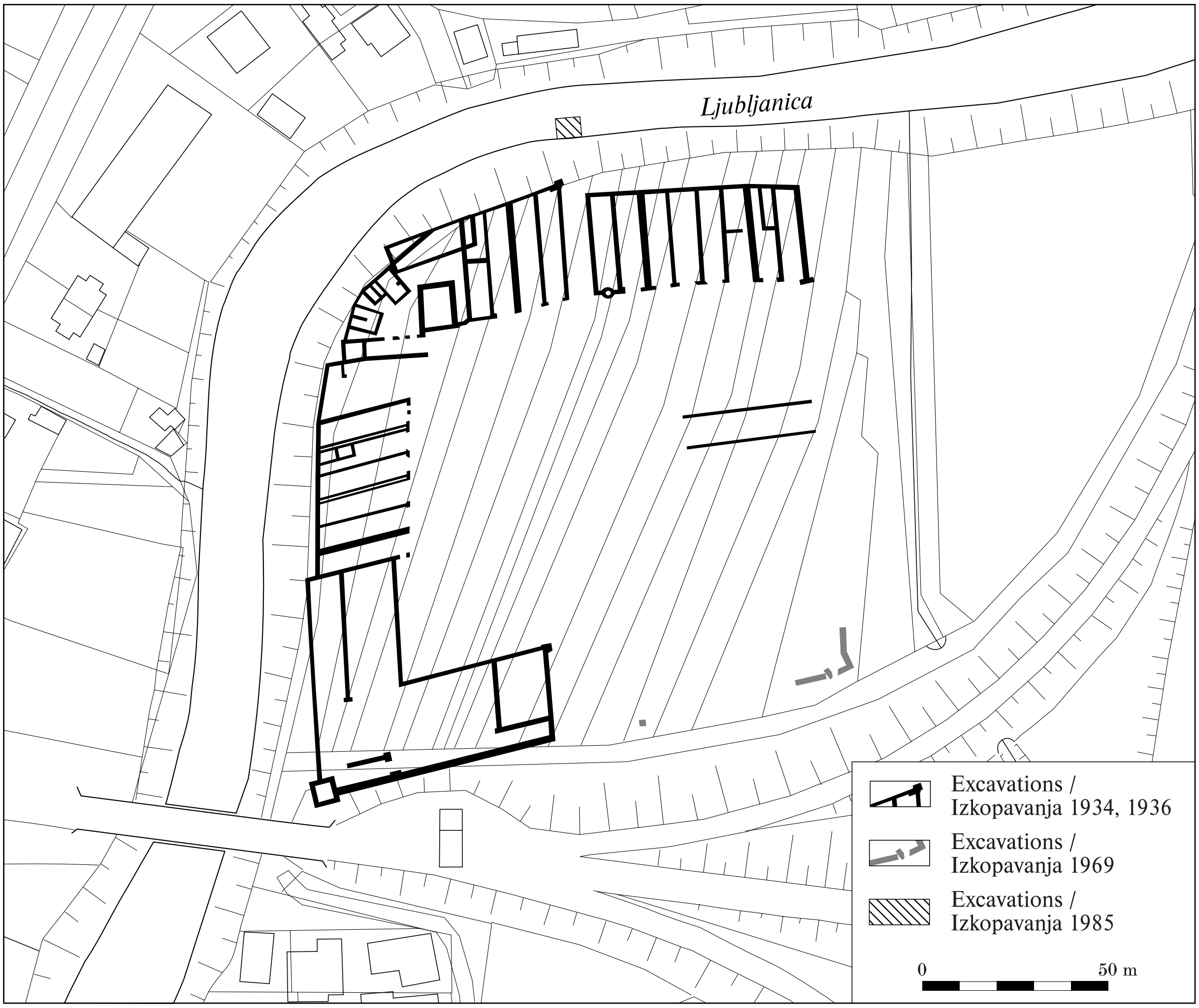

Fig. 2: Dolge njive. Plan of excavations carried out in the years 1934 and 1936, 1969 and 1985 (according to Horvat 1990, suppl. 2).
Sl. 2: Dolge njive. Raziskovanja v letih 1934 in 1936, leta 1969 in leta 1985 (po Horvat 1990, pril. 2).

never excavated in full length. This generated a series of errors, which are primarily observable in the regions of buildings 1, 16-18, 21 and 22, as well as in the course of the northern defence wall. Šmid excavated only the small buildings of 8, 9 and perhaps also 10 in greater detail, as well as the double walls between buildings 1 and 2, 2 and 3, 12 and 13, and 13 and 14 (*Fig. 2;* cf. *Fig. 36;* Horvat 1990, 49-57, 97-109, 172-173, 205-211, fig. 9).

On the initiative of Iva Mikl Curk, the Geological Survey in Ljubljana investigated a large part of the archaeological region at Dolge njive in 1969, as well as the tract where the new highway was about to be constructed. These represent the first measurements of geoelectric resistivity made for archaeological purposes in Slovenia. Areas evidencing high resistivity were discovered; these areas were linked with the archaeological remains, however no reliable interpretations could be proffered. High values were discerned in the areas where the southern, eastern and western defence walls run, as well as a paved tract along the exterior side of the eastern defence wall (Mikl Curk 1968-1969; Archives of the Institute for the Protection of Cultural Heritage of Slovenia; Archives of the Institute of Archaeology, ZRC SAZU). In November 1969, Mikl Curk carried out trial trenching along the southern edge of the settlement, which lay adjacent to the construction of the new highway; she discovered the defence wall and towers at the southwestern and southeastern corners (*Fig. 2;* cf. *Fig. 36;* Mikl Curk 1974; Horvat 1990, 97-99, 205-206).

A wooden structure found in the Ljubljanica riverbed, and representing a pier of the Roman port, was investigated in 1985 (*Fig. 2;* cf. *Fig. 36;* Horvat, Kocuvan, Logar 1986; Logar 1985).

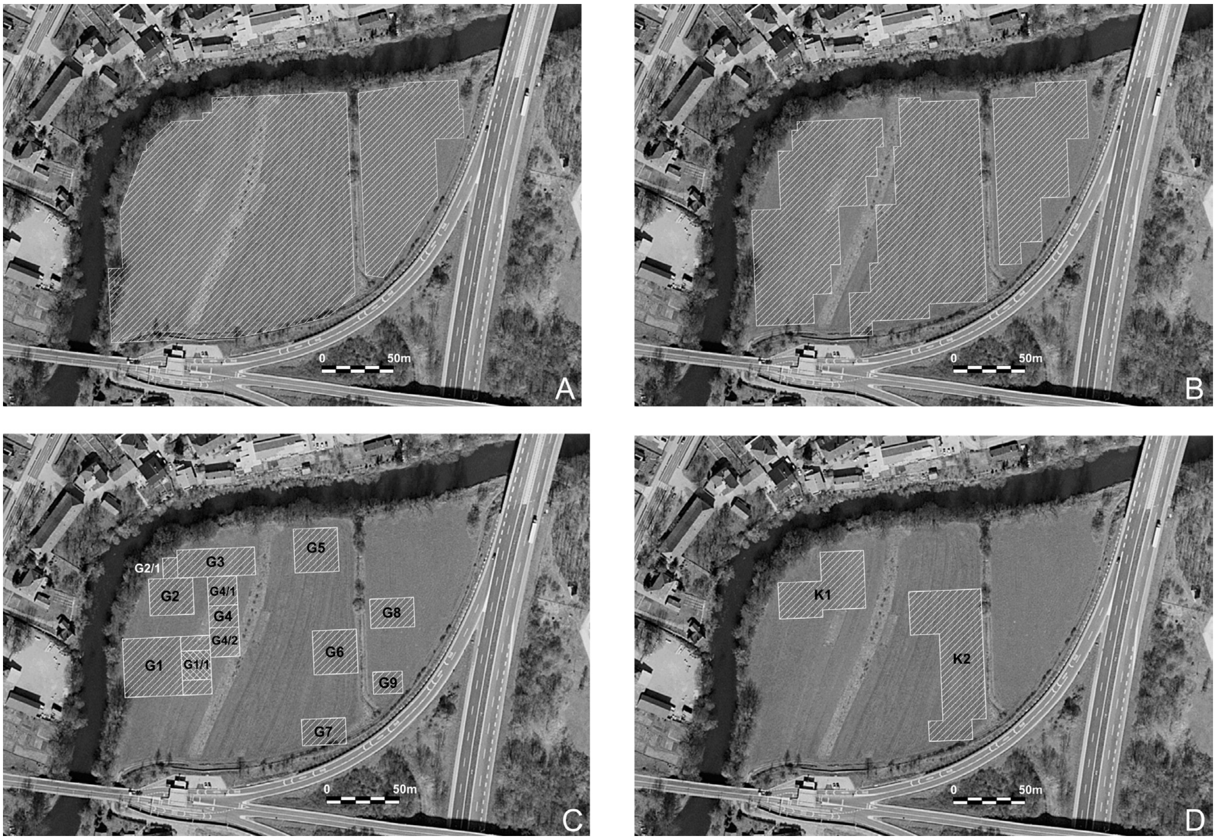

Fig. 3A-D: Areas investigated using the geoelectric resistivity method (A), the magnetic method (B), the Ground Penetrating Radar method (C: G1-G9) and the electrical conductivity method (D: K1-K2) (Source: © Surveying and Mapping Authority of the Republic of Slovenia, DOF at a scale of 1 : 5000).
Sl. 3A-D: Površine, raziskane z geoelektrično upornostno metodo (A), magnetno metodo (B), georadarsko metodo (C: G1-G9) in metodo električne prevodnosti (D: K1-K2) (vir: DOF v merilu 1 : 5000, © Geodetska uprava RS).

GEOPHYSICAL PROSPECTING

The geophysical prospecting at Dolge njive in Vrhnika incorporated, to different extents, the application of: the geoelectric resistivity method with Twin probes array (*Geoscan RM15*) (*Fig. 3A*), the magnetic method to measure changes in the gradient of the total Earth's magnetic field density (*Geometrics G-858*) (*Fig. 3B*), measurements of the apparent magnetic susceptibility of samples of soil and stone construction material (*Kappameter KT-5*), the Ground Penetrating Radar method using 200 and 500 MHz antennas (*GSSI SIR3000*) (*Fig. 3C*) and measurements of the electric conductivity by electromagnetic induction (*Geonics EM38*) (*Fig. 3D*).

The geophysical research strategy was prepared corresponding to the discoveries from current archaeological excavations, as well as to the results of geophysical prospecting in similar natural environments on pedosequences on clays (see: Stritar 1990). Due to the potentially poorly preserved dry-stone foundations of the buildings at Dolge njive, a profile separation of 0.5 m was used for all geophysical methods applied. Resistivity and conductivity measurements were taken at a distance of 0.5 m between measuring points along the profiles, while the magnetic field density readings were at a distance of 0.15 m and GPR traces at a distance of 4 cm.

Considering that resistivity measurements usually produce the best contrast for architectural remains on pedosequences on clays, geophysical prospecting was initiated with geoelectric mapping which clearly shows lateral changes in resistivity. Measurements of the magnetic susceptibility of soil and limestone samples revealed minimal differences; this also forecast the poor contrast in the results from the magnetic method of those building foundations made of quarried limestone. In such cases, the magnetic method is directed towards revealing those remains with a strong thermoremanent type of magnetization, which is characteristic for architectural elements made of brick, kilns and ruination layers with ceramic tiles. Other methods do not reliably recognize these types of remains.

GPR sounding was used to determine the depth and height of preservation and the mutual spatial relationship of the architectural elements in areas of the settlement; that is, wherever the results from geoelectric mapping deemed it advantageous to check. The GPR method is the only technique among the geophysical methods within Nauportus survey project, used for geophysical sounding. It enables a precise 3D visualization as well as analyses of the measurement results in a 3D environment. The electric conductivity method was introduced experimentally in two areas in order to test the response of the architectural remains and the defence ditch. As anticipated, the results were much more conducive to archaeological interpretation in the area of the defence ditch. In general it holds true that this method is used for determining negative structures, and furthermore, that the lateral resolution in the area of high resistivity structures (e.g. limestone foundations) is much lower than in the resistivity method. This research confirms this statement.

The continuation presents a few established procedures for quantifying, all of which were also applied in the geophysical prospecting carried out at Vrhnika: geophysical modelling for the creation of archeo-physical magnetic models of archaeological structures, inverse interpretation (e.g.: Mušič et al. 1998; Desvignes et al. 1999, 85-105; Hašek 1999, 25-42; Coskun et al. 2000, 179-186; Tsokas et al. 2000, 17-30; Eppelbaum et al. 2001, 163-185; Kochnev et al. 2004, 64-68; Diamanti et al. 2005, 79-91), simulation of resistivity anomalies for the evaluation of depth and width of architectural elements (De la Vega et al. 1995, 19-30), calculation of the apparent resistivity (Walker et al. 1994), the upward continuation of magnetic anomalies for determining the sources of magnetic anomalies at greater depths, residual magnetic anomalies for recognizing the sources of magnetic anomalies on the present-day surface or just beneath it, and synthetic gradients that apparently enhance otherwise weak magnetic anomalies (vertical gradients), or which efficiently demonstrate the magnetic effect of small modern iron particles on the present-day surface or just beneath it (horizontal gradients) (e.g.: www.geometrics.com).

Ideally, selection of the most suitable geophysical techniques is dictated solely by the archaeological objects targeted to locate. In reality, the targeted archaeological objects play a lesser role in determining the most appropriate geophysical techniques. An anomaly in the physical field, resulting from the presence of a targeted archaeological object, is termed a *signal*, while all other irregularities in the physical fields, resulting from various other factors, are termed *noise*. Selection of the most suitable method is dictated exclusively by an evaluation of the *signal to noise ratio*; and for a reliable method, this needs to be large enough that the difference between the two data sets demonstrates enough contrast so as to secure successful prospecting.

It is often difficult to define the signal to noise ratio for each of the various methods; so archaeological prospecting, by taking advantage of the complementarity of the various and physically independent methods, has adopted a multi-method approach for the development of efficient research strategies. This also helps to avoid the hazard of making an erroneous evaluation of the signal to noise ratio for a selected method due to insufficient knowledge of the archaeological and natural contexts. At the same time, additional independent and complementary data layers from measurements taken in a variety of physical fields are procured for a more detailed examination of the archaeological features and the natural environment.

The geoelectric resistivity method

This method is applied for geoelectric mapping; the values of the apparent resistivity, which is determined for the Twin probes array by the distance between the mobile probes (C_1P_1), are recorded at the same depth. At a distance of 0.5 m, and with optimal humidity of the soil, the depth range measures 1.5 m at the most. In addition to the distances between the mobile pair of probes in the depth range, the moisture content in the soil also has significant impact. The depth range is usually less when there is a high level of humidity in the top soil layer; this is because most of the electrical current flows in the direction of higher electrical conductivity shallowly beneath the surface. The geoelectric research at Dolge njive was carried out in stages. As such, the soil seepage, and hence also the depth range and the contrast in the results, were all variable; however not to any degree that made a significant impact on the measurement results and archeological implementation. Geoelectric mapping was executed in a grid of 0.5 x 0.5 m and the measured values were interpolated using a bicubic algorithm (Davis 1973, 204-207)

Fig. 4A: The results from geoelectric mapping on an aerial photograph. The low-pass filter with a matrix of dimensions 1 x 1. The span of values represents ranges between 10 and 50 Ω. The span of values represents the range between -0.5 and +0.5 of the standard deviation (Source: © Surveying and Mapping Authority of the Republic of Slovenia, DOF at a scale of 1 : 5000).
Sl. 4A: Rezultati geoeletričnega kartiranja na zračni fotografiji. Filter visokih frekvenc z masko velikosti 1 x 1. Razpon prikazanih vrednosti je med 10 in 50 Ω. Razpon prikazanih vrednosti je med -0,5 in +0,5 standardnega odklona (vir: DOF v merilu 1 : 5000, © Geodetska uprava RS).

to a grid of 0.25 x 0.25 m. The area investigated measures 31.500 m^2 (*Fig. 3A*).

The results from geoelectric mapping (*Figs. 4-6*) are presented as the electrical resistance (R, Ω) and not as resistivity (ρ, Ωm); this is because at archaeological sites, where the research substratum is heterogeneous, what is usually of interest is only a qualitative analysis of the results, based on the relative differences between the measured resistance values. Resistivity (Ωm) was calculated for classification of the natural substrata as well as to compare with the values of electric conductivity as measured by electromagnetic induction (*Figs. 7, 15, 26*). The literature cites a variety of equations that are more or less essentially creative derivations of the apparent resistivity for the twin probes array (e.g. Walker et al. 1994; Clark 1990, 20). The most reliable, and basically also the only correct solution is proposed by Martinaud (1990, 6). This author's equation takes into consideration also the apparent resistivity of the soil under a pair of remote twin probes, which also have a significant impact on the measured values.

A less precise equation ($\rho = \pi Ra$, whereby ρ is the apparent resistivity, R is the measured resistance and a is the distance between the mobile twin probes), proposed by Walker and colleagues (1994), was rather used at Dolge njive to calculate

Fig. 4B: The results from geoelectric mapping on an aerial photograph. The high-pass filter with a matrix of dimensions 5 x 5. The span of values represents the range between -0.5 and +0.5 of the standard deviation (Source: © Surveying and Mapping Authority of the Republic of Slovenia, DOF at a scale of 1 : 5000).
Sl. 4B: Rezultati geoeletričnega kartiranja na zračni fotografiji. Filter nizkih frekvenc z masko velikosti 5 x 5. Razpon prikazanih vrednosti je med -0,5 in +0,5 standardnega odklona (vir: DOF v merilu 1 : 5000, © Geodetska uprava RS).

the apparent resistivity. The results from this calculation are presented in *Fig. 7*; for the sake of a more explicit depiction of the general distribution of the apparent resistivity, the results are portrayed on a 2 x 2 m grid. The results demonstrate: that negative structures (e.g. the defence ditch) have characteristic resistivity values lower than 40 Ωm, the natural background (clay) falls in the range between 40 and 50 Ωm, paved surfaces (e.g. the market area) between 50 and 60 Ωm and architectural remains within the limits of between 60 and 120 Ωm.

The first geoelectric resistivity investigations at Dolge njive, carried out by Franc Miklič (Geological Survey Institute in Ljubljana) in 1969 with Wenner's electrode classification, established a division of the values of the apparent resistivity into four classes: 18-26 Ωm (background), 27-35 Ωm (weak anomalies), 36-44 Ωm (intermediate anomalies) and higher than 44 Ωm (strong anomalies) (Mikl Curk 1968-1969; Archives of the Institute for the Protection of Cultural Heritage of Slovenia; Archives of the Institute of Archaeology, ZRC SAZU). Our calculations of the apparent resistivity indicate that values characteristic for architectural remains are generally higher than 50 Ωm; this concurs with Miklič's class of strong resistivity anomalies. The conclusion follows that

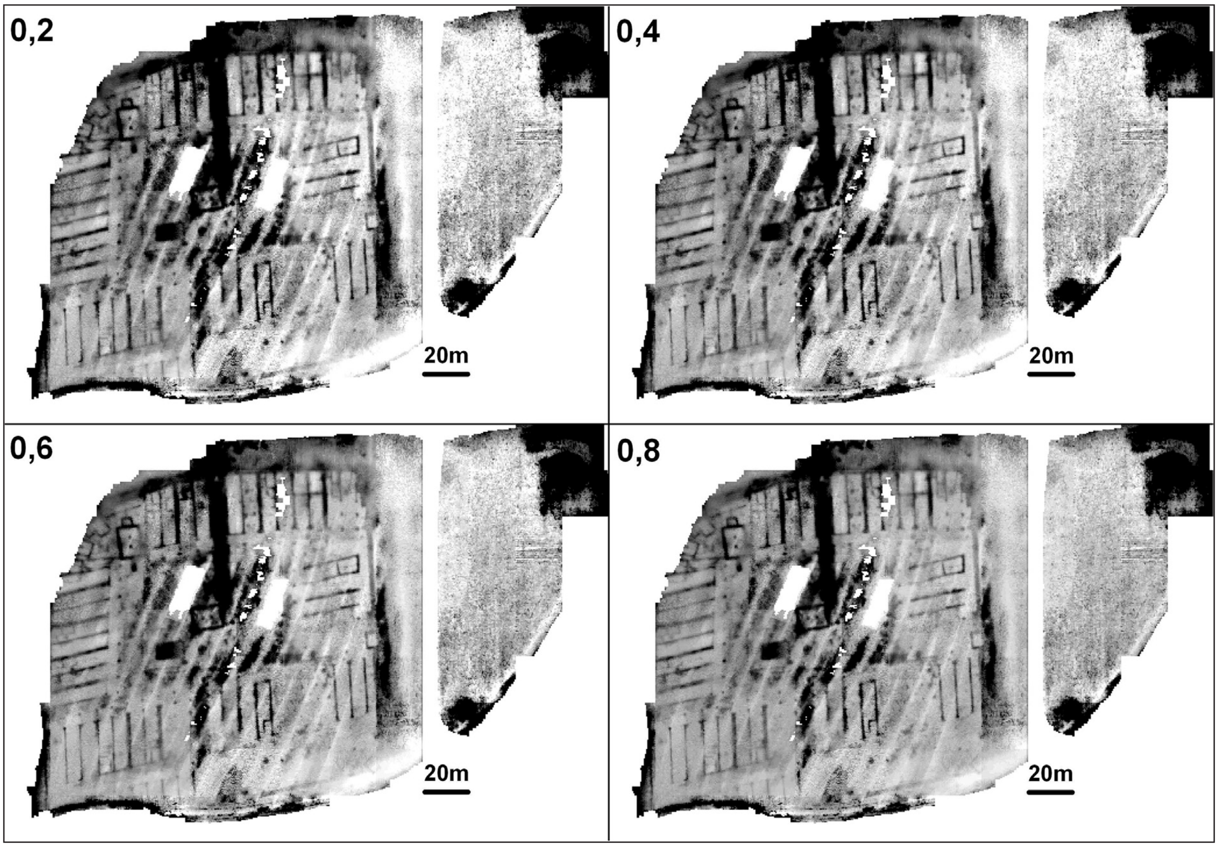

Fig. 5: The power function (R^x) was used for the removal of noise. The power variable (x) is written in the figures. The calculated values are shown in the range within the limits of -1 and +1 of the standard deviation. The archaeologically significant anomalies are thus emphasized on account of the background noise by equalizing the resistivity contrast in the regions with varying levels of water saturation.
Sl. 5: Za odstranjevanje šuma smo npr. uporabili eksponentno funkcijo (R^x). Faktor potence (x) je izpisan na slikah. Izračunane vrednosti so prikazane v območju od -1 do +1 standardnega odklona. Gre za poudarjanje arheološko pomenljivih anomalij na račun šuma ozadja oziroma izenačevanje kontrastnosti za območja z različno namočenostjo.

our calculations of apparent resistivity, calculated with a simple equation, are correct enough to convert the measured "relative" values of resistance into "absolute" resistivity values. These clearly classify the resistivity anomalies caused by the architectural remains and negative structures in similar natural environments throughout the wider region of the Ljubljansko barje.

The electrical conductivity method

Within the framework of geophysical research at Dolge njive, two areas were investigated with electrical conductivity survey (*Fig. 3D:* K1,K2). These areas were chosen on the basis of the resistivity results. Area K1 (*Fig. 3D:* K1*; Fig. 26:* B1,B2) was selected to check the efficiency of the electrical conductivity method in distinguishing architectural remains with high resistivity, which is otherwise a weakness of this method. The area K2 (*Fig. 3D:* K2*; Fig. 15:* B1 and B2) checked the response of the defence ditch, which was recognized from the results of the resistivity method as a 7 m wide zone bearing low resistivity values and running parallel with the eastern wall. As defence ditches generally accumulate much water, and are thus also highly electrically conducive, they are an ideal target for the electrical conductivity method.

The apparent electrical conductivity was measured with an instrument (*Geonics EM38*) in vertical dipole mode, whereby the longer side was set in the direction of the profiles. In this configuration, the sensitivity of the instrument is at its highest for depth, which is the same as the distance between the coils, that is, 1 m. The greatest depth range measured 1.5 m, which is the same as for the resistivity method. Measurements were executed in a grid of 0.5 x 0.5 m and interpolated into a grid of 0.25 x 0.25 m by way of a bicubic algorithm

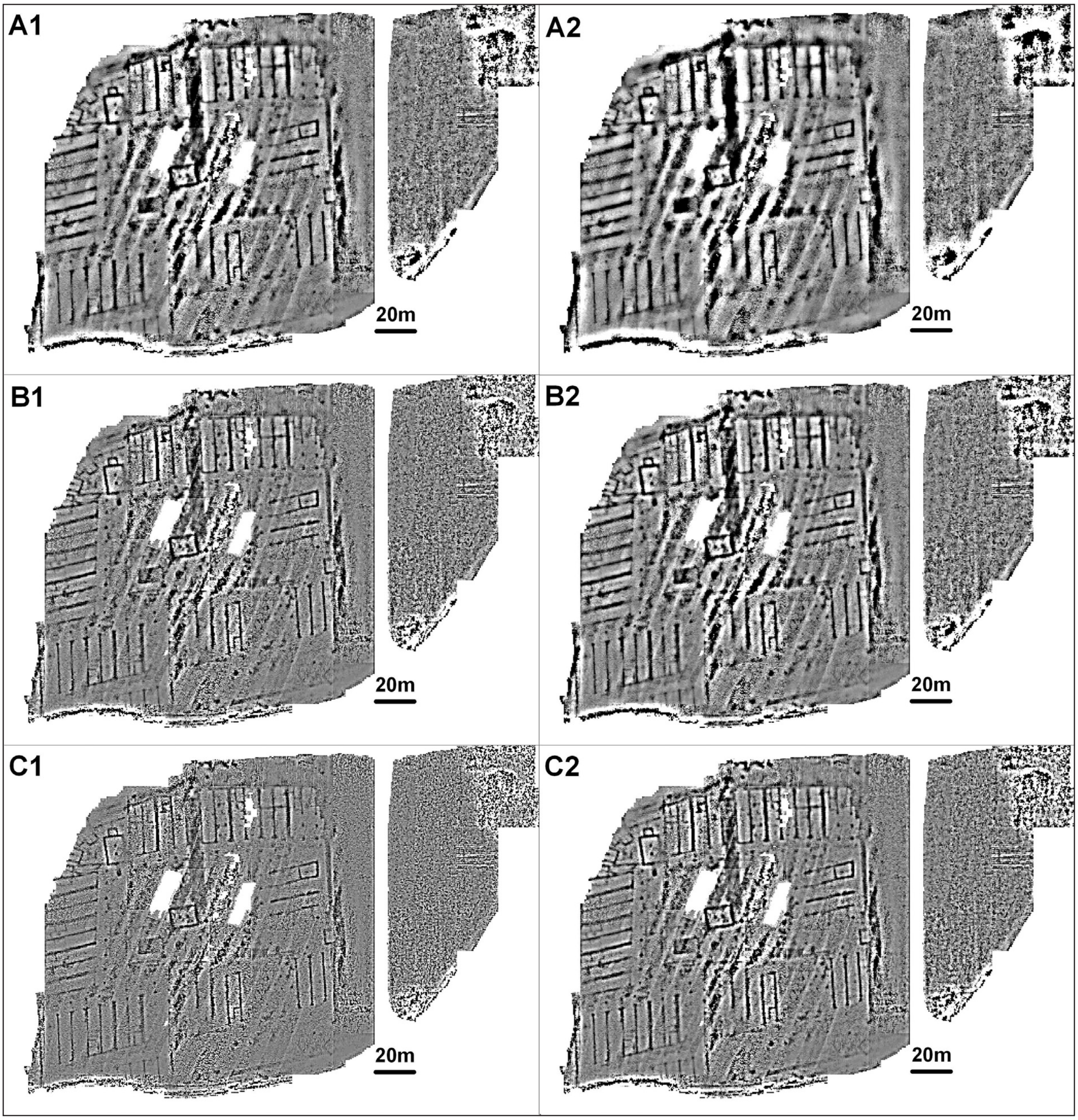

Fig. 6: The geoelectric mapping results after using the high-pass filter, which emphasizes the extreme differences in resistivity at short distances (high frequency anomalies). At archaeological sites, these are usually caused by architectural remains. This also eliminates the long wave resistivity anomalies, which are generally a consequence of lateral changes in the geological and pedological composition. The high pass filter window size for images A1 and A2 measures 10 x 10, 5 x 5 for images B1 and B2 and 3 x 3 for images C1 and C2. A Gauss matrix was used for images A1, B1 and C1 and a uniform matrix for images A2, B2 and C2. The calculated values are shown on all pictures in the range between -0.5 and +0.5 of the standard deviation.

Sl. 6: Rezultati geoelektričnega kartiranja po uporabi filtra nizkih frekvenc, ki poudari visoke razlike v upornosti na kratki razdalji (anomalije visokih frekvenc). Na arheoloških najdiščih so te praviloma posledica arhitekturnih ostankov. Na ta način se odstranijo dolgovalovne upornostne anomalije, ki so v splošnem posledica sprememb v geološki podlagi. Velikost okna na slikah A1 in A2 je 10 x 10, na slikah B1 in B2 je 5 x 5 in na slikah C1 in C2 3 x 3. Pri tem je bila uporabljena za slike A1, B1 in C1 Gaussova maska, za slike A2, B2 in C2 pa uniformna maska. Preračunane vrednosti so na vseh slikah prikazane v območju od -0,5 do +0,5 standardnega odklona.

(Davis 1973, 204-207). A surface area of 5.670 m^2 was investigated using the electrical conductivity method (*Fig. 3D:* K1,K2).

The magnetic method

Measurements of the variations in the total Earth's magnetic field density in a *(pseudo)gradient*

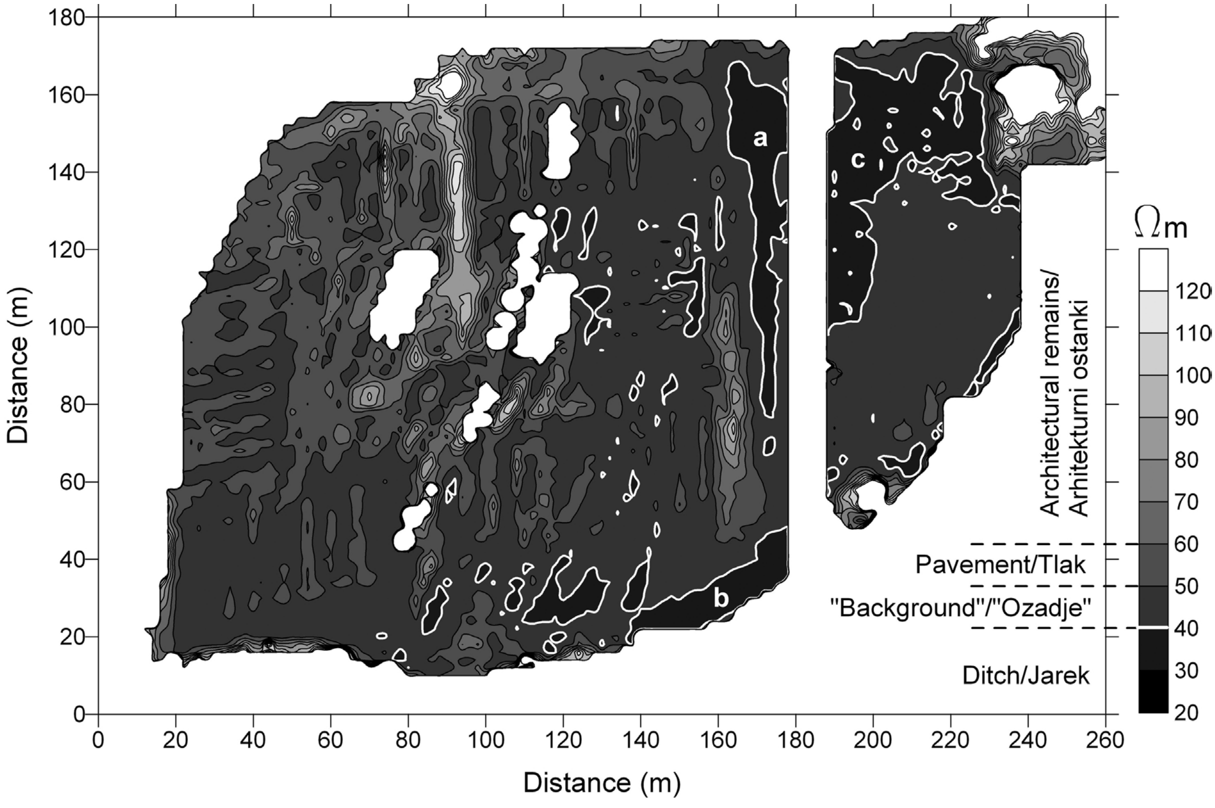

Fig. 7: A display of the apparent resistivity values calculated according to the ρ = πRa formula; ρ is the apparent resistivity, R is the resistance measured and a is the distance between the mobile probes. A generalized resistivity map on a 2 x 2 m grid enables a classification of these calculated values into a few archaeologically meaningful classes: values lower than 40 Ωm are characteristic for defence ditches and other highly water saturated areas, values between 40 and 50 Ωm are characteristic for natural backgrounds (clay), values between 50 in 60 Ωm are characteristic for pavements (e. g. market area) and values between 60 and 120 Ωm are significant for architectural remains. Values lower than 40 Ωm can be divided into three classes: defence ditch (a), defence ditch effect and/or drainage from the highway dike (b), resistivity values similar to those for the ditch (negative structure?) (c).

Sl. 7: Prikaz razširjenosti vrednosti navidezne upornosti, izračunane po izrazu ρ = πRa, pri čemer je ρ navidezna upornost, R izmerjeni upor in a razdalja med premičnima elektrodama. Generalizirana karta upornosti z mrežo meritev 2 x 2 m omogoča razdelitev tako izračunanih vrednosti na nekaj arheološko pomenljivih razredov: vrednosti, nižje od 40 Ωm, so značilne za obrambni jarek in druga dobro namočena območja, za naravno ozadje (glina) so med 40 in 50 Ωm, za tlakovane površine (npr. površina trga) med 50 in 60 Ωm in za arhitekturne ostanke vrednosti med 60 in 120 Ωm. Vrednosti, nižje od 40 Ωm, lahko razdelimo v tri razrede: obrambni jarek (a), učinek obrambnega jarka in/ali odvodnjavanja nasipa avtoceste (b), podobne vrednosti upornosti kot v jarku (negativna struktura?) (c).

mode (nT/m) are used much more frequently in magnetic prospecting for archaeological targets than measurements such as of the total magnetic field using only one sensor (nT) (check e.g.: Gaffney et al., 2000). The gradient mode actually works as a high-pass filter; it emphasizes the weak magnetic anomalies of small structures at lesser depths (signal) and eliminates long-wave anomalies that are a result of the geological background (noise).

The magnetometer Geometrics G-858 that was used in our research attains a resolution of 0.1-0.2 nT/m in measuring the total field density with an acquisition speed of 0.2 s. In practice this allows readings to be taken while walking at a regular speed in the direction of the profile at intervals of 15 cm.

The distance between the magnetic profiles measured 0.5 m, and readings of the magnetic field density were taken at 15 cm intervals in the direction of the profiles. The magnetograms (*Fig. 8*) portray the values calculated onto a grid of 0.25 x 0.25 m. A total area of 24.000 m^2 was investigated using the magnetic method (*Fig. 3B*).

The values of apparent susceptibility in the shallow pedologic boreholes at Dolge njive are within the limits between 0.08 and 0.42 x 10^{-3}SI (*Kappameter KT-5*), with a mean value of 0.27 x 10^{-3}SI. Higher values of susceptibility were measured on parts of the drilled cores where there were also fragments of ceramic material present. Disregarding those samples bearing traces of ceramic material, the mean value of susceptibil-

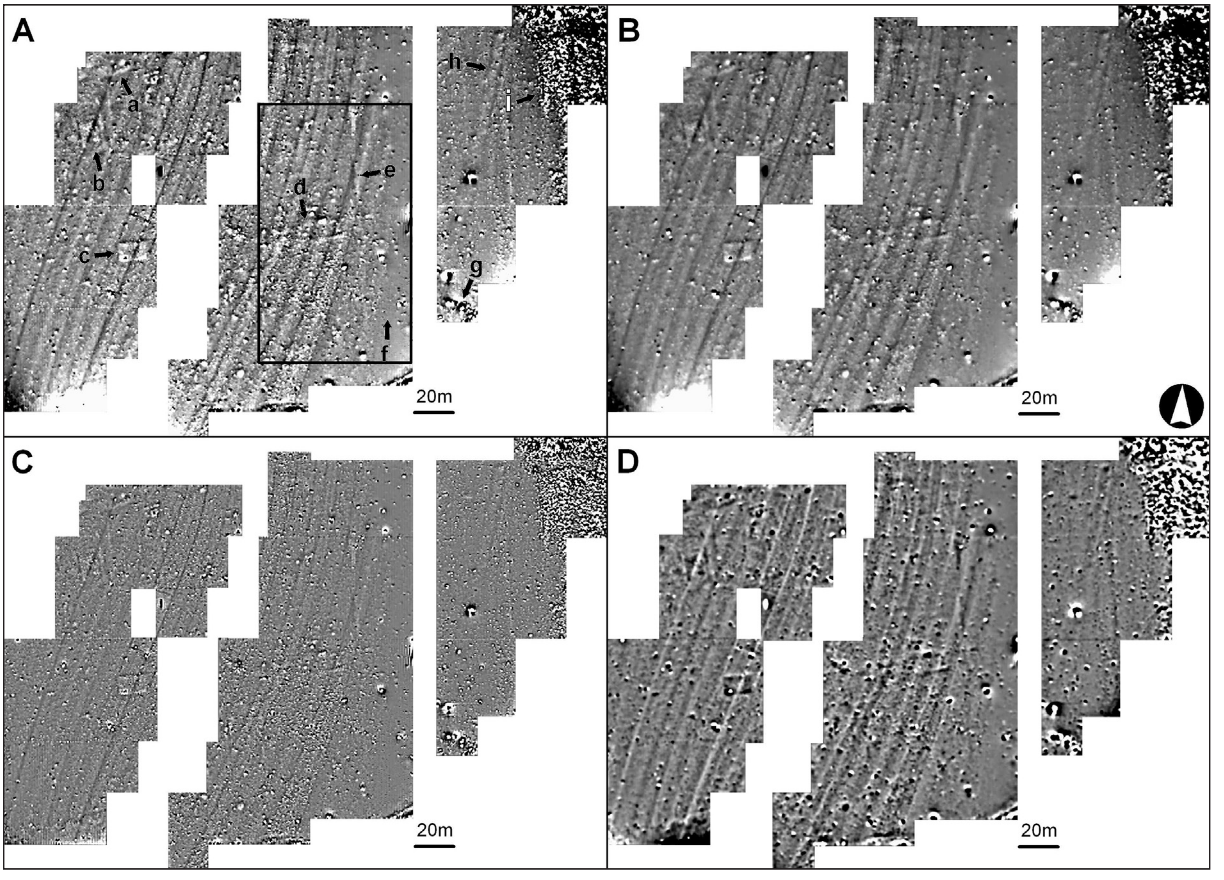

Fig. 8A-D: Magnetograms of the gradients of the magnetic field density. A: measured gradients between -7 and +5 nT/m; B: smoothed magnetic anomalies using the algorithm for the Upward continuation of magnetic anomalies at a relative vertical distance of 0.2 m in a measuring range between -7 and +7 nT/m, which generally emphasizes those anomalies originating at relatively greater depths; C: residual magnetic anomalies [measured values (A) -Upward continuation of magnetic anomalies (B)] in the range between -4 and +4 nT/m, which generally emphasize those anomalies originating upon the present-day surface or just beneath it; D: synthetic vertical gradients at a relative vertical distance of 0.5 m in the range between -3 and +3 nT/m, which somewhat emphasize all measured gradients of the magnetic field. Check the explanation in the text for an interpretation of *Fig. 8A*. The rectangle in *Fig. 8A* indicates the sector of the magnetogram in *Fig. 9*. The following structures are discernible: northern defence wall (a), building 6 (b), building 25 (c), eastern road (d), eastern defence wall (e), eastern defence ditch (f), workshop (g), traces of unknown origin (h), modern platform (i).

Sl. 8A-D: Magnetogrami (vertikalnega) gradienta gostote magnetnega pretoka. A: izmerjene vrednosti gradienta gostote magnetnega polja med -7 in +5 nT/m; B: zglajene magnetne anomalije z uporabo algoritma podaljševanja magnetnih anomalij navzgor na relativni navpični oddaljenosti 0,2 m v merilnem območju med -7 in +7 nT/m, kar v splošnem poudari anomalije z izvorom na relativno večjih globinah; C: rezidualne magnetne anomalije [izmerjene vrednosti (A) - navzgor podaljšane anomalije (B)] v območju od -4 do +4 nT/m, ki v splošnem poudarijo anomalije z izvorom na današnji površini ali plitvo pod njo; D: sintetični vertikalni gradienti na relativni navpični razdalji 0,5 m v območju od -3 do +3 nT/m, ki nekoliko poudarijo vse izmerjene gradiente magnetnega polja.

Za interpretacijo na *sl. 8A* glej razlago v tekstu (poglavje Magnetna metoda). Pravokotnik označuje izsek magnetograma na *sl. 9.* Vidni objekti: severno obzidje (a), stavba 6 (b), stavba 25 (c), vzhodna pot (d), vzhodno obzidje (e), vzhodni obrambni jarek (f), delavnica (g), neinterpretirani sledovi (h), sodobna ploščad (i).

ity measures 0.21 x 10^{-3}SI. The susceptibility of the limestone material, presumably used for the foundations of structures, measures 0.1 x 10^{-3}SI. A consequence of the small differences in the magnetic susceptibility between archaeological architectural remains and the natural environment are the weak anomalies of the induced magnetization, and thus also a weaker contrast in the architectural remains on the magnetograms (*Fig. 8*). The magnetograms reveal discernible traces of: parts of a defence wall (*Fig. 8A:* a,e), buildings 6 and 25 (*Fig. 8A:* b,c), a presumed road running between the central part of the settlement and the passage by the eastern tower (*Fig. 8A:* d, *Fig. 9A*), a defence ditch is discerned on the basis of a very unified background (*Fig. 8A*: f), a probable workshop outside the settlement (*Fig. 8A:* g), two parallel lines of unknown origin (*Fig. 8A:* h) and a larger surface of strong magnetic anomalies which are likely a consequence of a modern platform of modern concrete (*Fig. 8A:* i).

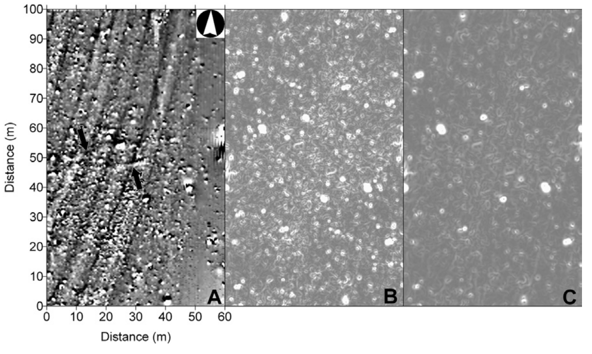

Fig. 9A-C: Detail of the magnetogram from the eastern gateway of the settlement (see *Fig. 8A* for its positioning). Image A (the gradient of the magnetic field density, "raw values": from -5 to +5 nT) shows two parallel magnetic anomalies running from the passage by the eastern tower towards the central area of the settlement (marked by arrows). They are most likely the result of the contrast in the magnetic susceptibility on the lateral transition between the ground (lower susceptibility) and the sandy road fill (higher susceptibility). The distance between the anomalous lines measures 5 m, which corresponds to the width of the paved road running north - south and discovered using the resistivity method. The small, light points are the effect of small, recent iron objects upon the present-day surface or just beneath it. The sources of strong magnetic anomalies are more discernible on magnetograms A and B, which depict the synthetic horizontal gradients (the supposed relative difference in the height of the sensors as corresponds to the initial height of the measurements is +0.2 m in image B and +0.5 m in image C).

Sl. 9A-C: Detajl magnetograma ob vzhodnih vratih naselbine (za položaj glej *sl. 8*). Na sliki A (gradient gostote magnetnega pretoka, "surove vrednosti": od -5 do +5 nT) se vidita dve vzporedni magnetni anomaliji, ki potekata od prehoda ob vzhodnem stolpu proti osrednjemu delu naselbine (označeni s puščicama). Najverjetneje sta rezultat kontrastne magnetne susceptibilnosti na bočnem prehodu med tlemi (nižja susceptibilnost) in peščenim nasutjem ceste (višja susceptibilnost). Oddaljenost anomalnih linij je 5 m, kar ustreza širini tlakovane ceste v smeri sever-jug, ki je bila odkrita z upornostno metodo. Majhne svetle točke so učinek majhnih novodobnih železnih predmetov na današnji površini ali plitvo pod njo. Na magnetogramih A in B, ki prikazujeta sintetične horizontalne gradiente, so ti viri močnih magnetnih anomalij bolje vidni (predpostavljena relativna višinska razlika senzorjev glede na prvotno višino meritev je na sliki B +0,2 m in na sliki C +0,5 m).

As is quite usual for modern agricultural surfaces, a high degree of noise, due to small modern-day iron objects on the surface or just beneath it, was detected here as well. These peaks of strong magnetic anomalies are reliably discernible on the magnetograms, which portray the artificial horizontal gradients, or rather, the changes in the magnetic field density in a horizontal direction (*Figs. 9B, 9C*). The magnetograms show only a few magnetic anomalies that are characteristic for archaeological remains with a thermoremanent type of magnetization (TRM) within the limits of the settlement. It follows that the inhabitants did not use ceramic tiles to cover their roofs, nor did they build architectural elements of brick. Furthermore, there were presumably no workshops that might have required high temperatures within the settlement, nor were there any baker's ovens or even a larger sized hearth.

For a more reliable interpretation using the magnetic method, theoretical 2D and 3D archaeophysical models are often applied (e.g.: Eppelbaum et al. 2001, 163-185). These are generated from the interpretations on the basis of the measured values of the magnetic field and comparisons with the calculated magnetic anomalies for the presumed archaeo-physical models (check *Fig. 31*). The variables comprise of the form of the structures, their size, depth and values of magnetic susceptibility. The most suitable archaeo-physical model is the one where the difference between the measured and theoretical or calculated values is the least. Additionally, data regarding the inclination (I), declination (D) and intensity of the Earth's magnetic field (F) in the investigated area are also required. The *International Geomagnetic Reference Field* (IAGA V-MOD Division) for Vrhnika cites the following: I = 63,15°, D = 2,10° and F = 47683 nT.

Ground Penetrating Radar (GPR)

The resolution of GPR is mostly dependent upon the wavelength of the transmitting antenna. The wavelength of electromagnetic waves from a 200 MHz antenna, as was used in the GPR investigations at Dolge njive, measures 1.5 m in the air. In materials with a relative dielectric constant of 15, this wavelength decreases to 0.52 m, and further down to 0.4 m with a dielectric of 25, etc. (Conyers et al. 1997, 45). The suitability of using an antenna with a central frequency of 200 MHz and twice as large a wavelength from a 400 MHz antenna, which is also most recommended for archaeological purposes, is best confirmed by the archaeological evidence corresponding to the results of the GPR research.

The vertical resolution is the smallest distance at which two GPR reflections can still be treated as two separate GPR limits (check e.g.: Jol 1995, 693-709; Piro et al. 1996, 89-105); generally it is determined by the wavelength of the electromagnetic waves. The upper and lower limits of the horizontal reflector, such as a paved surface in archaeological contexts, will only be visible on the radargram if its width exceeds one quarter of the wavelength. At the evaluated dielectric permittivity (15) of the soil type at Dolge njive, the wavelength of a 200 MHz antenna in this ground measures approximately 0.5 m. Essentially this means that horizontal layers (paved areas) thicker than 0.15 m will be reliably discernible on the radargrams.

The higher the permittivity of the top soil material, the slower the propagation of electromagnetic waves; at the same time, the sheaves of the elliptic cone determining the ratio between the depth and resolution will be narrower. The elliptic cone expands at a slower rate if the deeper layers have an increasing dielectric permittivity, as is characteristic for pedosequences on clays in the direct vicinity of rivers where the humidity and thus also the permittivity gradually increases with depth. This type of occurrence substantiates the high resolution of architectural remains in the time frame of 50 ns, which corresponds to the depth of approximately 1.5 m.

The measured parameter in GPR measurements is double the time a wave travels from the transmitting antenna to the underground reflector and it is expressed in nanoseconds (10^{-9}s). By knowing the dielectric permittivity, and thus also the propagation velocity of the EM waves in the investigated media, the times of the reflections may be calculated into units of length, or rather depth sections. The portion of the electromagnetic energy that reflects at a certain limit between two diverse materials (e.g. wall/ground-surrounding medium, etc.) depends upon the contrast in the dielectric permittivity (and to a lesser degree on the electrical conductivity and the magnetic permeability) and the ratio between the wavelength of the EM waves (determined by the frequency of the transmitter) and the width of the archaeological structure (Jol 1995, 693-709).

The best known approach for presenting results is by way of the so-called *time slices method;* these are essentially time slices of a series of parallel and usually equally distant GPR profiles (e.g.: Goodman et al. 1995, 85-89). Time slices together compose a diagram of equal amplitudes of GPR echoes in the same time range of returning waves. In the archaeological field this generates a series of "plan views" at arbitrary depths (check *Figs. 12, 14, 18, 20, 22, 25, 27, 29, 32, 35*).

The research presented in this contribution also generated the results in a 3D environment, thus providing cross sections of the investigated soil volume in arbitrary directions, as well as detailed insight into the spatial relationships of the architectural elements, their depths, widths and level of preservation. This procedure is still particularly welcome for interactive interpretation in a 3D environment; in an archaeological context this allows for the discernment of building phases (check *Figs. 13, 19, 28, 33*).

Meats (1996, 359-379), by introducing the migration procedure, which to a large degree lessens the subjectivity of interpretations from the results of GPR investigations, was the first to take a determinant step towards 3D displays of GPR results. The procedures used for the preparation of time slices and 3D presentations of GPR echoes are illustrated in *Fig. 10* (adapted according to Premrl 2004, figs. 15-21).

Nine regions were selected for GPR survey on the basis of the results from the resistivity method (*Fig. 3C:* G1-G9); a total of 8.100 m^2 was surveyed. This selection was determined by the demand for additional information concerning the mutual spatial relationships of the architectural elements, their depths and the level of preservation of the architectural remains discovered using the resistivity method. All regions were measured using a 200 MHz antenna, while a 500 MHz antenna was additionally used for the area around the temple (*Fig. 3C:* G1/1).

The manner for determining the width of the walls, the depth at which they are situated and the height of their preservation are all significant factors for a realistic 3D display of the archaeological architectural remains on the basis of results from geophysical prospecting. A qualitative analysis of the results from the resistivity method provided a good ground plan of the architectural remains; this was also a good foundation for reconstructing the urbanistic plan of the settlement. The quantitative data required for a 3D display of the architectural remains was attained by way of selectively choosing procedures for GPR data processing (*Fig. 10*) and an analysis of individual GPR echoes (e.g: Leckebusch 2003, 213-240). While the width of the walls were read in the GPR profiles by applying migration (*Fig. 10:* G) and Hilbert's transformation (*Fig. 10:* H), the depths and levels of preservation of the walls were determined by way of velocity analyses (Conyers et al. 1996, 25-38) supplementally corrected corresponding to data from excavations (Mikl Curk 1974, 370-386) and shallow boreholes. The results from archaeological excavations in the area of the southeastern tower (Mikl Curk 1974, 370-386; Premrl 2004, fig. 22) were used as a test area for determining the propagation velocity of electromagnetic waves; this was necessary so as to enable calculation of the real depths. Excavations in 1969 uncovered the upper layer of the foundations of the defence wall, made of quarried limestone, at a depth ranging between 0.5 and 0.75 m. The GPR profiles of the

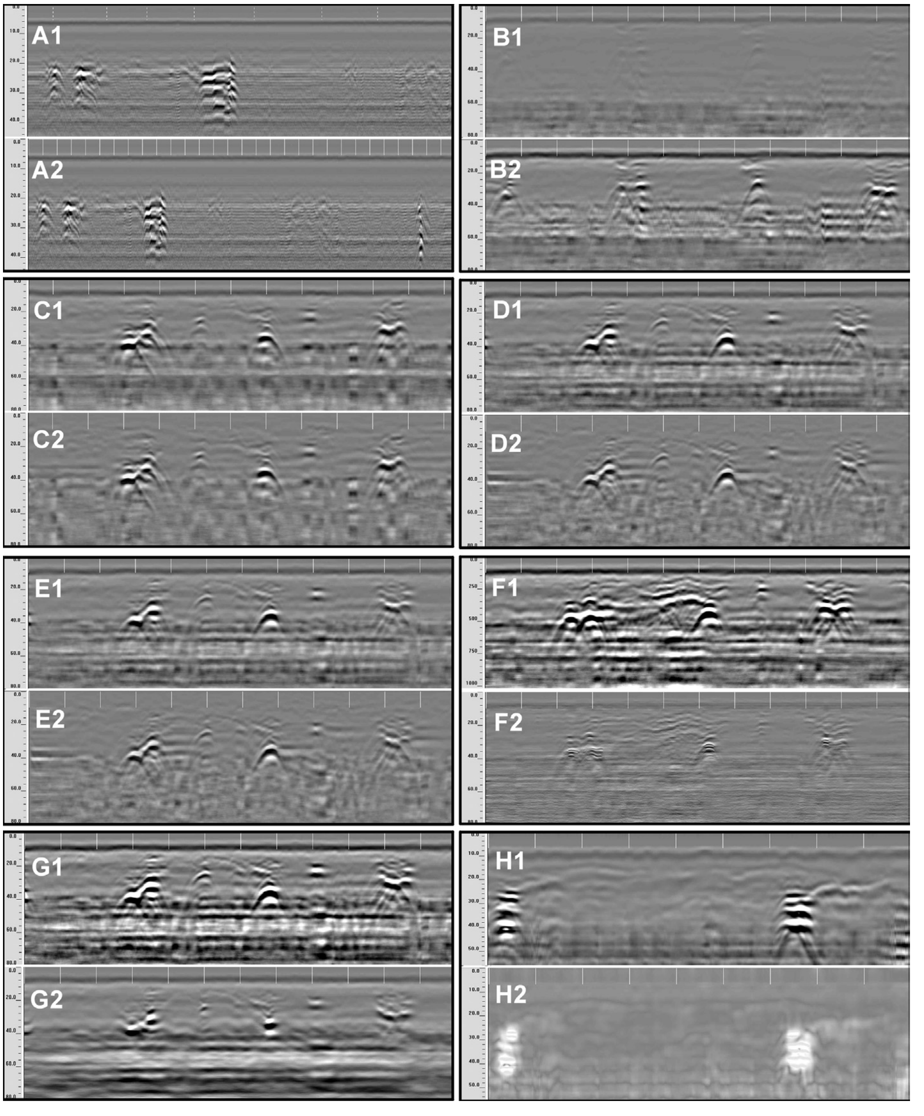

Fig. 10: An illustration of the procedure for processing GPR sections for the generation of time slices and 3D representations of GPR echoes. A: distance normalization (A1 - before processing, A2 - after processing); B: the range gain adjustment (B1 - before processing, B2 - after processing); C: background removal (C1 - before processing, C2 - after processing); D: FIR filter (D1 - before processing, D2 - after processing); E: IIR filter (E1 - before processing, E2 - after processing); F: deconvolution (F1 - before processing, F2 - after processing); G: migration (G1 - before processing, G2 - after processing); H: hilbert transformation (H1 - before processing, H2 - after processing) (adapted from Premrl 2004, figs. 15-21).

Sl. 10: Ilustracija postopka obdelave radarskih profilov za ustvarjanje časovnih rezov in 3D prikazov radarskih odbojev. A: umerjanje razdalj (A1 -pred obdelavo, A2 - po obdelavi); B: poudarjanje in izenačevanje amplitud odbojev (B1 - pred obdelavo, B2 - po obdelavi); C: odstranjevanje navideznih horizontalnih odbojev (C1 - pred obdelavo, C2 - po obdelavi); D: glajenje odbojev in odstranjevanje šuma (D1 - pred obdelavo, D2 - po obdelavi); E: glajenje odbojev in odstranjevanje šuma (E1 - pred obdelavo, E2 - po obdelavi); F: odstranjevanje ponovljenih odbojev oz. multiplov in ločevanje bližnjih odbojev (F1 - pred obdelavo, F2 - po obdelavi); G: elimininiranje difrakcije in hiperboličnih oblik odbojev (G1 - pred obdelavo, G2 - po obdelavi); H: poudarjanje in prikazovanje šibkih odbojev od manjših struktur (H1 - pred obdelavo, H2 - po obdelavi) (prirejeno po Premrlu 2004, sl. 15-21).

southeastern tower detected the upper layer of the defence wall at a depth of 18 nanoseconds; this means that at a dielectric permittivity of 13, the estimated velocity of the electromagnetic waves measures 6.9 cm/ns. Similar results were attained in several other places where boreholes also happened upon walls at a depth ranging between 0.3 and 0.55 m below the current day surface. Velocity analyses in the region of the western storehouses established a velocity of 6.5 cm/s (check the GPR profile in *Fig. 23*). It follows that the empirical and analytical procedures for determining the depths produced similar results. Nonetheless, the propagation velocity of electromagnetic waves will alter throughout the settlement, and this should not be neglected. Humidity levels of the soil will

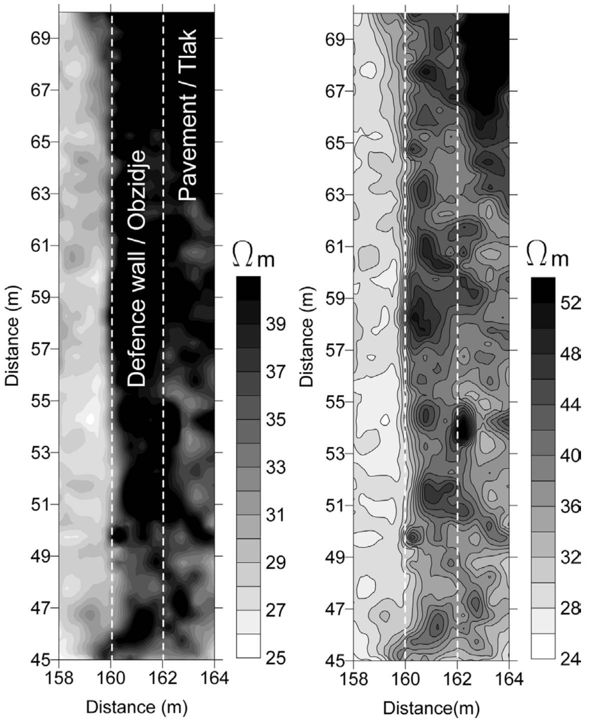

Fig. 11: According to the results of the resistivity method, the width of the eastern wall measures approximately 2 m. The right illustration shows discontinuations of high resistivity values in the direction of the wall; these could be an indication of the constructional particularities of the defence wall, which I. Mikl Curk (1974, 372) describes as the construction style "in boxes". Perhaps they only mark various states of preservation of the wall. Due to the poorly preserved eastern front of the defence wall (Mikl Curk 1974, 372) and the paved surface directly alongside, it is not possible to precisely establish the width of the wall in this segment.

Sl. 11: Po rezultatih upornostne metode meri širina vzhodnega obzidja približno 2 m. Na desni sliki vidimo v smeri obzidja prekinitve visokih vrednosti upornosti, ki so lahko učinek konstrukcijskih posebnosti obzidja, ki jih I. Mikl Curk (1974, 372) opisuje kot kasetni način gradnje. Morda gre samo za spremembe v stopnji ohranjenosti obzidja. Širine obzidja na tem odseku ni mogoče povsem natančno določiti zaradi slabše ohranjene vzhodne fronte obzidja (Mikl Curk 1974, 372) in tlakovane površine tik ob njem.

have a strong impact on the velocity; this is best demonstrated by the values of resistance (check *Fig. 7*). The velocity of electromagnetic waves used in our research to calculate depth was 6.5 cm/ns; essentially this means that 1 nanosecond on a radargram corresponds to a distance (depth) of 3.25 cm. As all the illustrations of the results from GPR sounding cite the time elapsed from the transmittance of one signal to the registration of its reflection (this is double the time), only half of the recorded time dictates the calculation of depth. For the purpose of our research, the return time of 30 ns corresponds to a depth of approximately 1 m (exactly 0.975 m).

DESCRIPTION AND EXPLANATION OF THE ARCHITECTURAL REMAINS

Defence wall

The course of the 2 m wide defence wall is best discerned on the resistivity results at the eastern part and less so at the southern part of the settlement (*Figs. 4-6*). The eastern part of the wall is situated at a depth ranging between 0.6 and 1.3 m (*Figs. 12-13*).

Poor resistivity results in the southeastern and southern parts of the settlement are perhaps due to the poor state of the defence structures. Alternatively, it might be a consequence of the high moisture content in the soil in this area, which always decreases the resistivity contrast between the natural background and architectural remains. Considering the estimated expansion of wetness based on the mutability of the background resistivity (*Fig. 7*) and the electrical conductivity measurements (*Fig. 3D*: K2; *Fig. 15*), the far edge of the southeastern part of the settlement is the most humid. The high humidity is presumably a consequence of the combined effect of the defence ditch, which collects a lot of moisture, and the inflow of meteoric waters due to drainage from the highway dyke. The electrical conductivity results show an apparently wider ditch in the area along the highway dyke due to the relatively higher level of moisture content. The GPR results (*Fig. 3C:* G7; *Fig. 14*) also show that the high moisture content had a strong impact on the decreased level of contrast in the regions of the southeastern tower and defence wall. The level of moisture content in the soil plays a major role in attenuation of electromagnetic waves (Conyers, Goodman 1997, 53); the radargrams also express this by way of substantially lower amplitudes of GPR echoes at the interfaces between clay soil and foundations of quarried limestone.

Iva Mikl Curk, in her excavations at the southeastern corner of the settlement, discovered the 2 m wide southern defence wall and the 3 m wide eastern defence wall. The foundations of the defence wall were built using blocks of quarried limestone, bound with mortar. The area between the two façades of stone blocks was filled with loam, small stones and sand. Transverse walls (0.5 m thick) connecting the two façades followed at intervals of 2 m, as well as transverse horizontal wooden beams. Details of the structure were most discernible along the eastern tract of the defence wall (Mikl Curk 1974, 372-376; Horvat 1990, 97-98, 205). The 2 m wide southern part of the wall was also documented by Šmid (*Fig. 2*).

The manner of construction and the level of preservation of the remains significantly influence the contrast in the resistivity between the defence wall and its near surroundings. The results from the resistivity measurements presumably reflect the particularities described by Mikl Curk regarding the construction of the eastern wall. Only the western (interior) front of the wall is clearly distinct. Mikl Curk reported that it was approximately 0.8 m wide and laid out of quarried stones (Mikl Curk 1974, 372). The exterior (eastern) front of the wall is not entirely discernible. Presumably this is due to the combined effect of the construction style "in boxes", the poorly preserved state of the exterior façade of quarried limestone and the paved surface, which leans upon the exterior side of the wall. Despite that the resistivity results do not enable a reliable interpretation of the defence wall's construction style, the variability of the resistivity values can be indicative of a more complex style of construction (*Fig. 11*).

Along the northern and northwestern part of the settlement the back walls of buildings 1-5 and 11-15 took on the function of the defence wall; in the continuation, these buildings are interpreted as storehouses (*Figs. 36, 39*).

Eastwards of the northern tower, the line of the defence wall is relatively poorly discernible in the resistivity results; that is, the contrast along the northern side is low due to the paved

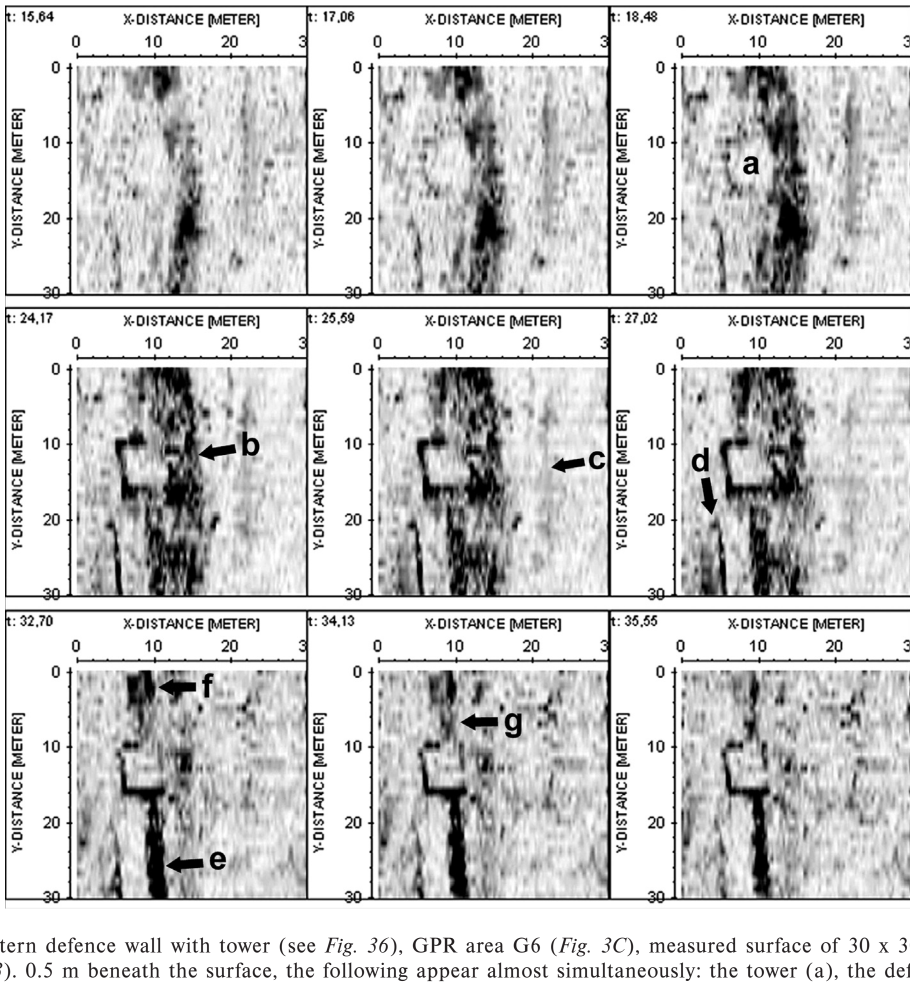

Fig. 12: The eastern defence wall with tower (see *Fig. 36*), GPR area G6 (*Fig. 3C*), measured surface of 30 x 30 m: time slices (see also *Fig. 13*). 0.5 m beneath the surface, the following appear almost simultaneously: the tower (a), the defence wall (e), a paved platform along the exterior of the defence wall (b), a small wall along the western edge of the defence ditch (c), which is perhaps a composite part of the support structure of the bridge, and the eastern wall of structure 20 (d). The paved surface and the wall along the ditch are the first to disappear with added depth. The tower and the defence wall are traceable to a depth of 1.3 m. The bottom three illustrations show the passage to the northern side of the tower (g) and the rectangular widening of the defence wall (f).

Sl. 12: Vzhodno obzidje s stolpom (glej *sl. 36*), georadarsko območje G6 (*sl. 3C*), površina 30 x 30 m: horizontalni rezi radarskih odbojev (glej tudi *sl. 13*). 0,5 m pod površjem se skoraj istočasno pojavijo stolp (a), obzidje (e), tlakovana ploščad na zunanji strani obzidja (b), manjši zidec na zahodnem robu obrambnega jarka (c), ki je morda del nosilne konstrukcije mostu, in vzhodni zid stavbe 20 (d). Z globino najprej izgineta tlakovana površina in zidec ob jarku. Stolpu in obzidju sledimo do globine 1,3 m. Na spodnjih treh slikah prepoznamo prehod na severni strani stolpa (g) in pravokotno razširitev obzidja (f).

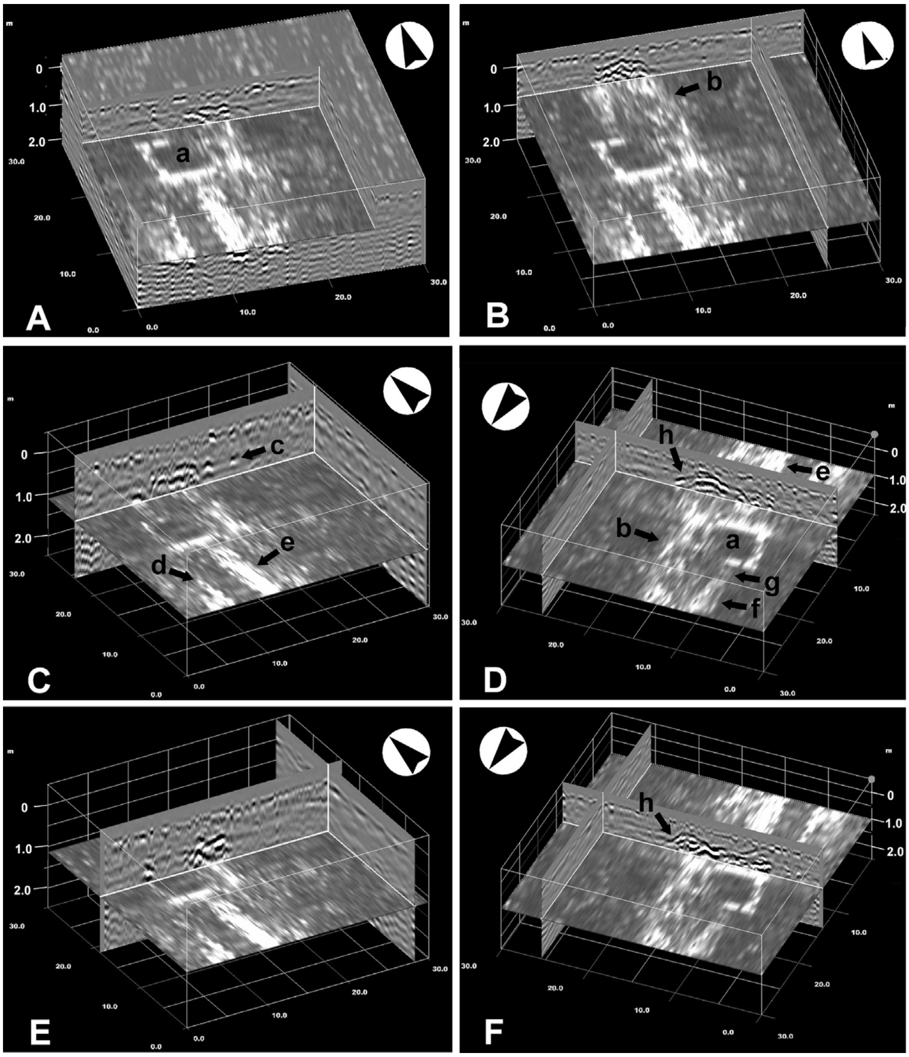

Fig. 13: The GPR area G6 (*Fig. 3C*), measured surface of 30 x 30 m: 3D portrayal of GPR echoes (see also *Fig. 12*): eastern tower (a), paved surface between the defence wall and ditch (b), small wall along the western edge of the defence ditch, which is perhaps a composite part of the support structure of the bridge (c), the eastern wall of structure 20 (d), the defence wall (e, f), the passage along the eastern tower (g), the western edge of the ditch with layers that is slanting at an angle of about 45° eastwards (h).
Sl. 13: Georadarsko območje G6 (*sl. 3C*), površina 30 x 30 m: 3D prikaz radarskih odbojev (glej tudi *sl. 12*): vzhodni stolp (a), tlakovana površina med obzidjem in jarkom (b), manjši zidec na zahodnem robu obrambnega jarka, ki je morda del nosilne konstrukcije mostu (c), vzhodni zid objekta 23 (d), obzidje (e, f), prehod ob vzhodnem stolpu (g), zahodni rob jarka s plastmi, ki vpadajo pod kotom približno 45° proti vzhodu (h).

surfaces and/or the ruination layers between the wall and the Ljubljanica riverbed (*Figs. 4-6*). The juncture between the storehouses and the defence wall is clearly discernible. The width of the wall measures approximately 1 m on the basis of the clearly visible southern façade, as well as on the basis of the edges of the paved surfaces along the northern side of the wall. The width of the wall corresponds approximately with the data from the archaeological excavations in 1934 and 1936. According to Šmid's plan, the northern and eastern defence walls do not exceed the width of the wall foundations of the storehouses, which measure 0.70 m (*Fig. 2;* Horvat 1990, fig. 9).

Westwards of the northern tower, the defence wall is offset 2 m to the south. A paved surface runs alongside the entire length of the northern side of the 1 m wide defence wall, which at the same time forms the back wall of the storehouse rooms (*Figs. 4-6, 18-19, 36*). An additional wall is discernible on the northern side of the defence wall in the vicinity of building 7 in the resistivity (*Fig. 6*) and GPR results (*Fig. 18*). It is parallel with the defence wall in one area, and in the other area it is slightly offset (*Fig. 36*).

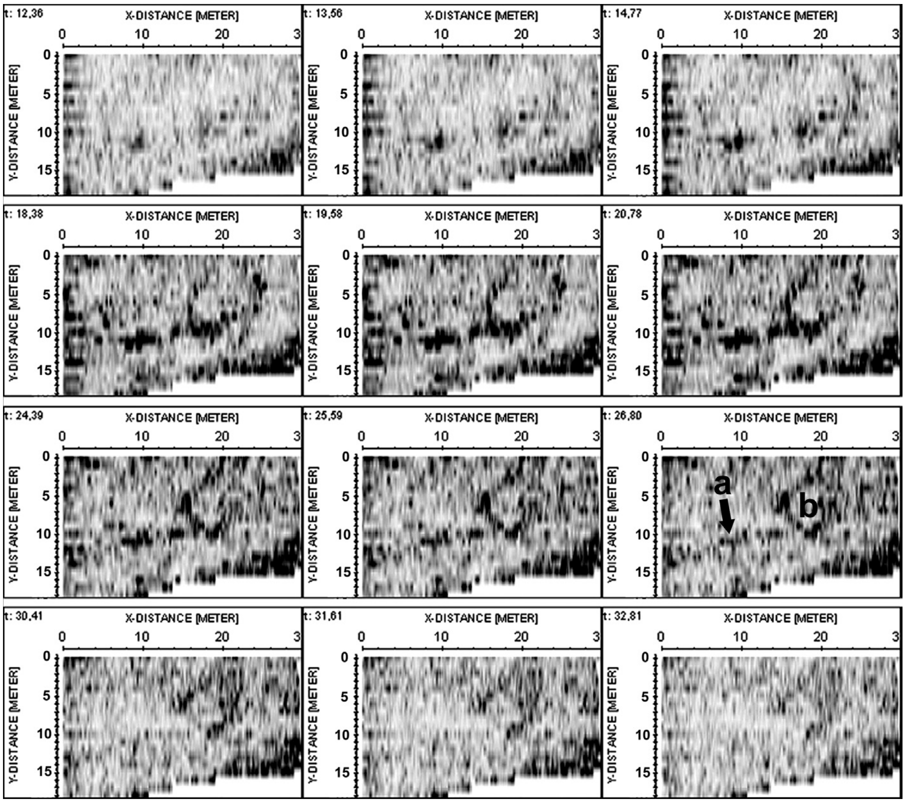

Fig. 14: A segment of the southern defence wall with the southeastern tower, GPR area G7 (*Fig. 3C*), measured surface of 30 x 20 m: time slices. Due to the high level of water saturation (*Fig. 7:* b) and consequently the attenuation of the electromagnetic waves, the amplitudes of GPR echoes are low. Nonetheless, a part of the southern wall is discernible (a), as well as the southeastern tower with its square ground plan and situated diagonally to the defence wall (b).
Sl. 14: Del južnega obzidja z jugovzhodnim stolpom, georadarsko območje G7 (*sl. 3C*), površina 30 x 20 m: horizontalni rezi radarskih odbojev. Zaradi visoke namočenosti terena (*sl. 7:* b) in posledično močnega dušenja elektromagnetnega valovanja so amplitude radarskih odbojev nizke. Kljub temu razločimo del južnega obzidja (a) in jugovzhodni stolp kvadratnega tlorisa, ki je postavljen diagonalno na obzidje (b).

The western edge of the settlement lies mostly beyond the region of the resistivity survey. The western defence wall, approximately 0.70 m wide, is presented on the ground plan from 1936 (*Fig. 2*). However, it is not clear whether the entire course was indeed investigated by Šmid, or whether the plan was completed on the basis of only a few excavated segments. Schulz reported that the walls along the western edge were damaged (Horvat 1990, 52, 101-102, 207-208). A segment of the western defence wall, the course of which corresponds with Šmid's plan, is probably seen on the GPR survey results of area 12b (*Figs. 22, 36*).

Towers and entrances

The tower at the southwestern corner of the settlement lies beyond the geophysically surveyed region. Šmid recorded the ground plan, and Mikl Curk carried out excavations along two sides of it (*Fig. 2*; Mikl Curk 1974; Horvat 1990, 97, 99, 205). The width of the foundations, built of quarried stone and initially also bound with mortar, measured 1.5 m; the ground plan of the tower covered an area of approximately 8 x 8 m (Horvat 1990, 99, 205, fig. 22).

The southeastern tower, positioned diagonally along the southern and eastern tracts of the defence wall, is poorly discernible due to the high moisture content in the soil (see above). Results from the resistivity method (*Figs. 4-6*) enable a relatively distinct portrayal with the use of a low frequency filter (*Fig. 6*). Mikl Curk investigated the tower already in 1969 (Mikl Curk 1974; Horvat 1990, 97-98, 205, fig. 21); the exterior dimensions are approximately 7 x 7 m, with walls measuring 1 m thick. The tower appears on the time slices of the GPR profiles at a depth of 0.5 m and reaches to a depth of 1.3 m (*Fig. 14*).

The unambiguous remains of the tower are not visible in the northeastern corner of the settlement, where the results of the resistivity method are indistinct (*Figs. 4-6*). Walter Šmid also made no mention of this tower. Large areas of high resistivity are visible however; they represent the well preserved paved surfaces and/or ruination layers in the interior side of the eastern defence wall (*Figs. 4-6, 36:* building 1). A region with somewhat higher values than the background is visible also along the exterior side of the northeastern corner of the defence wall in the resistivity results (*Fig. 3C:* G5; *Fig. 24:* b). The size of this area approximately corresponds with the dimensions of the southeastern tower. However, this low anomaly region is not distinct enough to be reliably interpreted as a defence tower. GPR sounding also failed to procure distinct echoes in this area.

A rectangular tower (approximately 8 x 6 m wide, 1 m wide wall, depth between 0.5 and 1.3 m) was situated along the eastern defence wall. The tower was partially offset, exceeding the exterior line of the wall (by 1 m, which is the width of the tower wall) (*Figs. 4-6*). The structure of the defence wall ruination, as seen in the results from the GPR survey (*Fig. 3C:* G6; *Fig. 12*), indicates that the approximately 5.5 m wide entrance into the settlement lay north of the tower. A part of the wall was additionally fortified (4 x 2.5 m) along the northern side of the entrance.

A 5 m wide paved tract lay along the exterior side of the defence wall in the area of the eastern entrance. The pavement is traceable along almost the entire length of the eastern side of the defence wall (*Figs. 4-6, 36*). Traces of a similar pavement were also reported near the southeastern tower by Mikl Curk (Mikl Curk 1974, 373, suppl. 2); however our measurements made no such recordings there.

The magnetic method results reveal that a 5 m wide road led from the eastern gateway to the interior of the settlement. Presumably it was made of consolidated layers of sand (see below; *Figs. 8-9, 36*).

The walls of the northern tower are clearly discernible only on the GPR results (*Fig. 3C:* G3; *Figs. 18; 36*) and less so on those of resistivity (*Fig. 4B*). They measure 1 m wide and between 0.8 and 1.6 m deep. The southern side of the tower measures 7 m. It seems that the tower is symmetrical, of a square form. The tower narrows in the centre, or rather, the walls are additionally fortified there.

A stone paved road leading through the tower interrupts the northern defence wall. The road lies 0.6 m deep and is between 0.3 and 0.6 m thick (*Figs. 4-6, 18, 36*). The altering thickness of the road as seen in the GPR profiles could be the consequence of road repairs carried out due to its sinking into the soft ground (*Figs. 20-21*).

The riverbank outside the northern defence wall was probably paved like the tract along the eastern defence wall (*Figs. 4A*; *5; 36*).

Defence ditch

The course of the defence ditch ran along the eastern and probably also along the southern tract of the wall. The ditch was not found during excavations (Mikl Curk 1974, 373). Results from geophysical prospecting reveal that the ditch has increased porosity in comparison with the natural environment and that it acts as a water collector in otherwise poorly permeable clay. This illustrates the

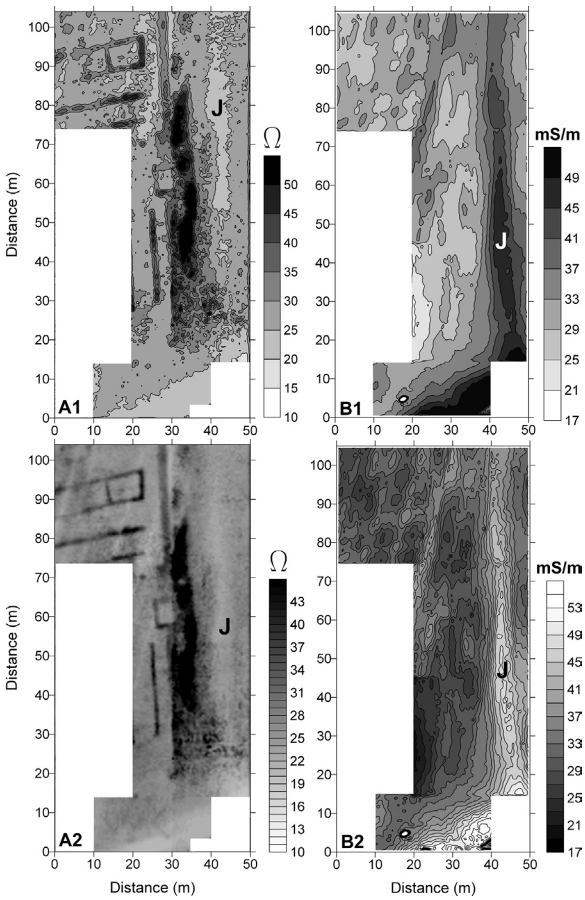

Fig. 15: The course of the defence ditch is traceable in the resistivity results (A1 and A2: J), however it is more discernible on the electrical conductivity results (B1 and B2: J).
The conductivity values gradually increase from the edges of the ditch towards the central axis, which is indicative of a triangular cross section (see *Fig. 16*).
Sl. 15: Poteku obrambnega jarka sicer sledimo na rezultatih upornosti (A1 in A2: J), vendar je bolje viden na rezultatih električne prevodnosti (B1 in B2: J). Vrednosti prevodnosti se postopoma višajo od robov jarka proti središčni osi, kar kaže na trikotni presek jarka (glej *sl. 16*).

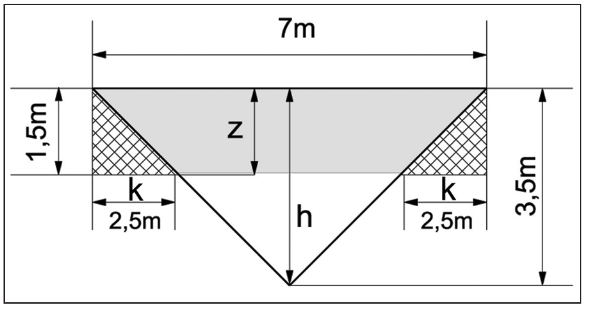

Fig. 16: A schematic illustration of the section of the ditch along the eastern defence wall: depth of the effective range of the electrical conductivity measurement (z), presumed depth of the ditch (h), the area of the combined effect of the electrically highly conductive ditch fill and the surrounding clay, with relatively lower electrical conductivity, into which the ditch is dug (k).
Sl. 16: Shematski prikaz preseka jarka ob vzhodnem obzidju. Globina efektivnega dosega meritev električne prevodnosti (z), predpostavljena globina jarka (h), območje kombiniranega učinka zelo dobro električno prevodnega polnila jarka (visoka prevodnost) in gline z relativno slabšo električno prevodnostjo, v katero je jarek vkopan (k).

higher electrical conductivity of the ditch fill, and consequently its visibility in the resistivity results (*Fig. 3D:* K2; *Fig. 15:* A1,A2), and even more so in the results from the electrical conductivity (*Fig. 15:* B1,B2). The results of the magnetic method, with no clearly distinguishable ditch, show that there is no great difference in the magnetic susceptibility between the fill and the natural environment; this indicates that the material in the fill and in the direct vicinity is the same. The ditch is thus recognized on the magnetograms only by its magnetically "quiet" background (*Fig. 8A:* f).

The edge of the pavement between the eastern defence wall and ditch is slightly inclined (*Fig. 13:* h). At the same time, this probably substantiates the inclination of the side of the ditch. The electrical conductivity results (*Fig. 15:* B1,B2) allow the supposition that the ditch is deepest in its centre; presumably it has a triangular cross section. The form and dimensions of the ditch are thus established on the basis of the results from the electrical conductivity and the GPR methods (*Fig. 16*). The ditch is 7 m wide and approximately 3.5 m deep (h). Considering the 1.5 deep range of the *Geonics EM38* instrument (z), high values of electrical conductivity were attained towards the centre of the ditch at approximately 2.5 m. These values are the result of the impact of the clay in which the ditch was dug (increased consistency, with a decrease in the seepage).

The ditch was positioned 9 m away from the eastern defence wall. A 12 m long wall (0.5 m wide, 0.5 m thick and at about 0.5 m depth) ran along the western edge of the ditch (*Figs. 3C:* G6*;12; 13:* c). The wall might have consolidated the edge of the ditch or was perhaps a part of the construction connected with the crossing over the ditch.

Market

Amidst the settlement lay a large stone paved area of an irregular parallelogram form (75 m x 51 m x 77 m x 59 m; the eastern limit is indistinct)

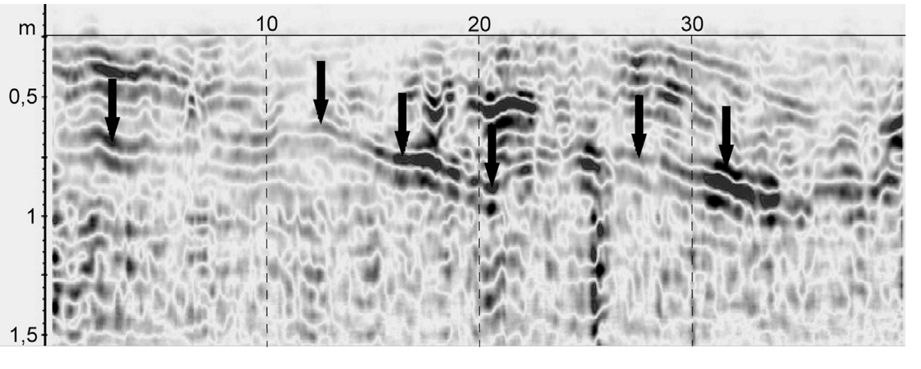

Fig. 17: GPR echoes from the paved surface of the market. The apparently unevenly paved surface is consequent to the variable present surface morphology and therefore the varying distances of the GPR antenna from the paved surface. The apparent depth of the pavement ranges between 0.5 m and 0.80 m. In view of the good resolution of the GPR echoes from the upper and lower pavement surfaces, it is known that the thickness of the pavement is greater than 0.15 m, which is one quarter of a wavelength of the electromagnetic waves of a 200 MHz antenna in the explored medium. The thickness of the pavement is determined on the radargrams and measures between 0.2 and 0.3 m.
Sl. 17: Radarski odboji od tlakovane površine trga. Navidezna povitost tlakovane površine je posledica morfologije površine zaradi različne terensko pogojene oddaljenosti antene od tlakovane površine. Navidezna globina tlaka se tako spreminja od 0,5 m do 0,80 m. Glede na dobro ločljivost odbojev od zgornje in spodnje ploskve tlaka vemo, da je debelina tlaka večja od 0,15 m, kolikor znaša četrtina valovne dolžine elektromagnetnega valovanja 200 MHz antene v preiskovanem mediju. Debelina tlaka, določena na radargramih, je sicer od 0,2 do 0,3 m.

and enclosed with a colonnade (*Figs. 4-6, 36, 39*). Already Šmid documented the area paved with stone slabs (Horvat 1990, 54). The pavement remains are indicated in the resistivity results by their somewhat higher background values (*Fig. 7*). The relatively low contrast is a consequence of ploughing damage as well as of the varying humidity between the altering consistency of the soil in former arable lands and land plot boundaries. The land plot boundaries, which look like small depressions in the field, are approximately parallel to each other and they run in a northeast - southwest direction (*Figs. 4-6, 7*). They were presumably used also as drainage ditches. They look like bright lines in the resistivity measurements, which indicate low resistivity values due to the concourse of water from higher field surfaces. The reduced sensitivity of the resistivity method on thin and low contrasting horizontal layers is another technical reason for the low contrast in resistivity.

The GPR profiles show that the pavement lies about 0.5 m deep and is between 0.2 and 0.3 m thick (*Fig. 17*). The altering thickness of the pavement on the georadar profiles is a result of the combined effect of the uneven morphology of today's surfaces and presumably also the unlevel surface of the pavement. The pavement is also discernible in the time slices of the GPR profiles as a slightly higher amplitude of GPR echoes as compared to the background (*Figs. 22, 27-28*).

Paths

Four passages open out from the market (*Fig. 36*). One 5 m wide and thickly paved road leads

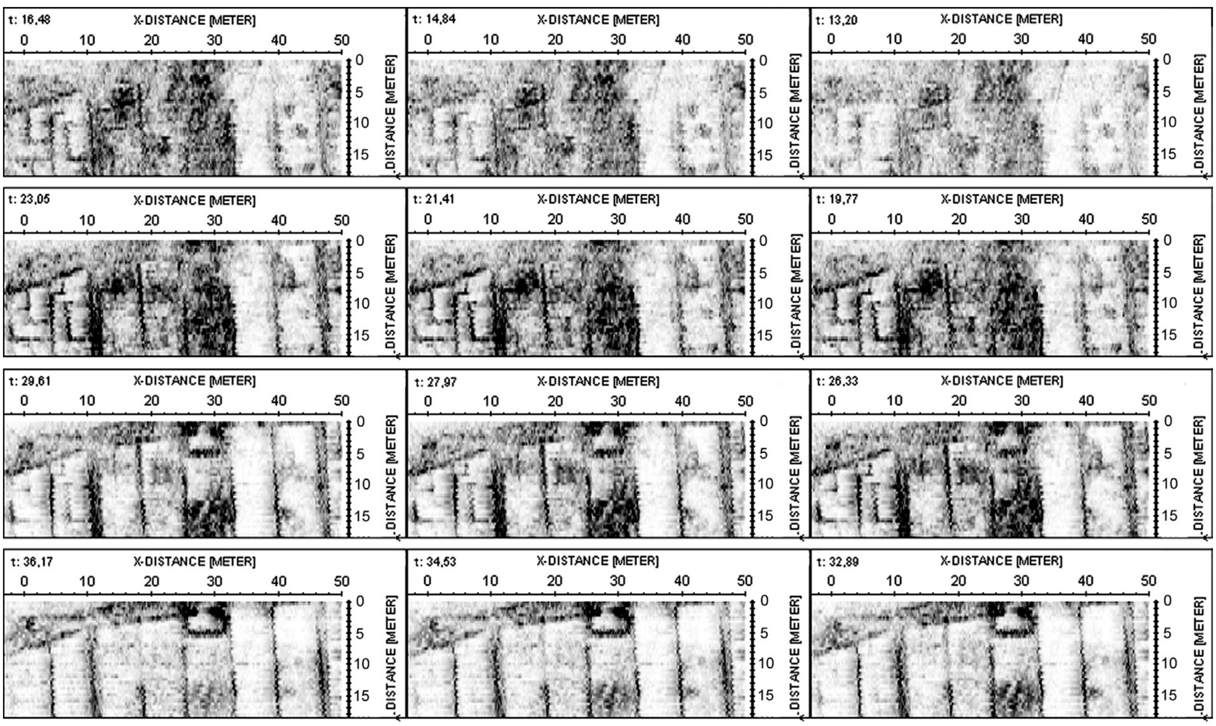

Fig. 18: Structures 3, 4 and 5, the northern defence wall and tower and the paved road (see *Fig. 36*), GPR area G3 (*Fig. 3C*), measured surface of 53 x 20 m: time slices. The single and double walls of the storehouse rooms 3, 4 and 5 are discernible, as well as the numerous walls that divide the interiors of the rooms. Some of these small rooms are paved. That the northern wall seems to be double is consequent to the paved platform on the outside of the defence wall and the wall that runs almost parallel with it. The 1 m wide walls of the northern tower are discerned at the approximate depth of the paved road, which runs from the northern gateway to the interior of the settlement. The tower is clearly distinguished only under the paved road; presumably it is not preserved higher up. Approximately in the centre of the tower is a narrowing with a passage into the interior of the settlement. The northern tower has the deepest foundations (reaching to a depth of 1.6 m) within the geophysically explored part of the settlement.

Sl. 18: Stavbe 3, 4 in 5, severno obzidje s stolpom in tlakovana cesta (glej *sl. 36*), georadarsko območje G3 (*sl. 3C*), površina 53 x 20 m: horizontalni rezi radarskih odbojev. Vidijo se enojni in dvojni zidovi skladiščnih prostorov 3, 4 in 5 s številnimi zidci, ki na različne načine pregrajujejo notranjost prostorov. Nekateri od teh manjših prostorov so tlakovani. Navidezna dvojnost severnega obzidja je posledica tlakovane ploščadi na zunanji strani obzidja in zidu, ki je skoraj vzporeden z obzidjem. Približno na globini tlakovane ceste, ki pelje od severnih vrat v notranjost naselbine, se pojavijo 1 m široki zidovi severnega stolpa. Stolp se vidi jasno šele pod tlakovano cesto in sklepamo, da višje ni ohranjen. Približno na sredini stolpa je zožitev s prehodom v notranjost naselbine. Severni stolp je najgloblje temeljena struktura na najdišču. Temelji segajo do globine 1,6 m.

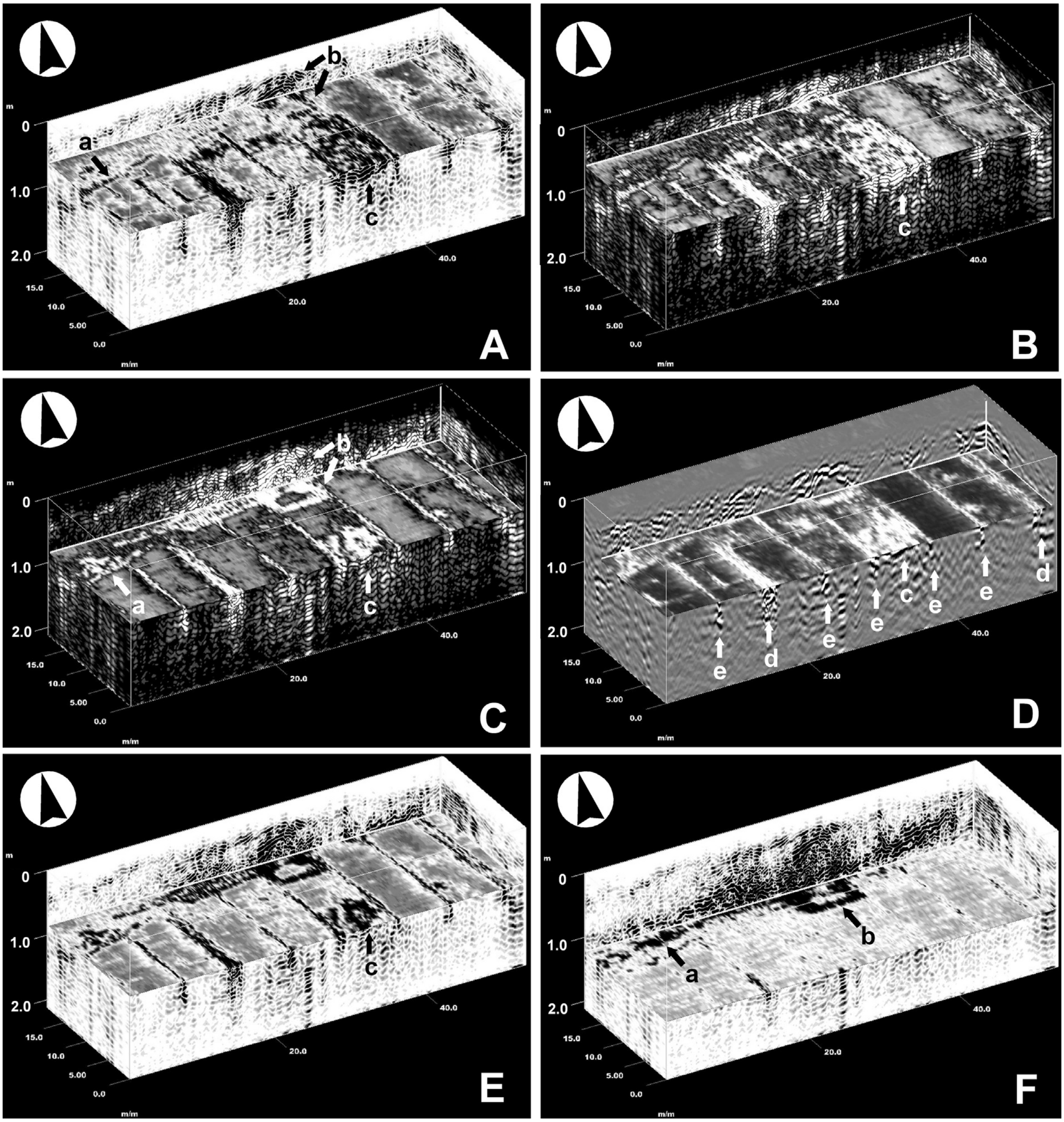

Fig. 19: Structures 3, 4 and 5, the northern defence wall and tower and the paved road (see *Fig. 36*), GPR area G3 (*Fig. 3C*), measured surface of 53 x 20 m: 3D portrayal of GPR echoes. The eastern tract of the northern defence wall (a), northern tower (b), paved road (c), double wall in the storehouse rooms (d), single wall in the storehouse rooms (e).
Sl. 19: Stavbe 3, 4 in 5, severno obzidje s stolpom in tlakovana cesta (glej *sl. 36*), 200 MHz antena, georadarsko območje G3 (*sl. 3C*), površina 53 x 20 m: 3D prikaz radarskih odbojev. Vzhodni krak severnega obzidja (a), severni stolp (b), tlakovana cesta (c), dvojni zid skladiščnih prostorov (d), enojni zid skladiščnih prostorov (e).

from building 24 towards the northern tower. This road lies at a depth of 0.6 m and has a thickness of between 0.3 and 0.6 m (*Fig. 21*). The road has a gradual upward incline towards the north; this is clearly visible on the time slices from the GPR profiles (*Fig. 3C:* G3,G4/1; *Fig. 18-20*). It first disappears on the northern side and only later on the southern side as well. The northern road is also the structure with the highest resistivity measurements in the entire settlement (*Fig. 7*). It follows that it is paved with stone slabs and that it is well preserved. It was most likely the main road through the settlement, whereby its solid construction ensured its durability and load capacity. The application of a high pass filter, which emphasizes shortwave resistivity anomalies, brought to light

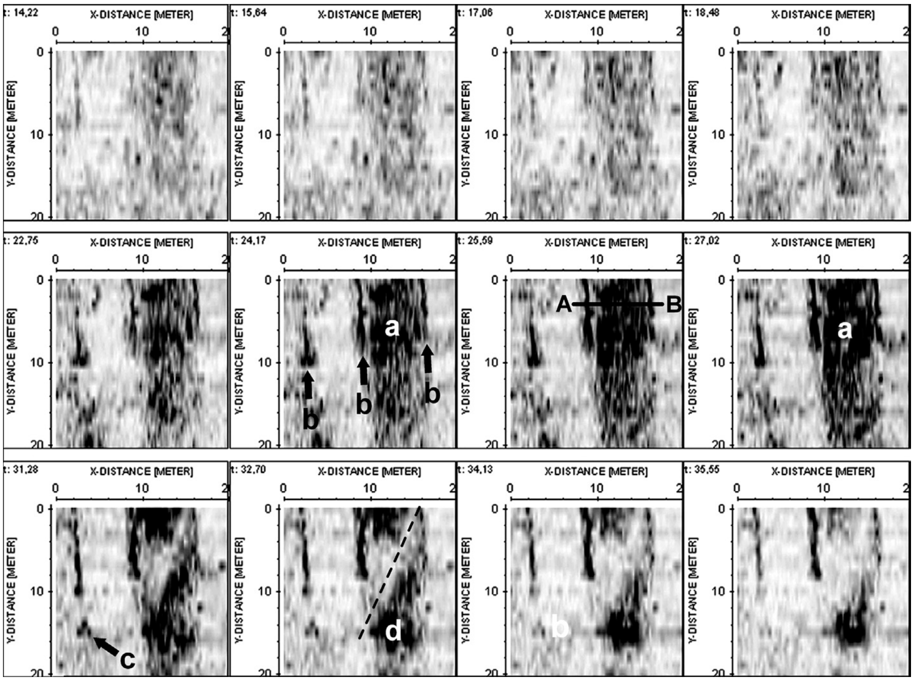

Fig. 20: The paved road leading from the northern gateway towards structure 24, GPR area G4/1 (*Fig. 3C*), measured surface of 20 x 20 m: time slices. The paved road (a), walls of the storehouse rooms 4b and 3a (b), column base (c), structure under paved road (it could be a structure with a square cross section and the side measuring 3 m, or even with a circular cross section of a similar size) (d). The dotted line denotes the smothered GPR signal along the well-saturated border (which functions as a drainage ditch) of the land plot. The AB line marks the positioning of the GPR profile on *Fig. 21*.
Sl. 20: Tlakovana cesta od severnih vrat proti objektu 24, georadarsko območje G4/1 (*sl. 3C)*, površina 20 x 20 m: horizontalni rezi radarskih odbojev. Tlakovana cesta (a), zidovi skladiščnih prostorov 4b in 3a (b), baza stebra (c), objekt pod tlakovano cesto - lahko gre za kvadraten ali krožen objekt s premerom 3 m (d). Črtkana črta označuje dušenje radarskega signala v smeri dobro namočene parcelne meje, ki služi kot drenažni jarek. Črta AB označuje položaj georadarskega profila na *sl. 21*.

the lot parcelling boundaries/drainage ditches that also “take their toll” on the road beneath (*Fig. 6*). The relative variations in the background resistivity are a consequence of the increased level of moisture as well as the partial destruction of the road in the direction of the former field boundaries/ drainage ditches.

A 5 m wide paved road also leads southwards to where there should be a passage through the defence wall (*Fig. 36*). It is much less distinct than

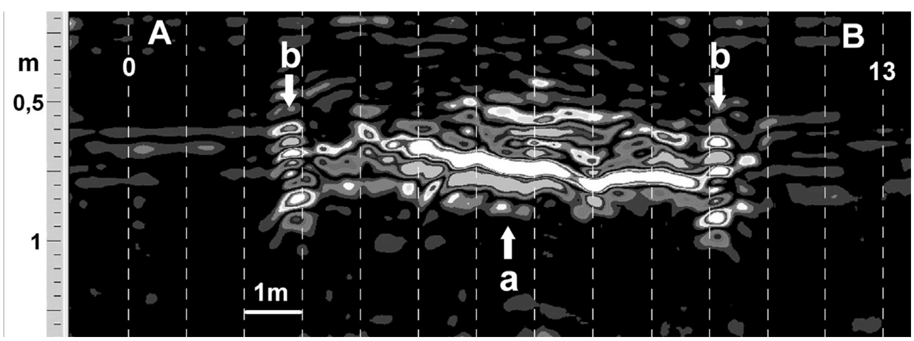

Fig. 21: The GPR section over the northern road (*Fig. 20:* section AB). The width of the road (a) is estimated to be at least 0.3 m, and it is slanting slightly eastwards on this GPR section (check the reflections along the upper and lower surfaces of the stone pavement as well as the reflections from the irregular layers above it). This could be indicative of road repairs carried out due to the sinking stone pavement. The arrows (b) mark the single walls of the storehouse rooms 3a and 4b.
Sl. 21: Georadarski profil čez severno cesto (*sl. 20:* profil AB). Debelina ceste (a) je ocenjena na najmanj 0,3 m in je na tem radarskem profilu rahlo nagnjena proti vzhodu (glej odboje od zgornje in spodnje površine kamnitega tlaka ter odboje od nepravilnih plasti nad njim). Lahko gre za popravila na cesti zaradi usedanja kamnitega tlaka. S puščicama (b) sta označena tudi enojna zidova skladiščnih prostorov 3a in 4b.

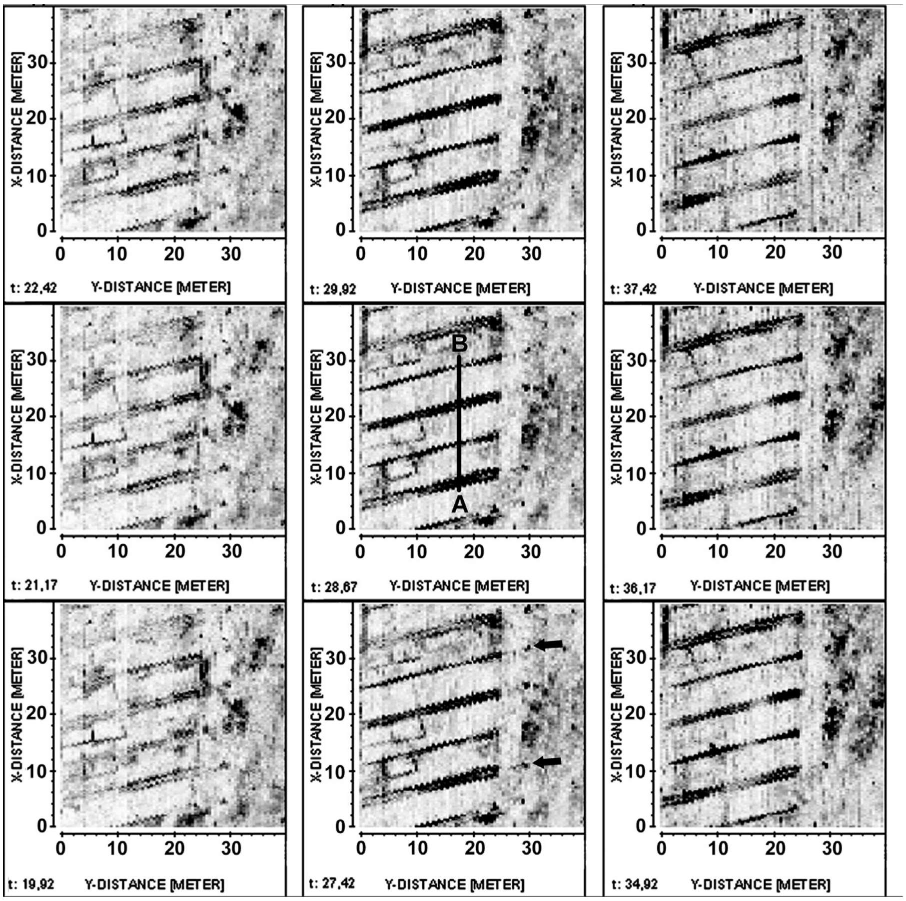

Fig. 22: The structures 12b through to 15 (see *Fig. 36*), GPR area G1 (*Fig. 3C*), measured surface of 40 x 40 m: time slices. The storehouse rooms with portico along the western side of the settlement. The single and double walls of the storehouse rooms are discernible, as well as the interior partition walls and the bases for the columns of the portico. The darker fields eastwards of the storehouse rooms are consequent to the paved surface of the market. The AB line demonstrates the positioning of the GPR section on *Fig. 23*.

Sl. 22: Objekti od 12b do 15 (glej *sl. 36*), georadarsko območje G1 (*sl. 3C*), površina 40 x 40 m: horizontalni rezi radarskih odbojev. Skladiščni prostori s portikom na zahodni strani naselbine. Prepoznamo enojne in dvojne zidove skladiščnih prostorov, notranje pregradne stene in baze stebrov portika. Temnejša polja vzhodno od skladiščnih prostorov so posledica tlakovane površine trga. Linija AB prikazuje položaj radarskega profila na *sl. 23*.

the northern road in the results of the resistivity measurements (*Figs. 4-6*). The resistivity values are within the limits for the paved surface of the market and the northern road. This indicates that the construction of the road was more solid than the paving of the market area, albeit less solid than the northern road. The road ends about 20 m before the line of the southern defence wall. There are two possibilities: that the road is destroyed further on or that the composition of the road changes drastically, e.g. into a sandy road that does not characteristically differ in resistivity from its environment. There are no GPR results and so the interpretation is based solely on the results from the geoelectric mapping. Šmid's plan (*Fig. 2*) shows that the southern defence wall ends where there might be a southern gateway. However, the remains of a pavement discovered by Mikl Curk in the southern edge of the settlement cannot be interpreted as the road leading southwards (Mikl Curk 1974, 374).

The road leading from the market to the east was not paved, nor was the passage westwards (between buildings 15 and 16) (*Fig. 36*). There are no visible anomalies near the eastern tower, which could be interpreted as a road either in the resistivity (*Figs. 4-6*) or in the GPR results (*Fig. 3C:* G6; *Figs. 12-13*). Two distinct and parallel lines of induced magnetization are seen on the magnetograms (*Figs. 8-9*); they run from the entrance by the eastern tower towards the interior of the settlement. They are the result of a substantial lateral difference in the magnetic susceptibility in a short distance. In this instance, this difference could represent the border between the road and the media in which it lies. The road might be built of a compact sand

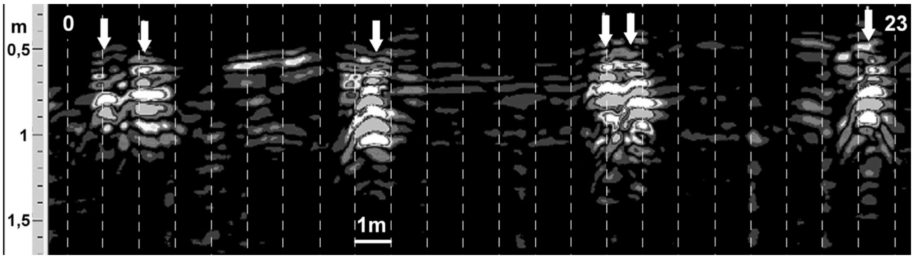

Fig. 23: The GPR section over the storehouse rooms 13b, 14a and 14b (see *Fig. 22*). The single and double walls at the depth range between 0.3 and 0.5 m below the present-day surface are clearly distinguishable, and they reach to a depth of 1 m, and occasionally to 1.3 m. The walls seem wider due to the hyperbolic echoes on the radargrams. The actual width of the walls ranges between 0.5 and 0.7 m. The closest approximation of the width of the walls is attained by the GPR sections after using migration algorithm (*Fig. 10:* G).

Sl. 23: Radarski profil čez skladiščne prostore 13b, 14a in 14b (glej *sl. 22*). Jasno ločimo enojne in dvojne zidove, ki se pojavijo na globini od 0,3 do 0,5 m pod današnjo površino in segajo do globine 1 m, le ponekod do 1,3 m. Zidovi so zaradi hiperboličnih odbojev na radargramih navidezno širši. Dejanska širina zidov se spreminja od 0,5 do 0,7 m. Najboljši približek širine zidov dobimo iz radarskih profilov po uporabi migracije (*sl. 10:* G).

that does not characteristically differ in resistivity and dielectric permittivity from its environment and thus remains indistinct in the resistivity and GPR results (check *Figs. 4- 6, 12-13*). The distance of 5 m between the linear magnetic anomalies is the same as the width of the road leading in the direction north-south.

Buildings 2-5, 11-17, 19-20, 22-23 (storehouses)

Buildings with long and narrow rooms in a row, and wide entrances are positioned around the market; these are in the continuation interpreted as storehouses. Buildings 2-5 are situated on the northern side of the market, buildings 11-15 along the western side and 22-23 along the eastern. Two rows of buildings stand along the southern side of the market: buildings 16-17, 19-20 compose the northern tract and may be interpreted as storehouses, while the building 21 along the southern tract is in form characteristic for *tabernae* (see the continuation).

The walls are well discernible on the resistivity results (*Figs. 4-6*). However, the magnetic method procured only the occasional weak lines of induced magnetization; consequently, these results were not applicable for fulfilling the ground plan of the architectural remains (cf. *Fig. 8*). The GPR survey proved much more useful as it produced a series of detailed data concerning the dimensions of the architectural elements, their depths and state of preservation. The resistivity results, for instance, show the double walls as relatively strong and wide resistivity anomalies, while the other walls demonstrate somewhat weaker anomalies (*Figs. 4-6*). The double walls are very distinct on the GPR profiles (*Fig. 3C:* G1; *Figs. 22; 23*), and the partition walls have relatively thin and shallow foundations (*Fig. 22*).

The double walls can be interpreted as narrow passages - *ambitus* - separating two individual buildings. According to the excavation report they are between 0.35 and 0.50 m wide. The passages served to drain away water from the roofs (dimensions: Horvat 1990, 55, 110, 212). Schulz' detailed description (the double wall between buildings 12 and 13: Horvat 1990, 52, 101-102, 207-208, fig. 24) and Šmid's plan (*Fig. 2*) both indicate that the passages facing the market were walled-in. Evidently they also functioned as drainage channels drawing off the rainwater towards the river (cf. *Fig. 23*).

Several buildings are composed of two long and parallel rooms (3-5, 12-14, 17, 20), each denoted by the letters *a* and *b* (*Fig. 36*). Structures 2, 16 and 19 are composed of a row of four rooms (a-d). The width of the individual rooms is uniform and measures about 6 m. The exterior walls of the buildings, and the long walls of the rooms are between 0.5 and 0.7 m wide (*Fig. 23*). All these walls are discernible at a depth of 0.3 m beneath the surface and they reach down to a depth of 1 m, or 1.3 m at the most.

The lengths of the buildings, as seen on the resistivity results, measure 23-26 m for the northern tract, 22-26 m for the western tract, and around 24 m for the eastern tract. Buildings 16-20, at the south of the market, measure approximately 24 m in length (*Figs. 4-6*).

The back walls of the northern and western tracts of storehouses form a part of the defence wall. The entrances face towards the market and cover the entire width of the rooms. It seems that the ends of the walls at the entrances, for the most part, are somewhat widened. The foundations for the columns of the portico were built in the extended lines of the walls.

Several buildings differ from the above description. Buildings 11 and 15 comprise of only one room. Building 11, which is positioned by the bend in the river, also has an irregular trapezoidal form. Buildings 22-23 at the eastern end of the market presumably also have only one room each. Rooms 16a-b, 20a-b, 22 and possibly also 19c, open wide on both of the shorter sides; that is, they have double entrances. Building 18, with two rows of columns, is entirely open towards the northern side facing the market, as well as on the eastern and southern sides.

A few entrances were walled in with shallow foundation walls: 3a, 5a, 5b, 11, 12a, 13a, 13b, 15, 19d. Some of the large rooms were additionally subdivided by partition walls with shallow foundations. These foundations are discernible from a depth of 0.6 to about 1 m (*Fig. 22*). The following rooms have such partition walls: 2a, 2c, 2d, 3b, 4a, 5a, 5b, 11, 13a, 13b, 14a, 14b, 16c, 17b, 19d, 23. Rooms 3b, 4a and 4b also reveal small paved surfaces.

Comparison with W. Šmid's plan:

The new ground plan differs greatly from the old version of Šmid in the area of the buildings 16-18 (*Figs. 2, 36;* according to Šmid I/3, 4, 7; Horvat 1990, 101, 207). The western wall of building 16, the wall between the rooms 16b and 16c, and the southern wall of room 16c are recognizable on the old plan. The fortified northeastern corner of room I/7, according to Šmid, is most likely the base for a column along the southern road or the southeastern corner of building 18. Šmid's plan depicts something here that is not discerned by the resistivity results (according to Šmid, the dimensions of this foundation measure 1.7 x 1.8 m; Horvat 1990, 57, 101, 207). Šmid noted a building 22, open on both sides, but he extended it too far westwards, so that the column of the portico was interpreted as the northwestern corner of the building (*Figs. 2, 36;* according to Šmid VIII; Horvat 1990, 109, 211).

Building 21 (tabernae)

Four rooms set in a row and separated by single walls were distinguished using the resistivity method: 21e-h (*Figs. 4-6, 36*). Most of the nearby area is situated beyond the range of our geophysically surveyed area. The rooms of building 21 most likely continued onwards towards the west, similar to the row of buildings 16-18 further north. Thus is posited the presence of the four rooms beyond, 21a-d (*Fig. 39*).

The eastern wall of building 21 and the wall between the rooms 21f and 21g were recorded by Šmid (he erroneously linked them with the walls of building 18) as well as two walls, each more than 1 m wide, that run parallel with and about 5 m away from the defence wall (*Figs. 2, 36;* according to Šmid I/2, 6, 5, 7; Horvat 1990, 101, 207). In comparison with the new plan, the last two walls can be interpreted as the southern walls of rooms 21a-b and 21g-h.

The resistivity measurements together with the excavations from 1934 and 1936 provide the basis for reconstructing a building with eight rooms, each about 6 m wide and 8.5 m deep (*Fig. 39*). Their entrances open wide towards the north and have broadened doorposts. The foundations of the southern wall are stronger than those of the other walls. Two additional reinforcements of the southern foundations are seen on Šmid's plan (areas 21b

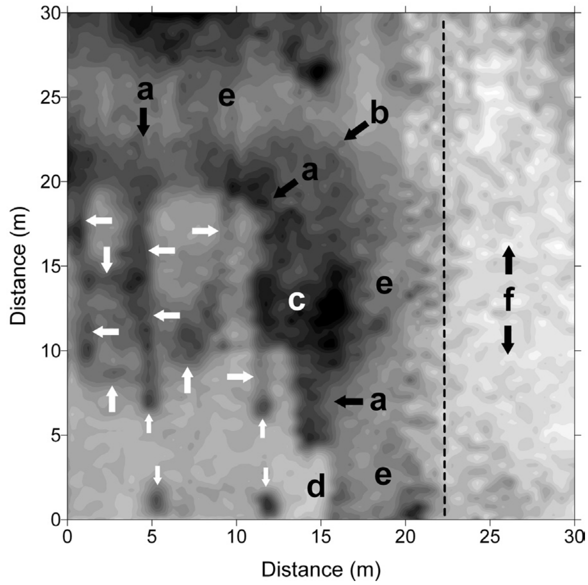

Fig. 24: Building 1. The results from the resistivity method. The defence wall (a); area of high resistivity values, which according to the surface and positioning correspond to the southeastern tower (b); clearly defined surface with exceptionally high resistivity values (paved surface and/or ruination layers) (c); discontinuation of the defence wall (?) (d); paved surface at the exterior side of the defence wall (e); defence ditch (f). White arrows mark the walls, small white arrows mark the widening of the wall endings and the bases for the columns.

Sl. 24: Stavba 1. Rezultati upornostne metode. Obzidje (a); območje visokih vrednosti upornosti, ki po površini in položaju ustreza jugovzhodnemu stolpu (b); jasno zamejena površina izrazito visokih vrednosti upornosti - tlakovana površina in/ali ruševinske plasti (c); prekinitev obzidja (?) (d); tlakovane površine z zunanje strani obzidja (e); obrambni jarek (f). Z belimi puščicami so označeni zidovi, manjše bele puščice označujejo razširitvi zaključkov zidov in bazi stebrov v smeri teh zidov proti jugu.

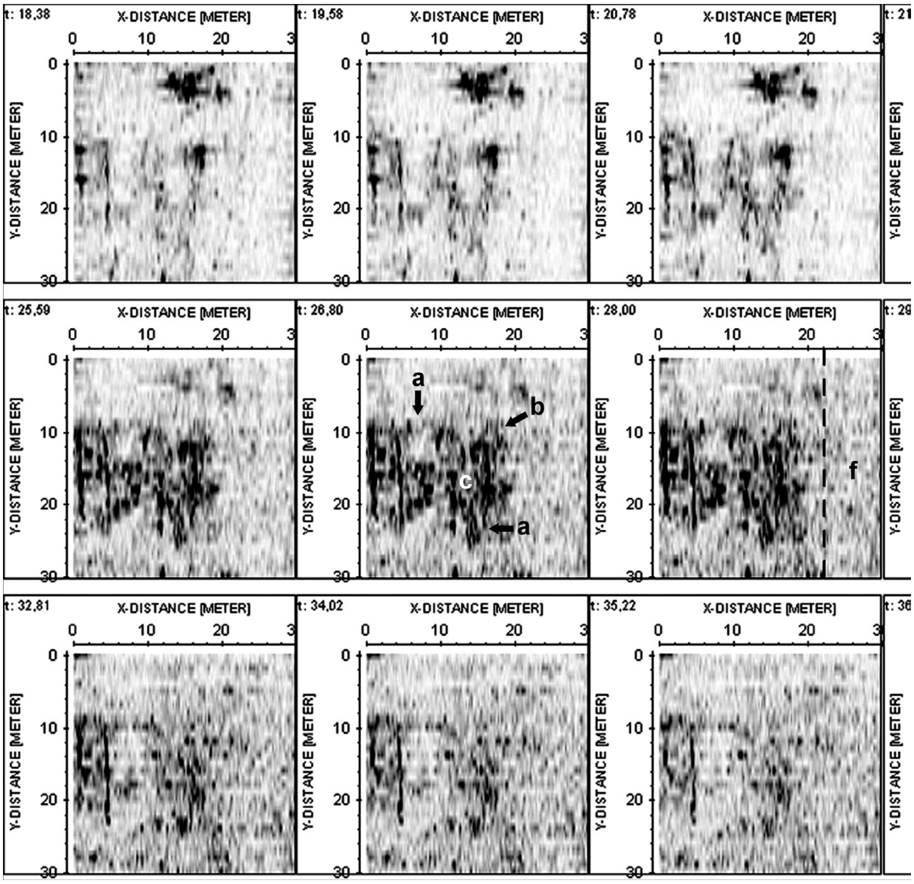

Fig. 25: Building 1, GPR area G5 (*Fig. 3C*), measured surface of 30 x 30 m: time slices. The results from GPR sounding generally confirm the determinations of the resistivity method (see *Fig. 24*). Precise measurements of the depths of the architectural remains and their level of preservation, obtained from GPR survey, are supplemental.
Sl. 25: Stavba 1, georadarsko območje G5 (*sl. 3C*), površina 30 x 30 m: horizontalni rezi radarskih odbojev. Rezultati georadarske raziskave v splošnem potrjujejo ugotovitve upornostne metode (glej *sl. 24*). Dopolnjujejo jih z natančnimi globinami arhitekturnih ostankov in stopnjo njihove ohranjenosti.

and 21g); this bespeaks at least two entrances on the southern side or a reinforcement of the walls in the form of buttresses.

Portico

The colonnade entirely surrounding the market was a composite part of the storehouses (*Figs. 4-6, 20, 22, 36*). The columns stand in line with the walls of the storehouses. The distance between the columns is approximately 6 m and they are about 4 m away from the entrances. The foundations have a square ground plan (1 x 1 m at most). Positioned about 0.6 m under the surface, the GPR time slices trace them to a depth of approximately 1 m (the same as the foundations of the storehouses).

There were 12 columns standing along the northern side of the market (also in front of building 2) and 9 along the western side. Along the southern side, where the remains are less discernible, there were 7 or more columns along the edge of the market. The covered area under the roof of the portico, in contrast with the market, was not paved with stones.

The southern colonnade continues with at least four columns into the passage between the buildings 15 and 16, which led straight onwards to the defence wall. A row of columns is also discernible along the middle of the passage between the buildings 16-18 and the *tabernae* 21.

Building 1

The walls of building 1 (*Fig. 36:* 1) are not very distinct on the resistivity and GPR time slices (*Fig. 3C:* G5; *Figs. 24-25*). Their construction was of inferior quality and/or their state of preservation was poor. The foundations are discerned at a depth

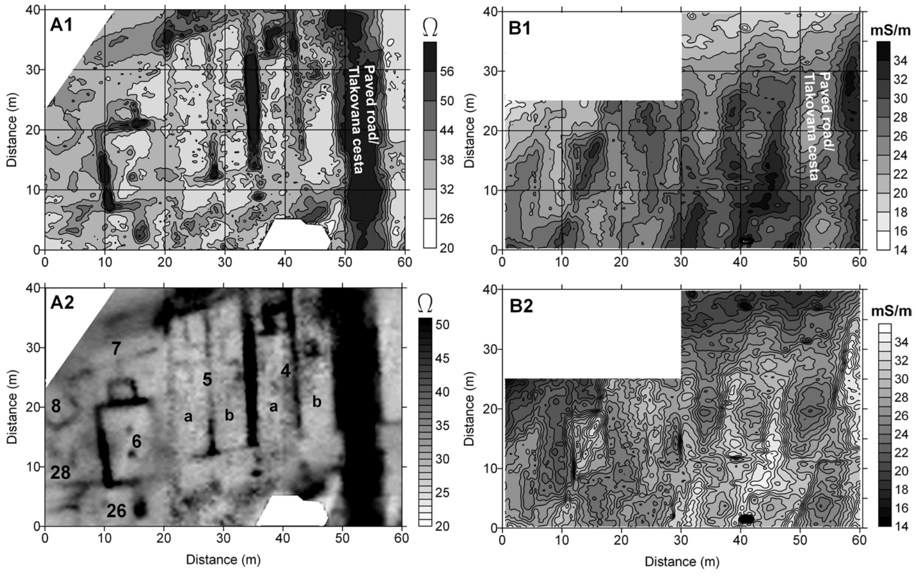

Fig. 26: Comparison of the resistivity results (A1 and A2) and those of the electrical conductivity (B1 and B2) in the area with architectural remains. Image A2 displays the structures from *Fig. 36*. The architectural remains are easily recognizable in the resistivity results. The results from the electrical conductivity measurements for the same area allow us to infer the positioning of the storehouse rooms only indirectly on the basis of the higher conductivity values of the interior structures. Structure 6 is clearly discernible due to the relatively higher level of moisture content in the interior. That the level of water saturation is higher than in the surrounding environment is probably consequent to the well- consolidated, and thus for water poorly permeable, former walking surface. The paved road is visible on the electrical conductivity results because its width exceeds the lateral resolution of methods for structures with low electrical conductivity (=high resistivity).

Sl. 26: Primerjava rezultatov upornosti (A1 in A2) in električne prevodnosti (B1 in B2) na območju z arhitekturnimi ostanki. Na sliki A2 so označeni objekti s *sl. 36.* Na rezultatih upornostne metode arhitekturne ostanke prepoznamo kot linije izrazito visokih vrednosti upornosti. V tem smislu so rezultati električne prevodnosti manj jasni. Arhitekturni ostanki dajejo šibke signale slabe prevodnosti medtem, ko so notranjosti skladiščnih prostorov električno dobro prevodna območja. Podobna konduktivnost je bila izmerjena tudi v smeri nekdanjih parcelnih mej, kar predstavlja dodatno omejitev te metode. Zaradi relativno višje vlažnosti v notranjosti se jasno loči od okolice samo objekt 6. Višja vlažnost od okolice je verjetno posledica dobro utrjene in za vodo slabo prepustne nekdanje hodne površine. Tlakovana cesta je vidna na rezultatih električne prevodnosti zaradi velike širine, ki ustreza lateralni ločljivosti metode za objekte slabe električne prevodnosti.

of about 0.6 m and traceable to a depth of 1 m. Building 1 differs slightly from the neighbouring buildings 2-3 in its direction, and even more so in the size of its rooms (room 1a: 13.5 x 6 m; room 1b: 14 x 7 m). The two long walls of the rooms a and b both end with widenings. The two columns were placed in the extensions of both walls with widenings, 5 m apart from each other. They presumably supported a roof covering the southern side of building 1. There are several partition walls with shallow foundations distinguished in the interiors of both rooms. It follows that this building had an extensive and open roof and thus differed greatly from the other storehouses (buildings 2-5, 11-17, 19-20, 22-23). (The old plan by Šmid for this area is very inaccurate; cf. *Fig. 2*).

Buildings 6 and 24 as well as structure 26

Building 24 lay in the centre of the market (dimensions 14 x 10 m, walls around 1 m thick; depth between 0.6 m and 1.6 m). Two columns (1 x 1 m) stood in the interior; their foundations were shallower than those of the peripheral walls (0.6-1.1 m). The entrance into the building was perhaps on its northern side (*Figs. 4-6; Fig. 3C:* G4/2; *Figs. 29; 36*).

Building 6 has very similar dimensions: the perimeter measures 14 x 10 m, the walls are about 1 m thick, and the depth range of the foundations is 0.5 to 1.5 m. The two columns (1 x 1 m) are discerned at a similar depth as the perimeter walls (0.8-1.3 m). Along the northern side, the building also has a rectangular room measuring 5 x 3.5 m and with foundations at the same depth (*Figs. 4-6, 26-28, 36*).

The results from the resistivity method (*Fig. 26:* A1,A2), the GPR time slices (*Fig. 3C:* G2; *Fig. 27*) as well as the 3D visualization of the GPR echoes (*Fig. 3C:* G2,G2/1; *Fig. 28*) all demonstrate that the eastern wall of building 6 is almost entirely destroyed. Considering that the destruction corresponds with the land plot boundary, it seems to

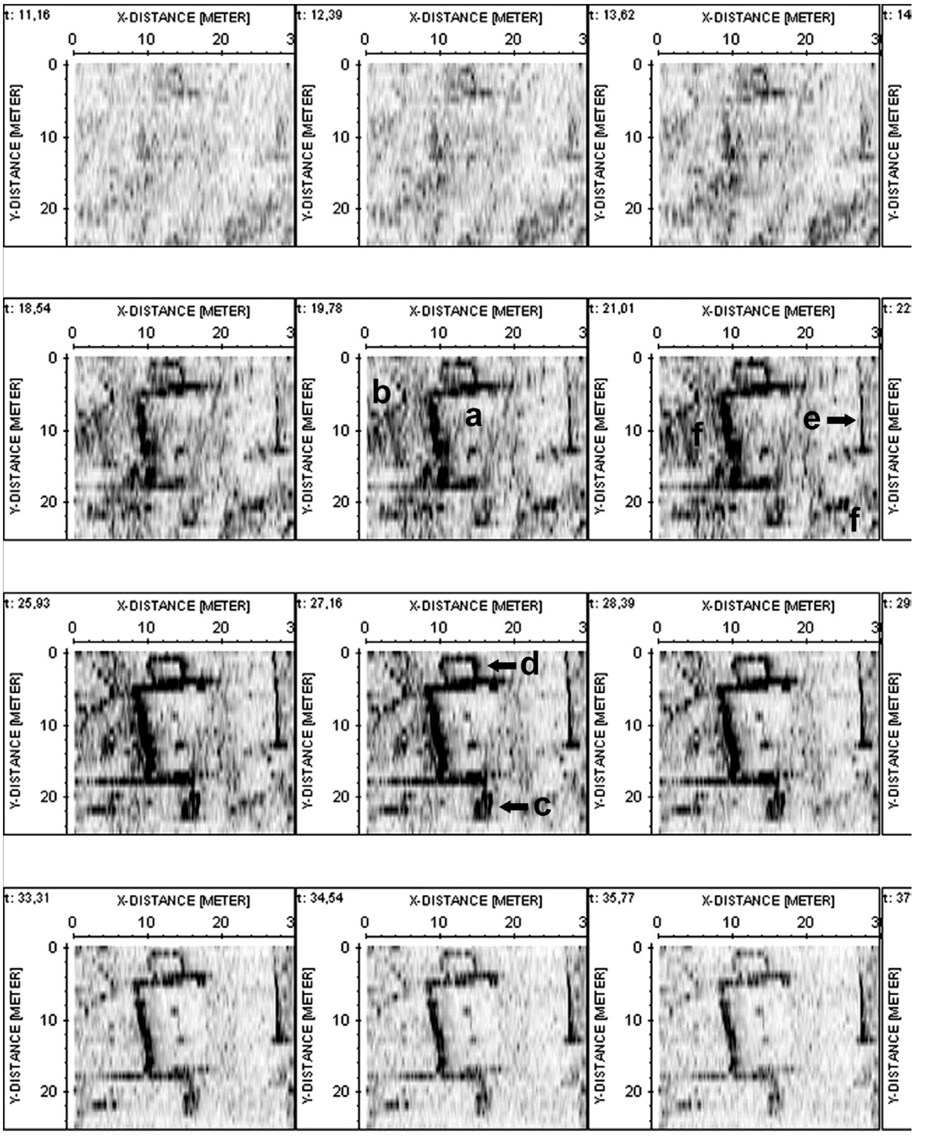

Fig. 27: Structure 6 (see *Fig. 36*), GPR area G2 (*Fig. 3, 28*), measured surface of 30 x 25 m: time slices. Structure 6 with two bases for columns in the interior (a); structure 8 (b); structure 26 (c); rectangular extension to structure 6 (d); western wall of the storehouse room 5a (e); part of the paved market surface and the paved area between structures 6 and 8 (f).
Sl. 27: Stavba 6 (glej *sl. 36*), georadarsko območje G2 (*sl. 3, 28*), površina 30 x 25 m: horizontalni rezi radarskih odbojev. Stavba 6 z bazama stebrov v notranjosti (a); stavba 8 (b); objekt 26 (c); pravokotni prizidek k stavbi 6 (d); zahodni zid skladiščnega prostora 5a (e); del tlakovane površine trga in tlakovano območje med stavbama 6 in 8 (f).

be the consequence of intensive agricultural usage. The walls of buildings 6 and 8 appear just beneath the surface (at 0.3/0.5 m) and are traceable to a depth of 1.5 m. The southern column foundation of building 6 was the first to be distinguished, which means that it is better preserved than the northern one. Both are traceable almost to the base of the building foundations (*Figs. 27, 28*). The walking surface in the interior was probably well hardened (*Fig. 26:* B1).

Structure 26 is situated 2 m away from the southern wall of building 6 (*Figs. 4-6, 26-28, 36*). This is a deep and rectangular foundation measuring 2.5 x 3 m and lying at a depth range of 0.6 to 1.3 m. Structure 26 and building 6 are connected by a wall.

The dark area (f) in the southeastern corner of *Fig. 27* represents the reflections of the paved market. Similar anomalies are also recognized in the area between buildings 6 and 8; these anomalies lead to the postulation that there was an at least partially preserved paved surface or structure 28, which was not discernible on the resistivity results.

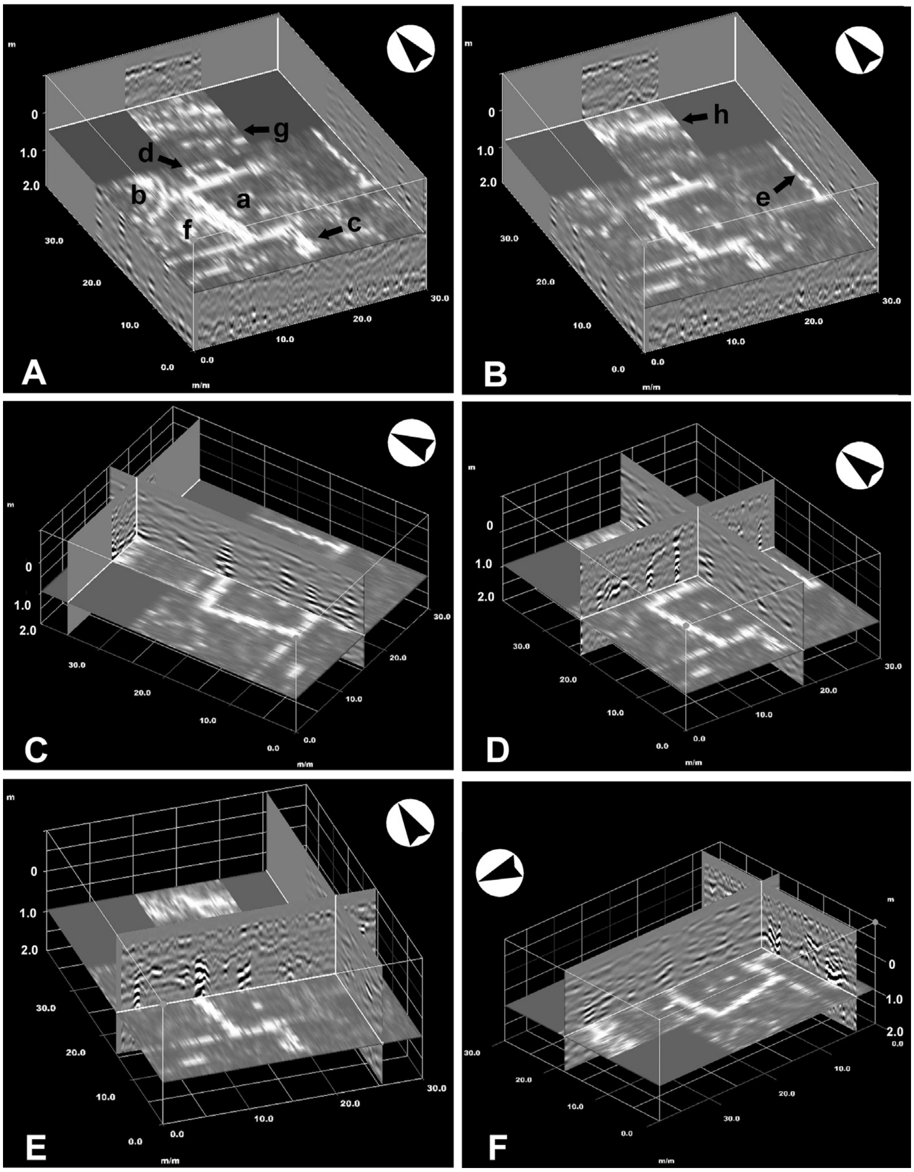

Fig. 28: Structure 6 (see *Fig. 36*), GPR area G2 (*Fig. 3C, 27*), measured surface of 40 x 30 m: 3D portrayal of GPR reflections. Structure 6 (a); structure 8 (b); structure 26 (c); rectangular extension to structure 6 (d); western wall of storehouse room 5a (e); paved area between structures 6 and 8 (f); structure 7 (g); defence wall (h).
Sl. 28: Stavba 6 (glej *sl. 36*), georadarsko območje G2 (*sl. 3C, 27*), površina 40 x 30 m: 3D prikaz radarskih odbojev. Stavba 6 (a); stavba 8 (b); objekt 26 (c); pravokotni prizidek k stavbi 6 (d); zahodni zid skladiščnega prostora 5a (e); tlakovano območje med stavbama 6 in 8 (f); stavba 7 (g); obzidje (h).

Building 7

Building 7 is represented by a rectangular, oblong delineation measuring 16 x 2 m and leaning upon the defence wall. The walls of this building are similar in width (approx. 0.7 m) to the foundations of the storehouses. Another wall links building 7 with the northern extension of building 6 (*Figs. 4; 5; 26; 28:* g; *36*). Šmid's plan (*Fig. 2*) anticipates multi-phases in this area.

Building 8

The geophysical measurements do not encompass the entire building (*Figs. 4-6, 36*), so the ground plan is completed on the basis of earlier data (*Figs. 2, 39*). The building has three rooms. Schulz was the first to investigate the northeastern room, measuring 9 x 6 m; Šmid later carried out excavations of the entire building along with the two extension rooms. The details of construction as documented by the two excavators are not discernible in the resistivity

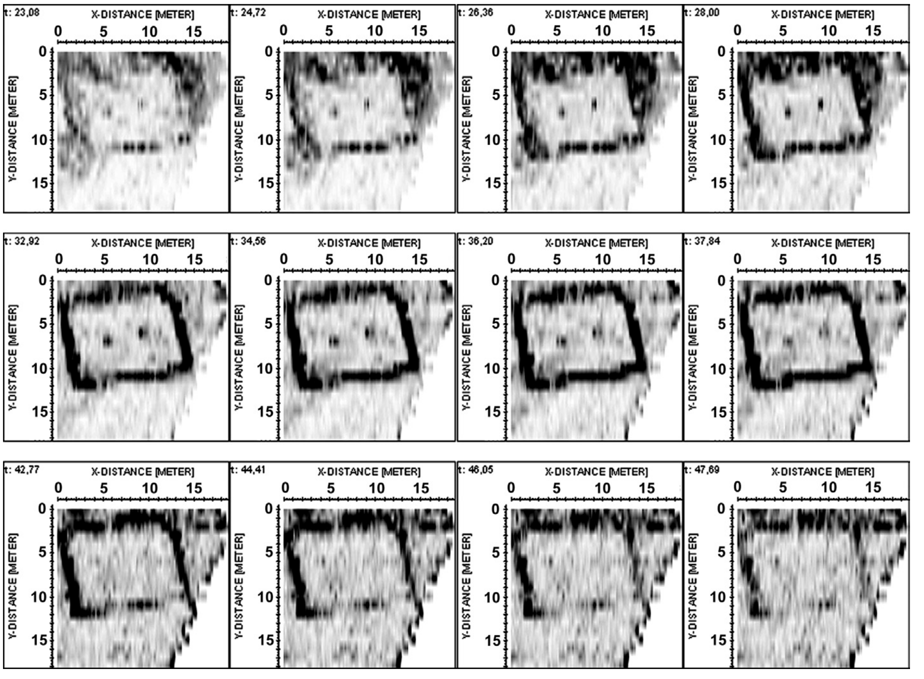

Fig. 29: Structure 24 (see *Fig. 36*), GPR area G4/2 (*Fig. 3C*), measured surface of 20 x 20 m: time slices. The rectangular ground plan of structure 24 and the bases of columns are documented at a depth of 0.6 m. The two walls of the structure are traceable to a depth of 1.6 m, and the column bases to a depth of 1.1 m. The discontinuation along the northern wall presumably represents a passage into the building.
Sl. 29: Stavba 24 (glej *sl. 36*), georadarsko območje G4/2 (*sl. 3C*), površina 20 x 20 m: horizontalni rezi radarskih odbojev. Pravokotni tloris stavbe 24 in bazi stebrov se pojavijo na globini 0,6 m. Zidovom sledimo do globine 1,6 m, bazam stebrov pa samo do globine 1,1 m. Prekinitev na severnem zidu verjetno predstavlja prehod v stavbo.

results. The discovered architectonic decoration demonstrates that the building retained an especial significance (Horvat 1990, 102-105, 208, fig. 25-29, building V according to Šmid). The walls are approximately 0.5 m wide and appear at a depth of between 0.3 m and 1.1 m (*Figs. 26, 27, 36*).

Building 9

The building is divided into two rooms of diverse width. Šmid excavated the entire building; as such the results from the resistivity measurements (*Figs. 4-6, 36, 39*) are completed according to his plan (*Fig. 2*; Horvat 1990, 103, 105, 208, fig. 30; building IV according to Šmid). The size of the eastern side of building 9 measures 7.5 m according to the resistivity results, while the width of the wall is estimated at 0.5 m.

Building 10

Šmid, who excavated also in this area, documented a small rectangular area (only partly in the area of resistivity measurements) and two long walls (*Figs. 2, 36, 39*). The southern wall is conjoint with building 11, while Šmid reports the northern wall as a colonnade (Horvat 1990, 103, 208, building III according to Šmid). The width of the foundations is estimated at 0.5 m on the basis of the results from the resistivity method.

Pavement or structure 28

An area of anomalies in the resistivity results was found near building 10 and between buildings 9 and 6. It seems to represent pavement or walls (*Figs. 4-6, 36*). An area with relatively strong radar echoes extends west of building 6 (*Fig. 3C:* G2; *Figs. 27; 28:* f). Šmid reports that the area around building 9 was paved (Horvat 1990, 56, 103, 209).

Building 25 (sanctuary)

Building 25 lies in the southwestern area of the market. It comprises of a central plateau and a peripheral wall. The peripheral wall delimits a surface of 18.5 x 17.5 m and has shallow foundations (*Figs. 4-6; Fig. 3C:* G1/1; *Figs. 32; 33; 36*). It is about 0.3 m wide and poorly discernible on both the resistivity and the GPR results. However, the GPR time slices show it from three sides, whereby it is traceable to a depth ranging from 0.3 to 0.8 m (*Figs. 32; 33:* c). Due to the lower amplitude of GPR echoes within the peripheral wall, as opposed to in the market area surrounding it, it is postulated that the interior was not paved (*Fig. 32:* a). Perhaps the market was paved subsequent to the construction of building 25.

A plateau measuring 12.5 x 7 m lies in the centre and is enclosed by a low wall (*Fig. 32: d*). The western part of the plateau, measuring 8 x 7 m, is preserved slightly higher (reaching from 1 to 1.3 m beneath today's surface) than the eastern part (lying between 1.3 and 1.6 m beneath today's surface). This leads to the posit of a bi-level construction. It could imply that the entrance was constructed on the eastern side and the central part on the western side (*Figs. 30-33*).

The resistivity results are significantly higher in the western half of the plateau (*Fig. 30:* small frame). It is postulated that the plateau is thicker on this side, or rather that it was built on two levels. The higher gradients of the magnetic field density were measured in the area of the plateau rather than in the direct vicinity (*Fig. 8*). This means that the plateau has a higher magnetic susceptibility than the environment, and that it cannot be attributed to quarried limestone. It seems probable that a thin layer of brick lies atop the limestone or sandstone construction (*Fig. 31*).

Structure 27 (tradesman's workshop?)

A small region of strong resistivity and magnetic anomalies lies outside the settlement, southeast of the defence ditch. A distinct rectangular ground plan of a structure is represented by the high values of resistivity (*Figs. 4-6, 36*). A few isolated magnetic anomalies with clear bipolarities appear in the same area (*Fig. 34*). The magnetic anomalies do not show a unified direction northwards, which is generally acknowledged as characteristic

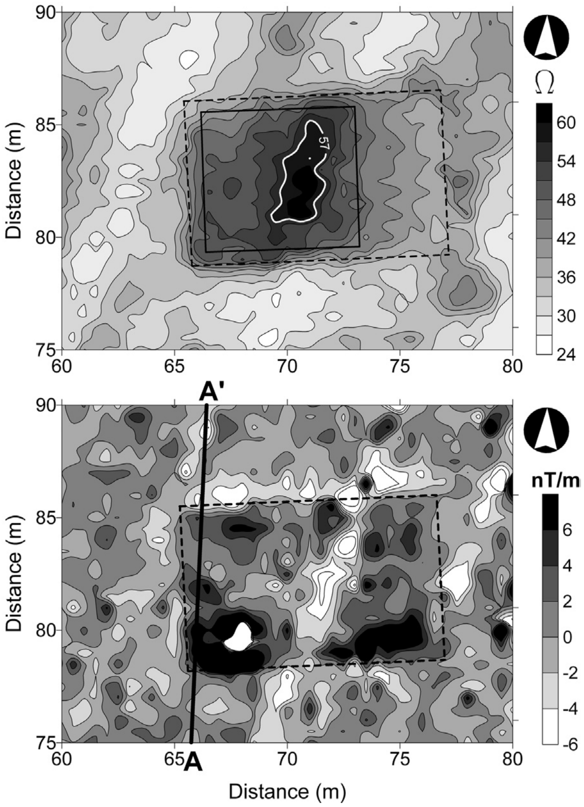

Fig. 30: Results from the conductivity (upper) and magnetic methods (lower) in the area of building 25 - temple. The position of section AA' is marked in *Fig. 31*.
Sl. 30: Rezultati upornostne (zgoraj) in magnetne metode (spodaj) na območju stavbe 25 -svetišča. AA': položaj radarskega profila s *sl. 31*.

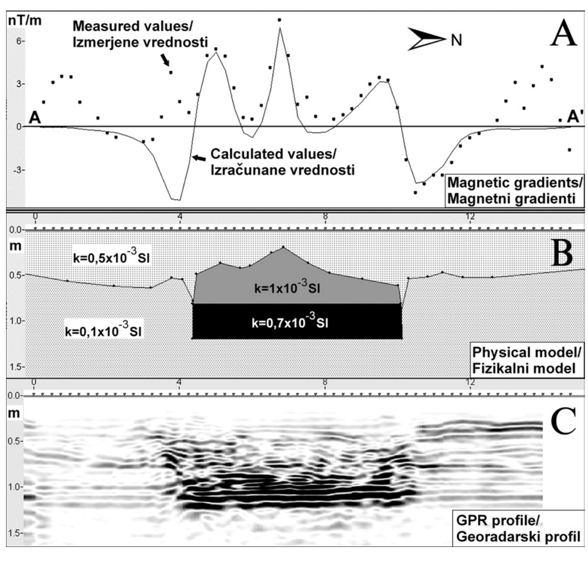

Fig. 31A-C: Building 25 - temple. An archaeo-physical model of the platform (B), which is composed of the lower stone construction and an upper layer with relatively higher susceptibility values (brick?). Image A portrays the measured values in the field and the values calculated for the physical model. Image C portrays the GPR section where the stone platform of building 25 is clearly discernible.
Sl. 31A-C: Stavba 25 - svetišče. Arheofizikalni model ploščadi (B), ki je sestavljena iz spodnje kamnite konstrukcije in vrhnje plasti relativno višjih vrednosti susceptibilnosti (opeka?). Na sliki A so prikazane vrednosti, izmerjene na terenu, in vrednosti, izračunane za fizikalni model. Na sliki C je prikazan radarski profil, kjer se dobro vidijo odboji od horizontalne plasti, ki je v tem primeru verjetno kamnita ploščad stavbe 25.

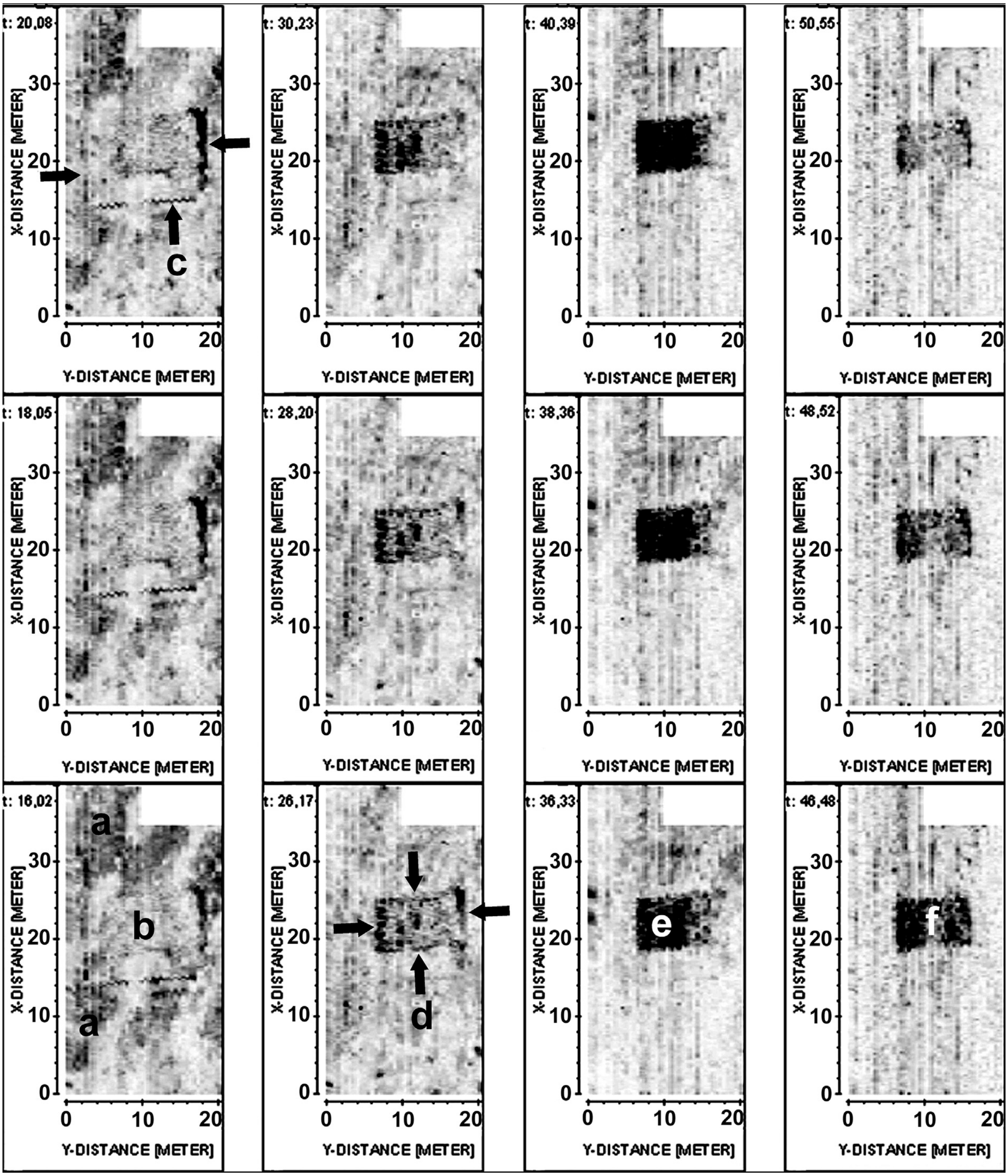

Fig. 32: Building 25 - temple (see *Fig. 36*), GPR area G1/1 (*Fig. 3C*), 200 MHz antenna, measured surface of 40 x 20 m: time slices. The temple comprises of a stone enclosure (c) with a rectangular platform in the centre (d). The surface within the enclosure (c) is not paved; the market area was probably paved later. This is conjectured on the basis of the lower amplitude of GPR echoes within the enclosure (b) than outside of it (a). The central stone platform is surrounded by a low wall (d). As the western half of the platform (e) is somewhat elevated above the eastern half, the platform was probably originally constructed in two levels. The entire ground plan of the paved platform (f) is discernible only at a greater depth.

Sl. 32: Stavba 25 - svetišče (glej *sl. 36*), georadarsko območje G1/1 (*sl. 3C*), 200 MHz antena, površina 40 x 20 m: horizontalni rezi radarskih profilov. Svetišče sestavlja kamnita ograda (c) s pravokotno ploščadjo v sredini (d). Površina znotraj ograde (c) ni tlakovana, ker je bil trg verjetno tlakovan pozneje. Na to sklepamo na osnovi nižjih amplitud odbojev znotraj ograde (b) kot zunaj nje (a). Osrednjo kamnito ploščad obdaja nizek zidec (d). Ploščad je verjetno zasnovana stopničasto, ker je zahodna polovica ploščadi (e) nekoliko dvignjena nad vzhodnim delom. Šele na večji globini se namreč pokaže tlak v celotnem tlorisu ploščadi (f).

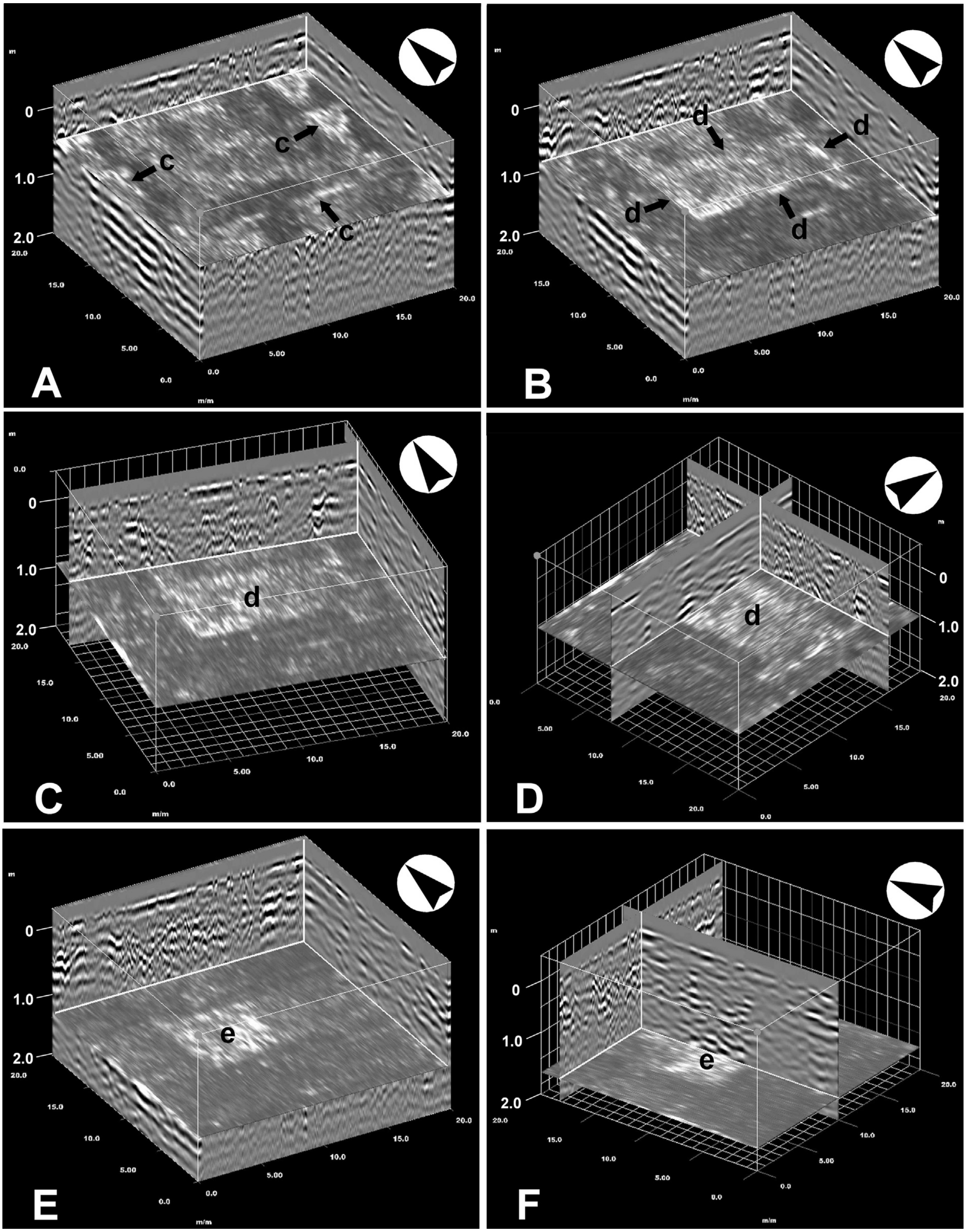

Fig. 33: Building 25 - temple (see *Fig. 36*), GPR area G1/1, 500MHz antenna (*Fig. 3C*), measured surface of 20 x 20 m: 3D portrayal of GPR echoes (see also *Fig. 32*). Stone enclosure of the temple (c); central rectangular platform surrounded by a low wall (B) (d); western, somewhat elevated area of the stone platform (e).

Sl. 33: Stavba 25 - svetišče (glej *sl. 36*), georadarsko območje G1/1, 500 MHz antena (*sl. 3C*), površina 20 x 20 m: 3D prikaz radarskih odbojev (glej tudi *sl. 32*). Kamnita ograda svetišča (c); osrednja pravokotna ploščad, ki jo obdaja nizek zidec (d); zahodni, nekoliko dvignjeni del kamnite ploščadi (e).

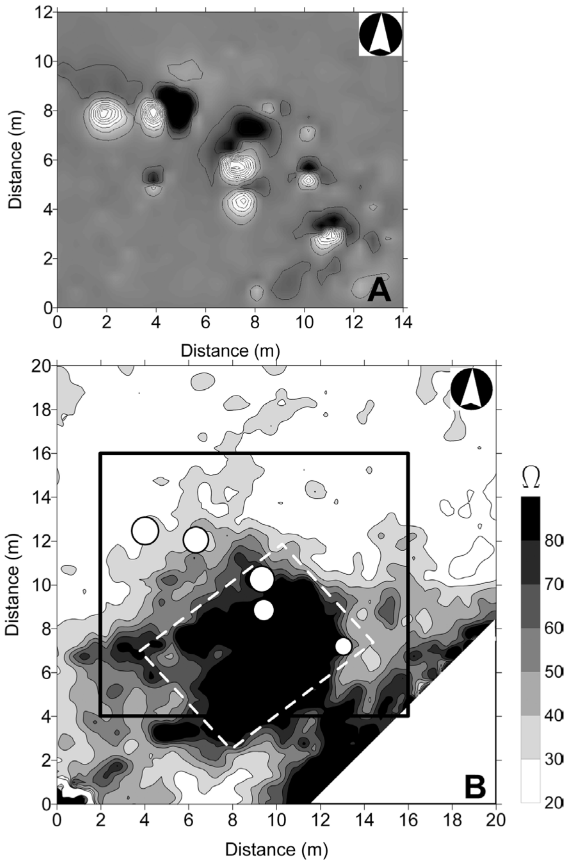

Fig. 34A,B: Structure 27 - tradesman's workshop (?) (see *Fig. 36*). The results from the magnetic (A) and resistivity methods (B). The high resistivity values (the dotted line) probably represent a tradesman's workshop. The white circles in this image (B) mark the positions of strong bipolar magnetic anomalies that are presumably of a thermoremanent type of magnetization (A). The magnetic anomalies do not show a unified orientation northwards (some randomly oriented iron objects?). The interior of the structure is filled with a high resistivity material; perhaps there was a stone pavement, ruination layers and/or architectural elements made of stone.

Sl. 34A,B: Objekt 27 - obrtniška delavnica (?) (glej *sl. 36*). Rezultati magnetne (A) in upornostne metode (B). Visoke vrednosti upornosti (očrtano s prekinjeno črto) verjetno predstavljajo obrtniško delavnico. Beli krogci na tej sliki (B) označujejo položaj močnih bipolarnih magnetnih anomalij domnevno termoremanentnega tipa magnetizacije (A). Magnetne anomalije ne kažejo enotne usmeritve v smeri severa. Notranjost objekta zapolnjuje visokoupornostni material. Lahko gre za kamnit tlak, ruševinske plasti in/ali arhitekturne elemente iz kamninskega materiala.

of well preserved structures with thermoremanent magnetization. The interior division of the structure is partly seen in the GPR results. The interior is filled with a high resistance material. Perhaps it is formed of a stone pavement, a ruination layer and/or architectural elements made of stone (*Fig. 35*).

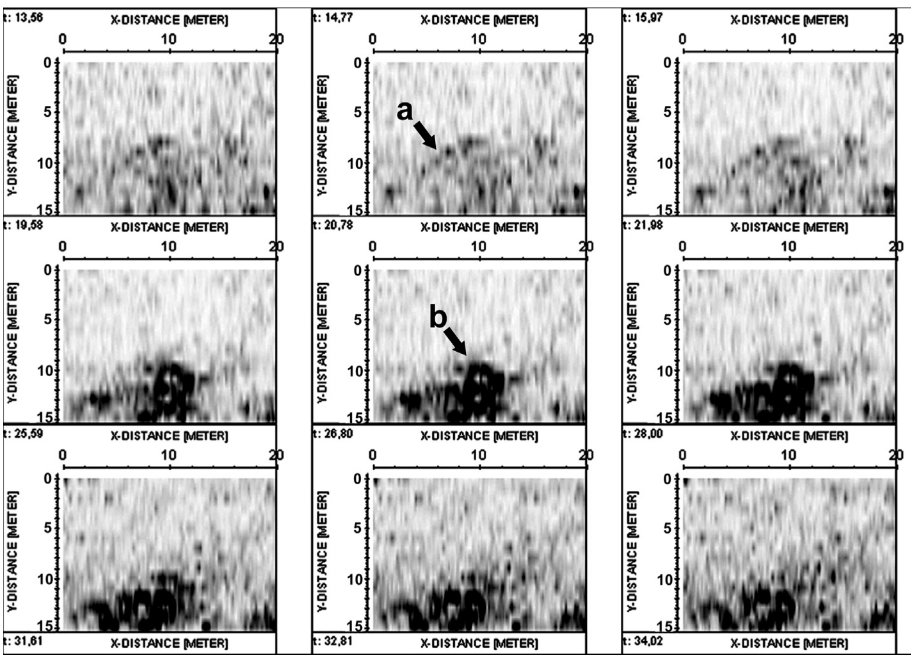

Fig. 35: Structure 27 - tradesman's workshop (?) (see *Fig. 36*), GPR area G9 (*Fig. 3C*), measured surface of 20 x 15 m: time slices. The line of strong GPR reflections (a) running in the same direction as the northwestern edge of the structure found in the resistivity results in *Figure 34* is clearly distinct. This is quite likely a small wall. Anomalies in the interior of the structure (b) are much stronger and they represent several small rooms or similar architectural elements.

Sl. 35: Objekt 27 - obrtniška delavnica (?) (glej *sl. 36*), georadarsko območje G9 (*sl. 3C*), površina 20 x 15 m: horizontalni rezi radarskih profilov. Jasno se vidi linija močnejših radarskih odbojev (a), ki poteka v smeri severozahodnega roba objekta, odkritega na rezultatih upornosti na *sl. 34*. Verjetno gre za manjši zidec. Anomalije v notranjosti objekta (b) so veliko močnejše in predstavljajo več enakih kamric oz. podobnih arhitekturnih elementov.

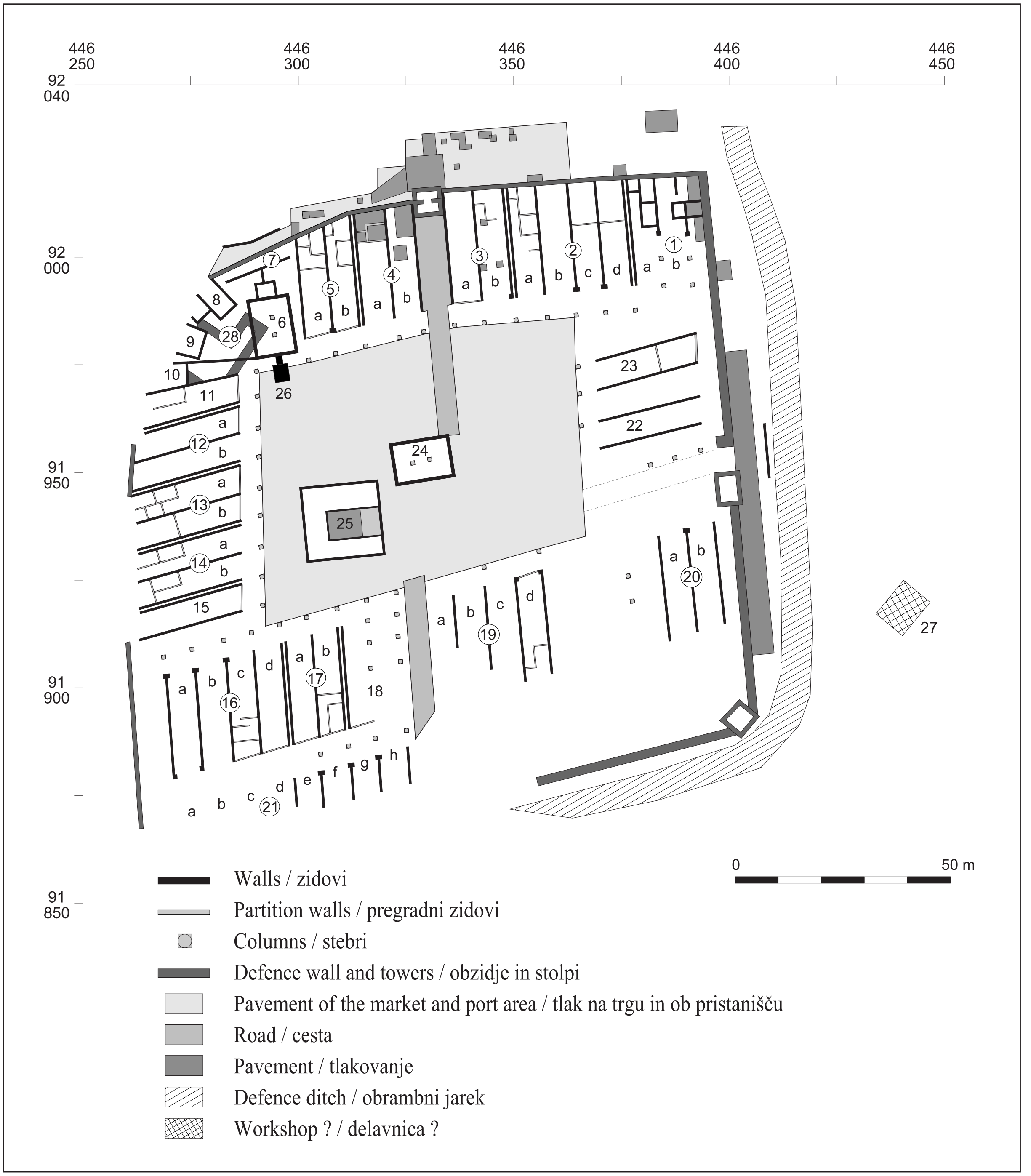

Fig. 36: Interpretation on the basis of the complementarity of the geophysical prospecting methods used.
Sl. 36: Interpretacija na podlagi komplementarnosti uporabljenih geofizikalnih metod.

Structure 27 was interpreted as a possible location for tradesmen's workshops. Considering the nature of magnetic anomalies, it is not possible to entirely exclude the possibility of it being a modern era construction.

CHRONOLOGY OF THE SETTLEMENT ON THE BASIS OF SMALL FINDS

Early Roman period

The majority of small finds from the excavations of Šmid in 1934 and 1936 is lacking detailed

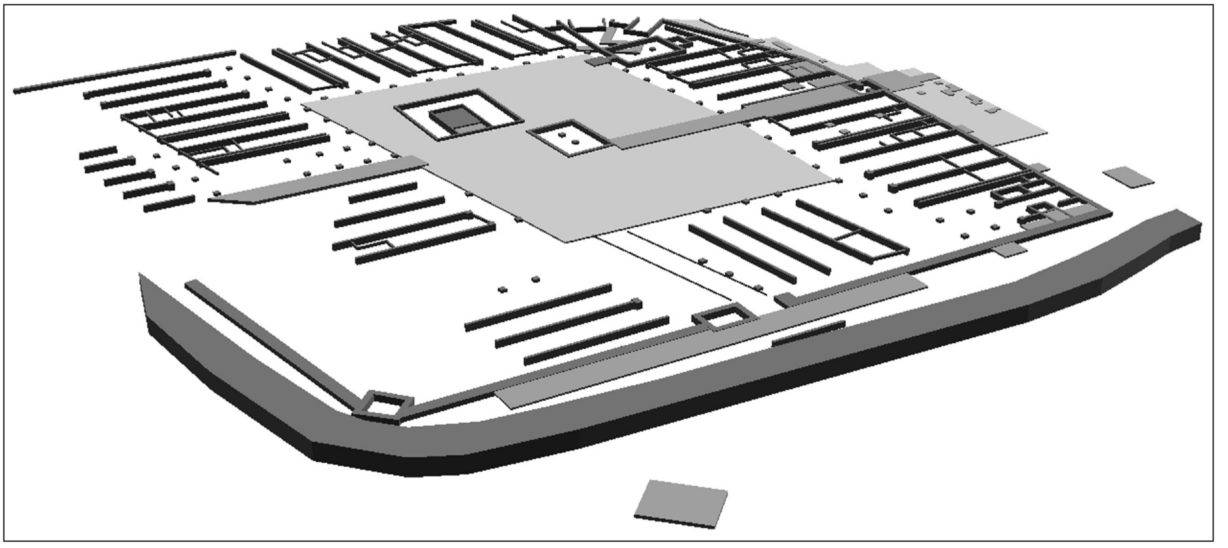

Fig. 37: Realistic 3D portrayal of the settlement remains on the basis of the combined interpretation of results from the application of several independant geophysical methods. View from the southeast.
Sl. 37: Realistični 3D prikaz naselbinskih ostankov na osnovi združene interpretacije rezultatov različnih geofizikalnih metod. Pogled z jugovzhoda.

stratigraphic data; only their approximate position in the settlement is known. Better data exists for the spatially very limited excavations of Iva Mikl Curk in 1969 (Fig. 2). Chronological and spatial analyses of small finds have already been completed previously (Horvat 1990, 126-129, 229-232). This contribution adds a more accurate interpretation to the earlier determinations. Lacking modern archaeological excavations with a larger quantity

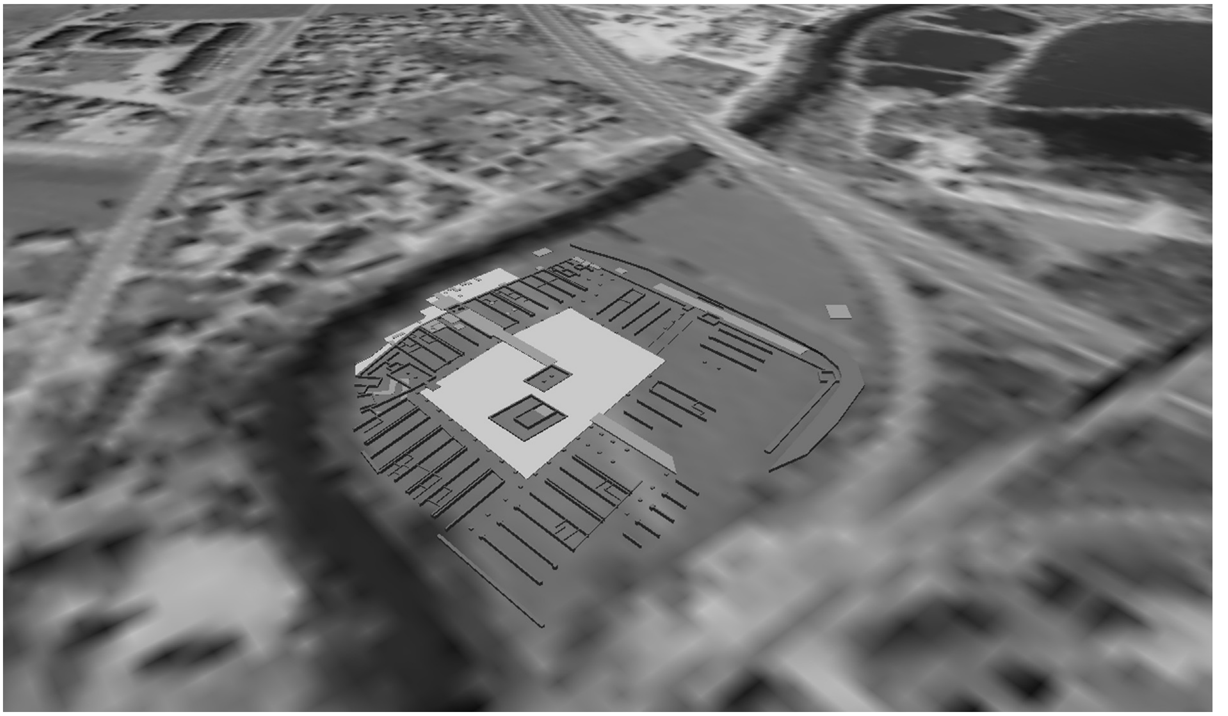

Fig. 38: Realistic 3D portrayal of the settlement remains on the basis of the combined interpretation of results from the application of different independent geophysical methods; on the background of an aerial photograph. View from the southwest. (Source: Public information of Slovenia, © Surveying and Mapping Authority of the Republic of Slovenia, DOF at a scale of 1 : 5000).
Sl. 38: Realistični 3D prikaz naselbinskih ostankov na osnovi združene interpretacije rezultatov različnih geofizikalnih metod na aerofotografiji. Pogled od jugozahoda (vir: DOF v merilu 1 : 5000, © Geodetska uprava RS).

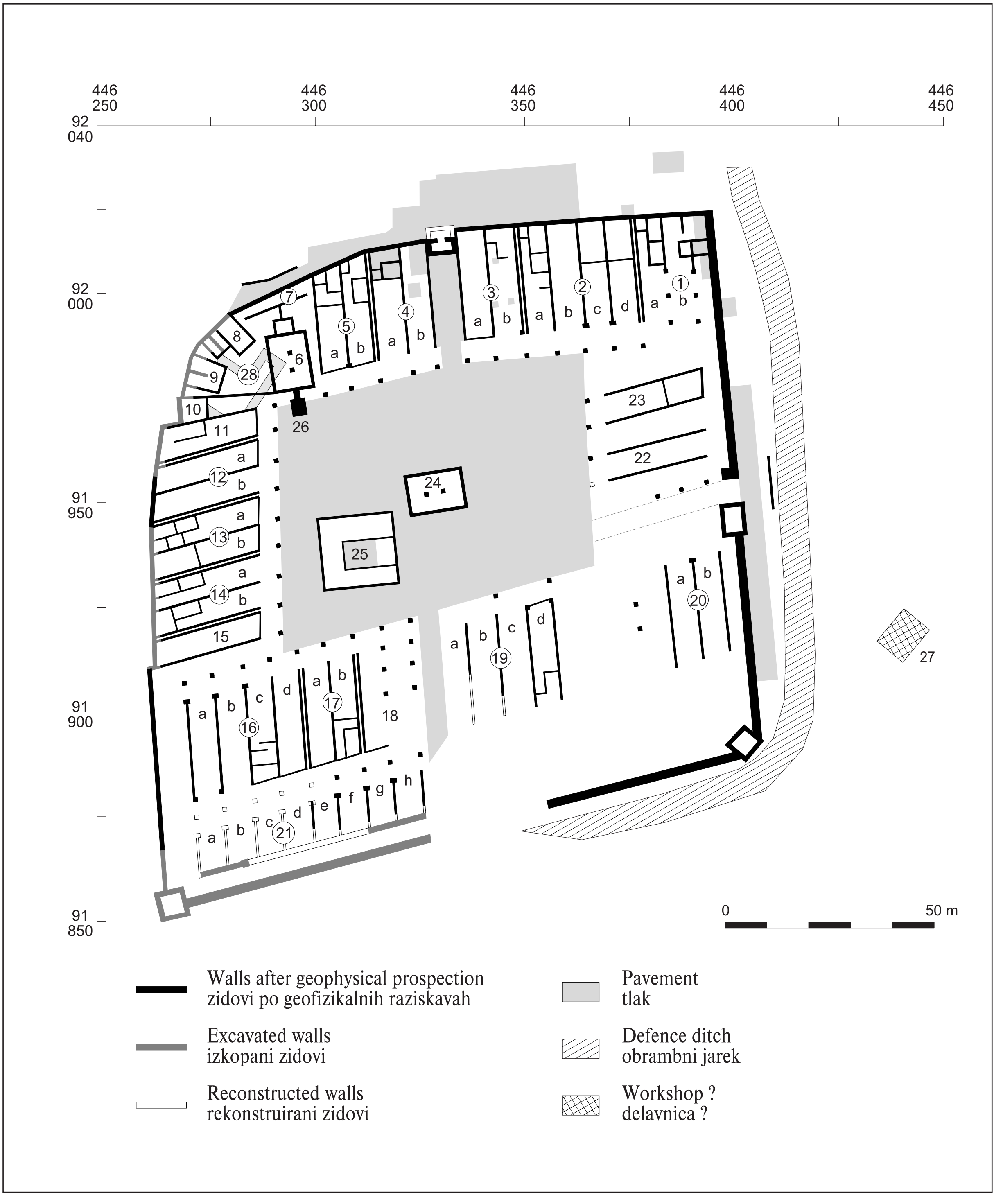

Fig. 39: Reconstruction of the settlement on the basis of results from geophysical prospecting, archaeological excavations and completion of the courses of the walls.
Sl. 39: Rekonstrukcija naselbine na podlagi rezultatov geofizikalnih raziskav, arheoloških izkopavanj in dopolnitve poteka zidov.

of material, the conclusions are obviously only preliminary.

The most sensitive Early Roman fine ceramics can be classified into three chronological groups. The classification of groups does not derive from the site at Dolge njive, after all it lacks any stratigraphic data. The groups are based on the forms of black glazed pottery and terra sigillata, which are dated according to the stratigraphy at Magdalensberg, Ljubljana and Kranj.

Chronological group 1

Late forms of black glazed pottery are known from Dolge njive (*Fig. 40*):

- plates with a horizontally offset and hanging rim, form Morel 1631 (*Fig. 40:* 1-5; Horvat 1990, 117, 219-220, pl. 1: 9; 7: 5; 14: 1-3)
- a plate with sloping wall, form Morel 2276 c1 (*Fig. 40:* 6; Horvat 1990, 116, 219, pl. 22: 4)
- a bowl, form Morel 2654 (*Fig. 40:* 9; Horvat 1990, 117, 219, pl. 13: 14)
- a bowl (*Fig. 40:* 7; Horvat 1990, 117, 219, pl. 22: 3)
- the base of a platter (*Fig. 40:* 8; Horvat 1990, 117, 220, pl. 24: 11).

Late La Tène fine pottery dates to the same period (*Fig. 41;* Horvat 1990, 123-124, 226-227). The black glazed pottery is analogous with the "porous product" found in the oldest layers at Magdalensberg, that is, in "complex 1" dating before 20 BC and in "complex 2" dating up to 10 BC (Schindler 1967; Schindler 1986; Scheffenegger, Schindler-Kaudelka 1977, 55, fig. 9-10: OR/39, Periode 2). Thus it is attributed to the Early Augustan or even the Pre-Augustan period (on the basis of pottery alone, without good stratigraphy, these two periods cannot be distinguished).

The pottery from this group 1 at Dolge njive corresponds with the phase II at Gornji trg 30 in Ljubljana, which incorporates local coarse wares,

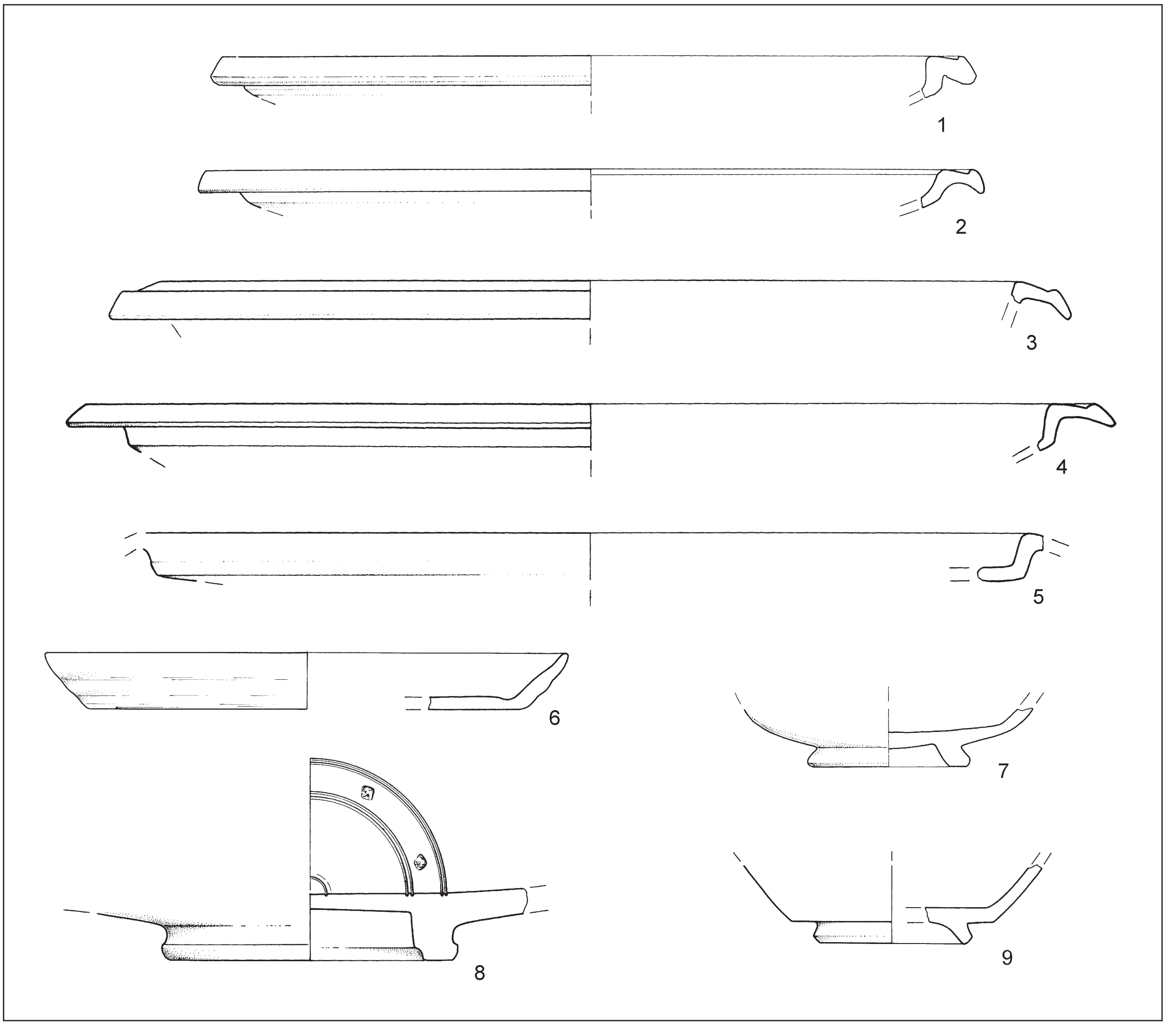

Fig. 40: Dolge njive. Black glazed pottery. Scale = 1:3.
Sl. 40: Dolge njive. Keramika s črnim premazom. M. = 1:3.

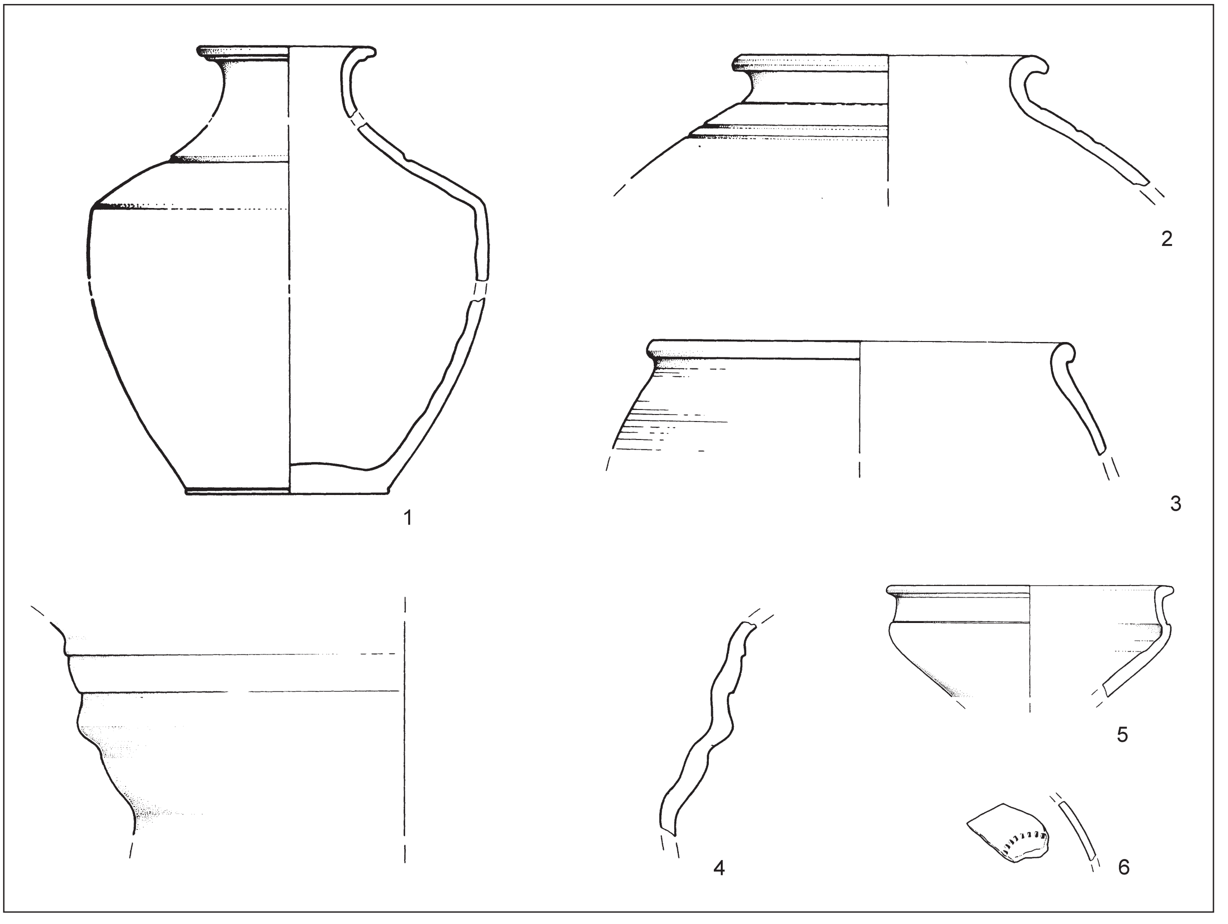

Fig. 41: Dolge njive. Fine La Tène pottery. Scale = 1:3.
Sl. 41: Dolge njive. Fina latenska keramika. M. = 1:3.

fine La Tène wares as well as several types of Italic pottery. Black glazed Italic pottery is present, while terra sigillata is not yet known. This phase is dated on the basis of its stratigraphy to the Late Republican or even the Early Augustan period (Vičič 1994, 27-30, pl. 1: 6-17; 2; 3: 1-13)

Chronological group 2

Italic terra sigillata characteristic for the middle Augustan period belongs to this second group (*Fig. 42:* 1-11):

- a plate with vertical hanging rim (*Fig. 42:* 1; Horvat 1990, 118, 221, pl. 5: 5; form Consp. 11 - similar)
- a plate with a simple sloping wall (*Fig. 42:* 3; Horvat 1990, 117, 220, pl. 24: 12; form Consp. 1.1)
- a plate with sloping wall and moulded inner face (*Fig. 42:* 2; Horvat 1990, 117, 220, t. 5: 6; form Consp. 1.2; Roth-Rubi 2006, 24, 35: horizon Dangstetten, 2nd decade BC)
- small hemispherical cups (*Fig. 42:* 5-10; Horvat 1990, 118, 221, pl. 3: 7-8; 10: 16; 13: 16-17; 24: 7-10; Schindler, Scheffenegger 1977, 59-61, pl. 12b: in particular the complexes 2 and 3; Vičič 1994, phase IIIa, t. 4: 18-20)
- a hemispherical bowl (*Fig. 42:* 11; Horvat 1990, 118, 221, pl. 13: 15; 18: 12)
- a dish with a broad and hanging rim (*Fig. 42:* 4; Horvat 1990, 117-118, 220-221, pl. 13: 18; similar to the forms Consp. 5.1, 10 and 13.1; Schindler, Schindler-Kaudelka 1997).

This period is approximately contemporary with the oldest settlement horizon at Kočevarjev vrt, which is a site that belongs to the *vicus* of Nauportus; it lies on the left bank of the Ljubljanica river, across from Dolge njive. Italic sigillata forms Consp. 11, 12 and 14 were found in the oldest layers, as well as rare fragments of black glazed pottery - plates or bowls with a simple sloping wall. Fine La Tène pottery was not found here (excavations in 2005, unpublished; cf. Horvat, Mušič 2007).

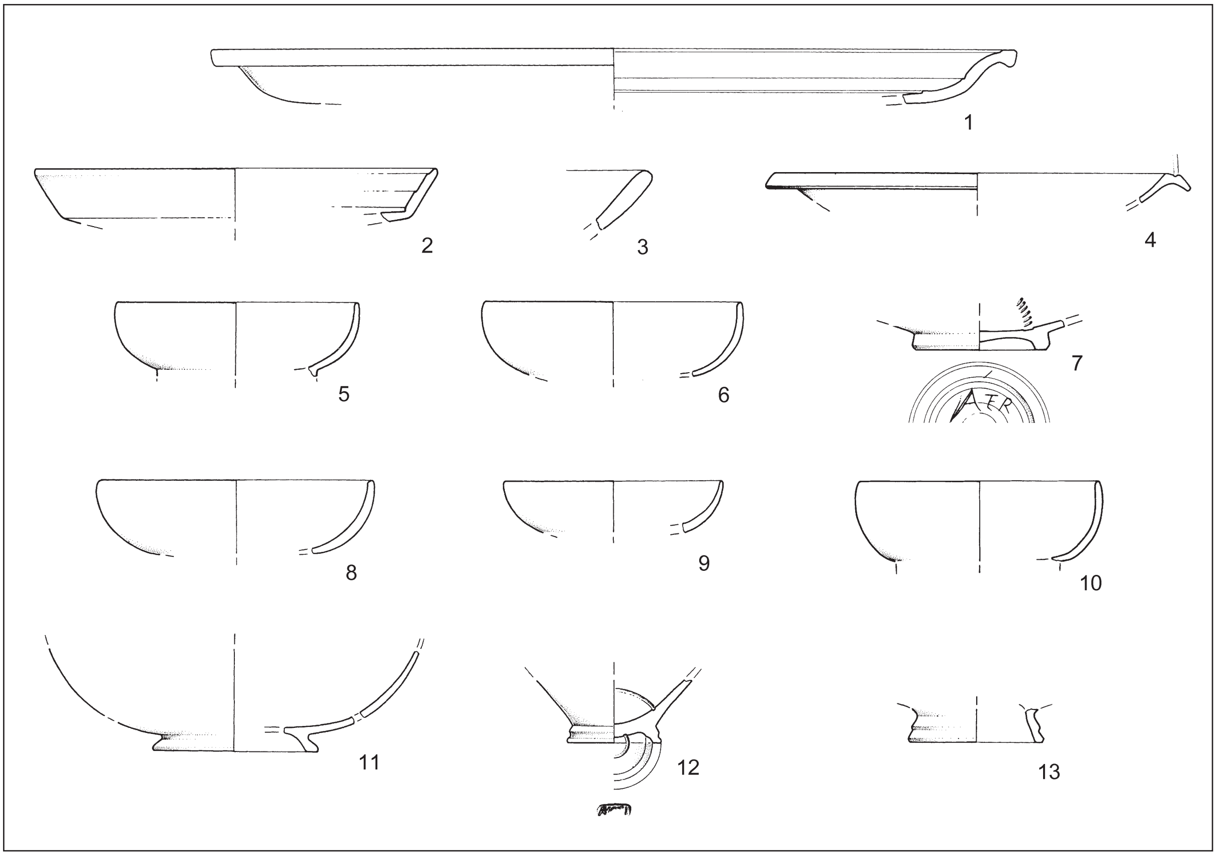

Fig. 42: Dolge njive. Terra sigillata. Scale = 1:3.
Sl. 42: Dolge njive. Tera sigilata. M. = 1:3.

The second group is also comparable with the material from Ljubljana, discovered at the well stratified site of Gornji trg 30 in the phases IIIa and III (Vičič 1994, 30-34), as well as with the majority of material found at Gornji trg 15 in Ljubljana (Vičič 1993). Terra sigillata forms Consp. 12 and 14 are characteristic for this time period; however, black glazed pottery (plates with a simple sloping wall) appears only sporadically (cf. Vičič 1993, 160-162, pl. 3: 8-9; 8: 1,3,4-5). Similar pottery is known also from the Early Roman settlement in Kranj (Sagadin 2003).

The above stated material from Vrhnika, Ljubljana and Kranj corresponds with the Dangstetten - Oberaden horizon, and as such is attributable to the Middle Augustan period (Roth-Rubi 2006; Schnurbein 1991).

Chronological group 3

Only Late Augustan cups are classified to the third group (*Fig. 42:* 12-13; Horvat 1990, 118-119, 221-222, pl. 5: 9; 9: 8).

***

Most of the pottery and other small objects from Dolge njive may only be approximately attributed to the Early Roman or Augustan period, without the possibility of distinguishing between the Early, Middle or Late Augustan periods (Horvat 1990, 112-132, 215-235). 17 Republican and 25 Augustan coins, which were found there, evidence activity at the site especially during the Augustan period (Horvat 1990, 87-89, 195-197).

The excavations of the southeastern tower and the southern and eastern defence walls revealed material originating from the fill between the foundation stones of the wall, from the walking surface and from the ruins. Black glazed pottery, terra sigillata, thin-walled pottery and Late La Tène pottery were discovered; in general, these are all finds belonging to our chronological groups 1 and 2 (*Fig. 43;* Horvat 1990, 128, 231, t. 21; Mikl Curk 1974, 373-374).

The narrow passages (*ambitus*) between the buildings 1 and 2, 2 and 3, 12 and 13 as well as 13 and 14 mainly revealed material from the chronological groups 1 and 2, and some chronologically less classifiable Early Roman material.

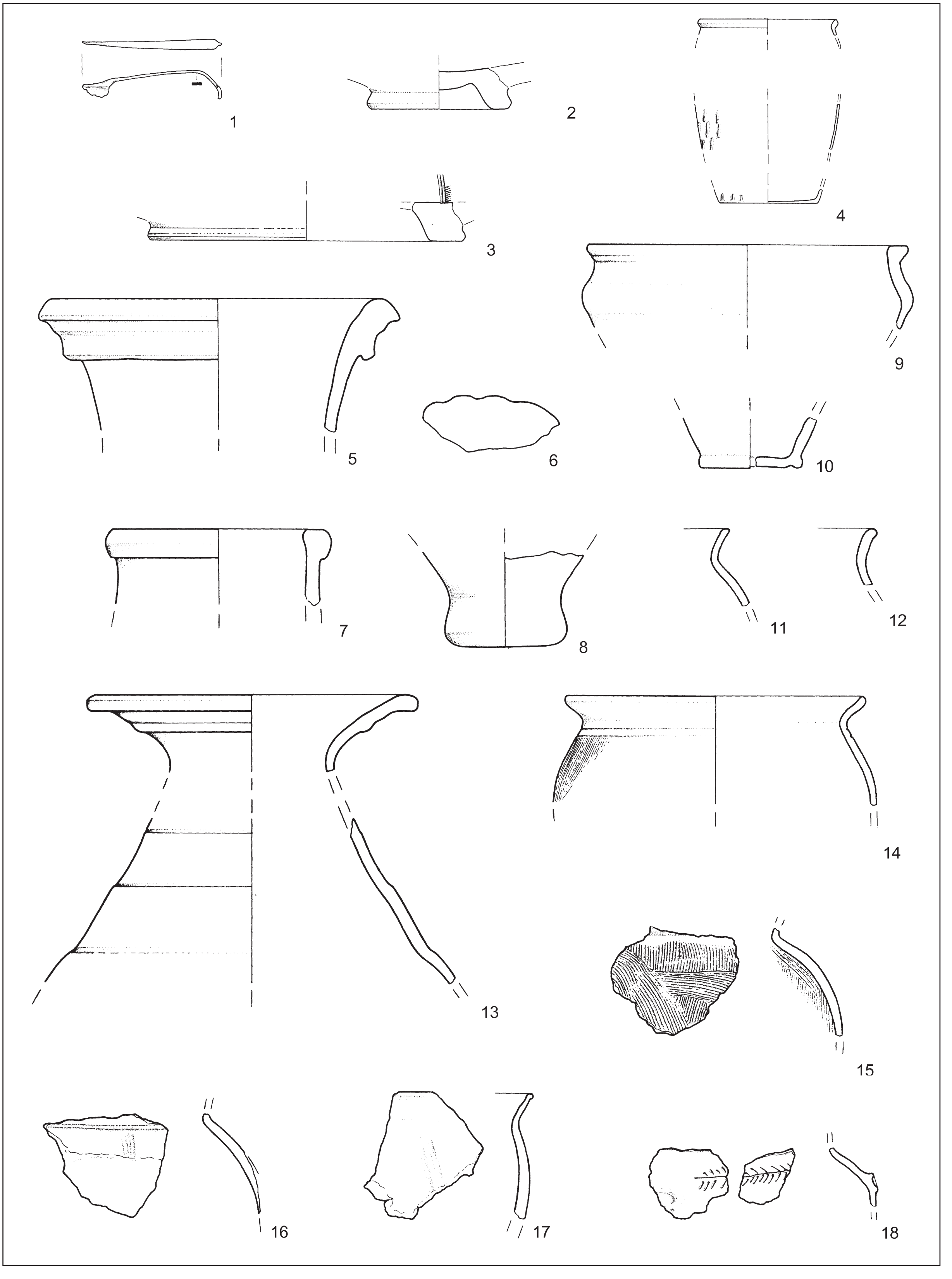

Fig. 43: Dolge njive. Small finds from the walking surface and from the ruins in the wider area of the southeastern defence tower (according to Horvat 1990, t. 21). 1 bronze, other ceramics. Scale = 1:3.

Sl. 43: Dolge njive. Drobne najdbe s hodne površine in iz ruševine na širšem območju jugovzhodnega obrambnega stolpa (po Horvat 1990, t. 21). 1 bron, ostalo keramika. M. = 1:3.

Very little Late Augustan material was found. Other material finds (pottery, coins) discovered in various areas of the buildings 1-5, 11-18, 21, demonstrate the same chronological span and similar quantitative relationships (Horvat 1990, 126-129, 229-232). A hoard of Celtic silver coins (23 small and one large silver coin) was discovered in the passage between the walls of buildings 4 and 5 (Horvat 1990, 89-90, 106, 197-198, 209). A large Celtic silver coin was found in building 8 - the northeastern room (Horvat 1990, 87-88: 1; 103; 195-196: 1; 208).

It follows that the construction of the defence wall and buildings throughout the settlement (at least buildings 1-5 and 11-15) is datable to the Early Augustan period at the latest. Life in the settlement continued at least to the end of the Augustan period (Horvat 1990, 126-129, 229-232).

Late Roman period

Late Roman material from Dolge njive is represented only by chance finds and lacking any accurate data.

An incendiary spear: area of buildings 4-8 (Horvat 1990, 106, 209, 269, fig. 32a; cf. Horvat 2002, 146, fig. 6: 8, pl. 21: 1).

The foot of a crossbow brooch: in the area of buildings 1-3 (Horvat 1990, 271, cat. no. 169, fig. 32 b: 2).

A Gallienus coin: area of buildings 11-12 (Horvat 1990, 88-89: 53; 127; 196-197: 53; 230).

A Constantine I coin: area of buildings 4-5 (Horvat 1990, 88-89: 54; 128; 196-197: 54; 231).

A Constantius II coin: area of the market, in front of buildings 4 and 5 (Horvat 1990, 88-89: 55; 196-197: 55).

A coin from the second half of the 4th century: northern part of the settlement (Horvat 1990, 88-89: 60; 127; 196-197: 60; 231).

A hoard of coins - buried in 270 AD and found in 1914 “between Vrhnika and Verd”. The exact position of its burial is not known; although it is possible the hoard originates from Dolge njive (Horvat 1990, 82, 93-94, 190, 201-202).

The distribution of Late Roman finds attests to the use of this area during the Late Roman period. However, it is not known whether these finds may be linked with the settlement at Dolge njive. Intensive traffic went on along the Ljubljanica all through to the Late Antiquity; furthermore, a settlement continued to subsist on the left bank of the river until the 4th century (Horvat, Mušič 2007). The finds from the 3rd and 4th century may connect not only with the site at Dolge njive but also with the events along the river and on the opposite riverbank as well.

INTERPRETATION OF THE ARCHITECTURE

Position, fortification and port

The Ljubljanica river flows along two sides of the settlement at Dolge njive; while along the eastern and probably also the southern sides ran a defence ditch filled with water.

The position of Nauportus is highly comparable with the positioning of Roman towns in the northern Italic lowlands; often they were situated near water, even in the hook of a riverbend. The riverbanks were consolidated, piers were constructed, and various port buildings stood in the vicinity, among others also storehouses. The water courses flowing around the settlements were important as navigable routes, the defence of the towns, sometimes they also served as drainage ditches. Regulation efforts and the digging of new channels are traceable from the 2nd century BC onwards. Aquileia for instance, was probably entirely surrounded by water (Uggeri 1990; Rosada 1990, 370-372; Conventi 2004, 234-235. Aquileia: Carre, Maselli Scotti 2001; Carre 2004. Altinum: Tirelli 1999, 12-18; Tirelli 2001. Opitergium: Cipriano, Sandrini 2001).

The Nauportus defence wall has four square towers that protrude beyond both the exterior and interior face of the wall. This type of tower is well-known from the defence walls of Roman towns dating to the Republican and Early Imperial periods (e.g. Nîmes: Varène 1992, 149-151; Cosa: Fentress, 2003, fig. 2; Aosta, Torino: Mansuelli 1971, pl. 7, 9; Emona: Plesničar Gec 1999, 45-60; Gurina: Gamper 2004, 159-163).

The northern gateway in the Nauportus wall was in the form of a tower with a 5 m wide passage. The relatively small dimensions of the tower, the presumably square ground plan and the two massive interior projections, could all be indicative of a covered passage, and also of the second floor. This form of a covered entrance passing through a tower is known primarily from the 1st century BC (Brands 1988, 29-33: Kammertore; Kader 1994, 337-338). Typologically, this entrance is similar with the entrances in the form of a tower and with an open, interior court - *cavaedium,* which were in use from the 3rd century BC onwards (Gros 2002, 32, 37-39; Brands 1988, 16-33; also Rosada 1990, 379).

The eastern gateway was unsymmetrical. A large, hollow tower stood on the southern side, while a smaller, massive tower stood on the northern side. Usually gateways were guarded by two identical or similar towers. Nonetheless, Early Roman towns could also have gateways with only one tower on the side (e.g. Brands 1988, 22, 82-84, 126-128). Nauportus' eastern gateway is also approximately comparable with the western gateway in Aquileia, which dates to the 2nd century BC. The latter has an interior court and an unsymmetrical, solid and rectangular (oblong) tower on one side only, as well as two small and square reinforcements on the exterior on each side of the entrance (Bertacchi 1965, 7-8, fig. 2).

The simplicity and expressed functionalist character of the fortification at Nauportus have their origins in the fortifications of Roman towns in Republican Italy. This is also in accordance with the dating of construction at Dolge njive to the Pre-Augustan or Early Augustan periods, which is based on the chronology of pottery.

The river port lay north of the settlement. A paved road led through the northern gateway to the bank of the Ljubljanica. Positioned directly in the line of the road, two broad rows of wooden posts stood in the river. Presumably these are the remains of a rectangular wooden pier measuring 6 x 4.5 m (Logar 1985). The riverbank by the pier was also reinforced with wooden posts (unpublished, documentation of the National Museum of Slovenia). The results from the resistivity measurements show that the tract between the defence wall and the river was paved. The areas of possible ruins are discernible as well (*Figs. 2-4, 36*). A damaged wall in the riverbank provides evidence for the existence of structures built directly along the Ljubljanica (Horvat 1990, 49, 171).

Market

The market in Nauportus does not have the canonical characteristics of a Roman forum, which is rectangular in form and enclosed with a portico, with a dominant temple and basilica, that is, with elements that classify a forum as the religious and administrative center of an autonomous town (cf. Gros 1990; Gros 2002, 207-234). It has an irregular form of a parallelogram and is surrounded by a colonnade. It is not large in comparison with town forums; however, it covers about 30 % of the settlement surface (approximately 5.500 m^2, with the portico), which is a lot more than is usual in Roman towns. The relatively small building 25, which is interpreted as a sanctuary (see below), is situated in the corner of the market. Nonetheless, it stands almost in line with the axis of the eastern road, it does not hold a dominant position. The pair of buildings 22 and 23, which are situated on the eastern side of the market, do indeed stand out - perhaps they held a special function - and yet they are very similar to those buildings interpreted as storehouses (see below).

The form of the market is indicative of the status of the settlement as we know it from literary and epigraphic sources (Šašel Kos 1990). Nauportus was a *vicus* with minimal autonomy and did not necessitate any larger religious or administrative buildings. The market, surrounded by storehouses and *tabernae*, bespeaks the highly economical role of the settlement. Several forums in the northern Adriatic region also held distinctive economic functions during the Republican period (Zaccaria 1999, 76-78). For instance, during the Late Republican period, Iulium Carnicum (today Zuglio) - which at the time had the status of *vicus* - had an open paved area; presumably this was the market in front of a row of buildings with oblong rooms. Subsequently this market was rebuilt into a forum (Zaccaria 1999, 77; Maggi 2003, 235-236, note 54, fig. 5).

Storehouses (buildings 2-5, 11-17, 19-20, 22-23) and tabernae (21)

The largest area within the settlement is built-up with rows of buildings with long and narrow rooms and a portico. They occupy about 30 % of the area, that is, about 5.500 m^2 (buildings 2-5, 11-17, 19-20, 22-23; without the portico). Comparisons with similar buildings at other Roman sites confirm that these were probably storehouses.

Roman civilian storehouses were built in two ways. The majority of storehouses were constructed as a building with rectangular rooms (15 m long at most) arranged around a central court (or less frequently, around a central corridor). These types of storehouses are known from e.g. Ostia and Rome (Rickman 1971, 15-122). The Romans adopted the type of courtyard storehouses from the Greek world, perhaps already in the 2nd century BC (Rickman 1971, 153-155; Virlouvet 1995, 90).

Dolge njive presents the other form of Roman civilian storehouses: very long rooms (20 m and more) that are all lined in a row. Rickman also postulates eastern, Hellenistic origins for this type (Rickman 1971, 153). At Masada (today Israel), two storehouses with rooms in a row were built probably in the years between 37 and 31 BC (Rickman 1971, 153-154, fig. 34). The type was well known throughout the Roman world primarily in ports; the entrances to the rows of storehouses were frequently open towards the piers in the ports. The type appears in the various parts of the Empire during the large chronological span between the 1st century BC and through to the 2nd century AD.

In Valentia (today Valencia, Spain), a building was discovered dating to the Late Republican period and interpreted as a storehouse: four long rooms (6 m wide, more than 15 m long) all set in a row and with wide openings on to the portico (Ribera i Lacomba, Calvo Galvez 1995, 20-21, fig. 1).

Vienna (today Vienne, France), a significant traffic crossing in Gallia Narbonensis, revealed a large storehouse complex dating to the second quarter of the 1st century AD. At least four groups of large rooms in double rows were positioned along the left bank of the Rhône; they occupied an enormous area of somewhere between 4 and 6 ha. The reconstruction of the ground plan of one of the groups shows two parallel rows comprising of 21 rooms separated from each other by a 12 m wide road. The total size of one group, estimating from the publication, measures about 340 x 80 m. According to the publication, the size of the individual rooms measures approximately 12/15 x 30 m. The entrances open wide onto the central road (Helly-Le Bot 1989).[1]

The expansive storehouse complexes, in which rows of long rooms predominate, are discernible in the partially sunken port quarters of Puteoli (today Pozzuoli, Italy). The individual buildings are not well researched and dated. Large parts of the Puteoli port were constructed during the Augustan period, and the port continued to operate all through to the Late Antiquity (Camodeca 1994, 112-113, t. 1).

Storehouses from Patara and Mira (ancient Lycia, today in Turkey) also stood in the ports, or nearby. They were built by Hadrian in 128 and they are likely connected with the collection of annona (Rickman 1971, 137-140). The storehouse from the town of Cuicul (today Djemila, Algeria), built in the year 199, is not positioned in a port but it is also linked with the collection of annona (Rickman 1971, 140-144).

Storehouses in rows, which have rooms that do not exceed a length of 15 m are known from the port of Claudius in Portus [Italy; Keay et al. 2005, 278, figs. 5.9, 5.10 (Foro Olitorio); figs. 5.13, 5.14 (around the interior port)], the port of Traianus in Portus (Rickman 1971, 123-132; Lanciani 1888; Keay et al. 2005) and the Severan port in Lepcis Magna (today in Libya; Rickman 1971, 132-136).

The military camps in central and western Europe for the most part built a different type of storehouse architecture: granaries with raised floors predominate. These stand independently or are built in pairs; in larger complexes they are positioned together in groups (review: Rickman 1971, 213-250; Johnson 1987, 162-179). Only a few examples of forms similar to the Nauportus type of storehouse are known from select military outposts. A storehouse was discovered in Numantia, in Scipio's camp at Castillejo (around 134 BC), in which three large rooms (17.80 x 5.60-6.80 m) compose the entire complex. Narrow passages divide the rooms. The floors were raised, so evidently the complex did function as a granary (Rickman 1971, 251-252).

Of great significance for the architecture at Dolge njive is the military supply post discovered at Melun along the Seine (France), which dates to the second decade AD. Two rows of wooden buildings were excavated; all interpreted as storehouses. The best preserved row, measuring 140 m long, comprises of 21 rooms, 22 x 6 m in size, all in the form of parallelograms. The rooms had wide openings on each of their narrower sides, and a double portico ran alongside on each side (entire width 34 m) (Galbois, Petit, Reddé 2006). Double entrances are known also at Nauportus in buildings 16, 20 and 22.

Long and narrow storehouse rooms, with openings on each end, are also known in Rome in the *horrea Lolliana*. The ground plan of this storehouse, which M. Lollius had built (the consul in 21 BC), is known only from Severan Marble Plan of Rome. The rooms are distributed around two courts. The four rooms by court b are longer than the others (about 21 m long and 3 m wide), and open out into the court as well as out from the building (Virlouvet 1995, 98, 108-113, fig. 11; Rickman 1971, 108-112, fig. 23).

The accordance between the storehouses at Dolge njive and that of the row type is determined with the distribution and dimensions of the rooms, as well as the accompanying portico and the port position. There are also a few particularities. Most of the rooms at Dolge njive are built in pairs, for

[1] During the second half of the 1st century, a large storehouse of the courtyard type was built along the right bank of the Rhône in Vienna (present day Saint-Romain-en-Gal) (Laroche, Savay-Guerraz 1984, 85-90).

which we lack any close analogies. The entrances are wide, as is the custom for *tabernae* and rare for storehouses; this seems to indicate a mixture of their functioning for storage as well as trade (DeLaine 2005, 39-45; *Horrea Agrippiniana* in Rome: Astolfi, Guidobaldi, Pronti 1978; Melun: Galbois, Petit, Reddé 2006). A few of the buildings have wide entrances at both shorter ends, this being a relatively rare characteristic (see above). The two buildings (22 and 23) at the eastern side of the market stand out a bit from the other storehouses as regards their architecture; however there seems to be no alternative interpretation proposing a different functioning.

On the basis of small finds, the storehouses are dated to the Early Augustan or even Pre-Augustan period, which is contemporary with the defence wall (see above).

The long and narrow building with eight rooms (21), according to its form and dimensions (6 x 8.5 m), is attributed to the architecture of *tabernae* (Baratto 2003; DeLaine 2005, 32-35).

Building 25 - sanctuary

Building 25 stood in the southwestern part of the market. It is not oriented towards any of the market sides, nor does it lie directly in line with the axis of the eastern road. It seems that the building was not planned and constructed concurrent with the market, storehouses and defence wall. It is not known whether it is an earlier or later construction.

A final interpretation of the architecture on the basis of geophysical prospecting is not possible; however, certain characteristics are discerned. The rectangular bi-level plateau is similar to the podium of a temple with a stairway on the eastern side. The peripheral wall, with shallower foundations than the plateau, could be the delimitation of the temenos. Regarding its dimensions, and considering that the eastern edge of the plateau reaches all to the peripheral wall, it seems most reasonable that it served as the outer wall of the colonnaded ambulatory. The form and dimensions of the foundations at Nauportus are close to the particular type of sanctuaries with ambulatories in which the Celtic tradition mixes with Roman "Classicistic" elements. Building 25 is generally comparable with the following temples: Celje - sanctuary with ambulatory 3 (Krempuš, Gaspari, Novšak 2007, 42-43, fig. 3: Late Tiberian), Augst - Sichelen 2 (in use from the mid 1st century onwards), Kornelimünster - temple F 1 (built during the time of Vespasianus), Trier - the temple for Mars at Irminenwingert (approximately 2nd century), Trier - Altbachtal, temple with ambulatory 2 (the first seven decades of the 3rd century) (Trunk 1991, 80-85, 172-173, 204-206, 226-230; Gros 2002, 199-203).

Buildings 6 and 24 as well as structure 26

The buildings 6 and 24 are alike in size, the thickness of their walls (about 1 m), the depth of their foundations as well as by the two central columns within. Most likely they belong to the same construction program; however their relationship to Early Roman storehouses, the market and the fortification is yet unclear.

Building 6 was built in an "empty" corner between the northern and western row of storehouses. Its positioning is offset from the line of entrances into the storehouses 2-5, as well as from the line of columns along the northern edge of the market. It is possible that it was constructed later than the storehouses, however with respect to the earlier architecture. The deep foundations of structure 26 seem to be related to building 6 and are thus attributed to the same construction phase.

Building 24 is situated almost exactly in the centre of the market and is oriented the same as the sanctuary (building 25), which is also very close by. A paved road leads from building 24 through the northern gateway to the river. The pavement of the road is thicker than the pavement in the market area. Building 24 is presumably contemporary with building 6 and thus also originates from a later construction phase. The strong construction of the road leading northwards could be also connected with building 24.

Buildings 6 and 24 (together with structure 26 and the paved road northwards) were thus most likely built during the period when the storehouses and the fortification were still functioning, or at least their remains were still well preserved. The positioning of building 24 in the center of the market bespeaks its especial significance.

The question arises as to whether the foundations of buildings 6 and 24 are characteristic enough to substantiate a chronological determination.

Two very similar buildings, of which one has two support columns and the other does not, were discovered at Porečka reka along the southern bank of the Danube in Djerdap (Serbia). The buildings were situated alongside a fort of the *quadriburgium* type and behind a blockade wall, which formed a barrier in the valley through which a very important route led from the Danube southwards. On the basis of the isolated positioning, the exceptional thickness of the walls (1.5-1.8 m), the thick floor and large amount of amphorae and dolium fragments, the two buildings were interpreted as storehouses. They functioned contemporary with the fort and the blockade wall - during the reign of Constantine the Great; whereby, the entire complex was presumably built during the tetrarchy as a supply centre for the military along the *limes* (Petrović 1977; Petrović 1980; Petrović 1982-1983).

A similarity with one of the storehouses discovered at the villa 1 in Montana in Lower Moesia (Bulgaria) substantiates that the structures at Porečka reka indeed were used as storehouses. The long and narrow building with buttresses has a row of four columns in the centre. The villa was built in the 2nd century, it was renovated after having been destroyed in the late 3rd century and it continued to function through to the end of the 4th century (Mulvin 2002, 95-96, fig. 45). Storehouses of smaller dimensions, with or without buttresses and with or without a raised floor, were found in many military fortifications in the Djerdap region throughout the entire Roman period to the Late Antiquity (Petrović, Vasić 1996, 25, fig. 5).

Regarding their size, the buildings from Porečka reka and Nauportus correspond with the smallest storehouses from military fortifications (e.g.: Gentry 1976, 41; Kortüm, Lauber 2004, 395-399, fig. 180). The two buildings from Nauportus are thus comparable with storehouses in general. However, they cannot be defined as granaries, because certain important elements, such as buttresses, a raised floor, ventilation and possible remains of grain, is lacking (Rickman 1971).

The foundations of the central columns could theoretically support a raised floor (the largest possible span between stone piers supporting a raised floor in granaries measures 4-5 m, e.g.: Rickman 1971, 241, fig. 51 - Hüfingen). It is also possible that columns supported the ridge of the roof or are indicative of a second floor.

The defence walls of Late Roman fortifications incorporated towers with an oblong ground plan, which occasionally also had two central columns (e.g. Capidava; Lander 1984, 218-221, fig. 227). Rectangular towers with two columns are known also from the 4th century fortified landings along the Rhine and Danube rivers (Zullestein, Verőce, Tahitótfalu; Soproni 1978, 74-75, 78, pl. 78:1; 81; Lander 1984, 284-289, fig. 295, 296).

Buildings 6 and 24, structure 26 and the pavement of the nothern road, all likely belong to a single construction phase; it seems that this phase is a later one than the construction phase of the market and storehouses, as well as of the sanctuary. On the other hand, comparisons with similar buildings, especially those at Porečka reka, indicate a dating to the Late Roman period, which would ultimately signify a large chronological gap between the construction phases. If the dating typology for buildings 6 and 24 holds true, then the Late Roman small finds from Dolge njive correspond to this same construction phase.

CONCLUSION

Geophysical prospecting produced a very detailed ground plan of the site at Dolge njive. Combined with the results from previous archaeological excavations, the new ground plan has good interpretative potential.

Dolge njive formed the central part of Nauportus during the Early Roman period. The position of the settlement in the hook of the riverbend and along the fringes of marshland qualified it to function excellently for river traffic as well as for defence purposes. At the same time, it was less convenient for land traffic travelling along the route passing by Nauportus along the opposite riverbank. During the time that the Romans were building at Dolge njive, the desire for a strong defensive capacity is quite evident; this is seen in the defence walls, towers and defence ditch. A defence wall and water-filled defence ditch surrounded the site from all directions. A river port was situated just north of the built-up area.

A market enclosed with a portico occupied almost a third of the surface of the settlement. The storehouses (2-17, 19-20, 22-23) as well as a row of *tabernae* (21), all together covered a very large part of the built-up area. This makes up 33 % of the settlement surface area, or 6.400 m^2 of storage capacity. Four small buildings (7-10) in the northwestern corner of the settlement probably served a different function; however which function is difficult to determine solely from the ground plan. A Celtic-Roman sanctuary with an ambulatory stood in the market area (25). A tradesman's workshop where kilns were in use (27) was probably situated beyond the limits of the settlement.

The small archaeological finds from the defence wall and storehouses demonstrate that most of the settlement was probably planned and constructed according to a unified plan in the Pre-Augustan or Early Augustan period. The buildings were for the most part planned along two orientational directions that followed the courses of the eastern and southern defence walls; together they formed an angle of 100°. The line of the eastern wall deviates 5° to the west. The majority of storehouses and *tabernae* (4-23) have a parallelogram form, while the market forms an irregular parallelogram with its northern line broken off.

The sanctuary (25) slightly deviates from the direction of the market and buildings. It is presumed that it was built somewhat later than the first settlement phase.

The ground plan of the entire settlement and the individual buildings, storehouses and *tabernae* corresponds with the examples found in the Late Republican towns in northern Italy, as well as with the architecture of the ports throughout the whole Empire. The economic role of the settlement is clearly manifested in its architecture; the settlement was a trade, traffic, storage and reloading post as well as a river port.

The origins of the settlement at Dolge njive are attributed to the Pre-Augustan or Early Augustan period on the basis of analyses of small finds; furthermore, it approximately corresponds with the dating by epigraphic monuments from Nauportus, which Šašel Kos attributes approximately to the Caesarean period, or the time of Octavian at the latest (Šašel Kos 1998; Šašel Kos 2000, 294-297). It is highly likely that these monuments do indeed originate from the settlement at Dolge njive. The inscriptions mention the construction of a portico and a temple to the local deity Aequorna. These are buildings that might be recognized also in the new ground plan of Dolge njive. Of course the link between the architectural remains and the construction inscriptions is only hypothetical.

Small finds show that the decline of the settlement at Dolge njive occurred during the first half of the 1st century AD (Horvat 1990). Also confirming the relatively short span of its prosperity are the results from the new prospecting; that is, there are no traces of any larger building reconstructions. Nonetheless, the interruption at Dolge njive does not necessarily bespeak the decline of Nauportus in its entirety. Excavations along the opposite riverbank of the Ljubljanica, in the vicinity of Breg, have demonstrated continuous settlement from the end of the 1st century BC through to the 4th century AD (Horvat, Mušič 2007).

The narrow chronological span of settlement at Dolge njive to the Pre-Augustan and Augustan periods is certainly an expression of the more general course of events in the southeastern Alpine region (Šašel Kos 1997; Šašel Kos 2000). During the 1st century BC, important Aquileian merchant families maintained control over the *vicus* via freed men; they also controlled the transit of the long distance traffic that passed by Nauportus (Šašel Kos 1990). Strabo reports that goods were transported by cart from Aquileia to Nauportus, then reloaded onto ships that navigated the rivers to the Danube (Strabo 4, 6, 10; Šašel Kos 1990, 17-21, 143-148). Nauportus was thus a highly significant post for Aquileia. The Aquileian town territory extended like a shank reaching 100 km eastwards along the Amber Route, so that Nauportus could be included (Šašel Kos 2002).

Roman merchants advance along all important routes into the Norican kingdom and southern Pannonia during the 1st century BC. The *vicus* Iulium Carnicum, controlled by merchant families from northern Italy, developed in the Late Republican period along the route over the Monte Croce Carnico pass / Plöckenpass (on the border between Italy and Austria) leading into the Norican kingdom. An open, paved area - the market - was in the centre of the *vicus*. The continued development then proceeded differently from that at Nauportus, as during the Augustan period it became a *municipium*, or in fact already even a *colonia*. The market was rebuilt into a real forum (Šašel Kos 2000, 289-291; Zaccaria 2001; Vitri 2001). On the Norican side of the pass, in the valley of Gailtal, Italic merchants dominated a trading post at Gurina already in the Late Republican period (Jablonka 2001; Gamper 2004). The most important stronghold for the Italic merchants was in the centre of the Norican kingdom at Magdalensberg. The early phase of the forum at Magdalensberg, which dates to the Late Republican and Early Augustan periods, seems similar to the complex at Dolge njive. The forum is surrounded by small buildings - "cellars" - and long buildings in rows where the blacksmith's workshops operated. This forum differs from the market at Dolge njive mainly due to the construction of the basilica (Piccottini 1991; Dolenz 1998, 15-35). Dolenz compares Dolge njive with the remains at St. Michael am Zollfeld (Austria) which was situated along a traffic route below Magdalensberg. Large buildings were discovered here - presumably storehouses - dating to the Early Roman, most likely the Augustan period. Some of the rooms are long and narrow and in the form of a parallelogram, or rather slightly trapezoidal; as such, they are similar to the storehouses at Nauportus. A temple complex built during the time of Hadrian covered the entire area (Dolenz 2005, 41, 45-46, 49-50, figs. 6, 8, 10).

Several trading posts are also known from the region south of Noricum. At the Ocra pass (today Razdrto below Nanos), that is, along the route linking Aquileia with Nauportus, there was such a trading post already at the end of the 2nd century BC. Initially it was an intruder within the autochthonous environment (Bavdek 1996; Horvat 2002, 142-143, 159). A trading post with strong Italic elements stood in Emona as well already in the Early Augustan period at the latest. Emona lies at a significant crossing of routes in central Slovenia (Vičič 1993; Vičič 1994; Šašel Kos 1998, 104-105; Šašel Kos 2000, 294-297). The settlement at Kranj, fortified with a stone defence wall and rectangular, protruding towers similar to those at Magdalensberg and Dolge njive, dates to the Middle Augustan period. Kranj is situated along the route linking the region of central Slovenia with Carinthia / Noricum (Sagadin 2003 and unpublished data; cf.: Dolenz 2004, 123; Dolenz 2007, 66, fig. 1).

In comparison with other Early Roman trading posts in the eastern Alps, the main characteristic of Nauportus is its key position at the junction between land routes leading from northeastern Italy and Istria and water routes leading eastwards. Large storehouses, which are mainly limited to the Augustan period, are also characteristic. Nauportus is thus a reloading trading post, where long distance transit traffic and trade could operate. The extensiveness of the complex demonstrates the exceptionally large amount of traffic and goods, particularly in the Augustan period.

During the time of Caesar, Roman authority consolidated along the northeastern borders of Italy and Roman influence systematically spread to the eastern Alps and Illyricum (Šašel Kos 2000). During the Octavian and Augustan periods the Romans comprehensively proceeded to occupy the eastern Alps, the middle Danube region and the western Balkans: the Octavian wars in the western Balkans (35-33 BC), the peaceful annexation of Noricum (15 BC), the Pannonian war (14-9 BC) and the Pannonian-Dalmatian rebellion (6-9) (Šašel Kos 1997). This historical background is likely to hold the key to understanding the presence of the large storehouses at Dolge njive during the Augustan period. In light of this, the conscientious defence of the trading post begins to make sense.

In addition to the regular merchant traffic, military shifts and supplies also passed through Nauportus. A hoard of lead sling shots was found probably in the storehouse room 4a (Horvat 1990, 106, 209, pl. 9: 5-7). The material traces of military transports are also apparent in numerous finds of weaponry and military equipment from the Ljubljanica riverbed, for the most part dating to the Augustan period (Istenič 2006). Further down along the Sava, in the Brežice gateway entering into the Pannonian plain, a whole series of military camps dating to the Augustan period are known (Guštin 2002; Mason 2003). These only further substantiate the high significance of the navigable route of Nauportus - Ljubljanica - Sava - Danube. Nauportus - in particular the building complex at Dolge njive - had to have played a very important role in supplying the legions in the regions of the middle Danube and the northern Balkans (Egri 2006). Furthermore, it is entirely probable that the supplying of the army was in the hands of Aquileian merchants who controlled Nauportus (Whittaker 1989, 69-73; Whittaker 1994, 99-112).

The trading post at Dolge njive was abandoned during the peaceful times of the 1st century AD. The nucleus of settlement transferred during the 1st century AD to the area of Breg, which lies along the Roman road westwards of the Ljubljanica. The road linking Aquileia and Emona was most likely built during the Augustan period (Festus, Breviarium, 7; Šašel 1975-1976, 604-606). Large storehouses stood at Breg during the second half of the 1st and the 2nd centuries, however of a different architectural type from those at Dolge njive and lacking any traces of defence structures (Horvat, Mušič 2007). The river traffic along the Ljubljanica was significant throughout the entire Roman period (cf. Šašel Kos 1990, 29, 155; Šašel Kos 1994). Nonetheless, the shift of the centre core of settlement indicates that land routes gained on importance, and that the functions of the settlement underwent a certain change.

The wider area of Vrhnika regained much strategic significance during the Late Roman period, in terms of defending the northeastern passage towards Italy. A fort at Gradišče and the nearby tower were perhaps built already at the end of the 3rd century. A long defence wall (Ajdovski zid) was built in the 4th century in the surrounding hills; it closed off the routes westwards (Šašel, Petru 1971, 75-81; Horvat 1990; Pröttel 1996, 138-139). The settlement at Breg continued to subsist in the plain along the Ljubljanica through to the end of the 4th century (Horvat, Mušič 2007). The renewed usage of the area at Dolge njive on the right bank of the Ljubljanica during the Late Roman period is perhaps indicated by surface finds and perhaps also by two isolated buildings (6, 24) with a paved road.

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Nauportus - zgodnjerimska trgovska postojanka na Dolgih njivah na Vrhniki
Rezultati geofizikalne raziskave z več neodvisnimi metodami

UVOD

Ena najpomembnejših starih poti, ki povezuje Italski polotok z osrednjim Podonavjem, poteka preko prehodov na stičnem območju Alp in Dinarskega gorstva in se pri Vrhniki spusti v Ljubljansko kotlino. Tukaj, na izvirih reke Ljubljanice, se je pričela stara plovna pot na vzhod, po Ljubljanici, Savi in Donavi.

V bližni rečnih izvirov, na območju današnje Vrhnike, je stalo naselje Navport, ki je znano iz antičnih literarnih virov in od koder izvirajo pomembni zgodnjerimski epigrafski spomeniki. Navport je bil že v 1. st. pr. Kr. vikus na akvilejskem mestnem ozemlju (Šašel 1966; Šašel Kos 1990; Šašel Kos 1998; Šašel Kos 2000, 294-297; Šašel Kos 2002).

Lega keltskega Navporta iz 2. st. pr. Kr. ni poznana. V zgodnjerimski dobi je bilo težišče poselitve v ravnini, ob zavoju Ljubljanice na zamočvirjeno ravnico Ljubljanskega barja (*sl. 1*). Po zahodnem bregu Ljubljanice, imenovanem *Breg,* je potekala rimska cesta med Akvilejo in Emono. Arheološko ugotovljena poselitev se je začela v srednjeavgustejskem obdobju in trajala neprekinjeno do 4. st. (Horvat 1990; Horvat, Mušič 2007).

Na vzhodnem bregu, v okljuku Ljubljanice, je ležala rimska naselbina na *Dolgih njivah*. Tu je stal trg, ki so ga obdajala skladišča ter obzidje s stolpi. Ugotovljen je bil začetek poselitve v zgodnjeavgustejskem obdobju in prekinitev najpozneje v sredini 1. st. po Kr. (Horvat 1990).

V našem prispevku predstavljamo nov, dopolnjen tloris naselbine na Dolgih njivah, ki smo ga pridobili s pomočjo geofizikalnih raziskav. Podrobneje smo analizirali tudi funkcijo posameznih stavb, kronologijo in pomen celotne naselbine.

ZGODOVINA RAZISKOVANJ RIMSKE NASELBINE NA DOLGIH NJIVAH

Obstoj rimske naselbine na Dolgih njivah so ugotovili sredi 19. stoletja (Horvat 1990, 50-57, 171-173).

V letu 1884 je Deželni muzej iz Ljubljane raziskoval dno Ljubljanice pri Dolgih njivah. Takrat je preparator Ferdinand Schulz izkopal tudi tri sonde na območju rimske naselbine: predelni zid med prostoroma c in d v stavbi 2, severovzhodni prostor stavbe 8 in dvojni zid med stavbama 12 in 13 (prim. *sl. 36;* Horvat 1990, 49-50, 101-103, 108, 172, 207-208, sl. 8).

Domačini so pod vodstvom Gabrijela Jelovška kopali v letih 1885 in 1886, na območju prostorov 4a, 5a-b, 6, 7. S. Jenny je leta 1900 raziskoval območje stavb in prostorov 4a-b, 5b in severno cesto (prim. *sl. 36;* Horvat 1990, 50, 106-108, 172, 209-210).

Obsežna izkopavanja je vodil na Dolgih njivah v letih 1934 in 1936 Walter Šmid / Schmid. V kratkem času in s skromnimi sredstvi je Šmid uspel razkriti osnovne obrise celotne naselbine. Ob tem je bil izdelan geodetski načrt izkopavanj, ki kaže, da sta bili podrobneje raziskani severna in zahodna stran naselbine. Po analizi skromne dokumentacije izkopavanj se je tudi pokazalo, da je Šmid sledil zgolj vrhovom zidov. Potek zidov je bil večkrat predpostavljen, ne da bi izkopali zid v celotni dolžini. Tako je prišlo do napak, ki so vidne predvsem na območjih stavb 1, 16-18, 21 in 22 ter pri poteku severnega obzidja. Šmid je natančneje izkopaval samo manjše stavbe 8, 9 in mogoče tudi 10 ter kanale med dvojnimi zidovi med stavbami 1 in 2, 2 in 3, 12 in 13 ter 13 in 14 (*sl. 2;* prim. *sl. 36;* Horvat 1990, 49-57, 97-109, 172-173, 205-211, sl. 9).

Geološki zavod Ljubljana je septembra 1969 na pobudo Ive Mikl Curk raziskal velik del arheološkega območja na Dolgih njivah in tudi prostor trase avtoceste, ki je bila takrat v izgradnji. Gre za prve meritve geoelektrične upornosti v arheološke namene na Slovenskem. Odkrili so območja visokih vrednosti navidezne upornosti, ki so jih povezali z arheološkimi ostanki, niso pa jih mogli še zanesljivo interpretirati. Visoke vrednosti so se pokazale na predelih, kjer poteka južno, vzhodno in zahodno obzidje. Videl se je tudi močno tlakovan pas na zunanji strani vzhodnega obzidja (Mikl Curk 1968-1969; Arhiv Republiškega zavoda za varstvo kulturne dediščine; Arhiv Inštituta za arheologijo ZRC SAZU). Novembra 1969 je Mikl Curkova sondirala predele na južnem robu naselbine, ki se jih je dotaknila gradnja avtoceste: obzidje in stolpa na jugozahodnem in jugovzhodnem vogalu (*sl. 2;* prim. *sl. 36;* Mikl Curk 1974; Horvat 1990, 97-99, 205-206).

V letu 1985 je bila raziskana lesena struktura v strugi Ljubljanice, ki predstavlja del rimskega pristanišča (*sl. 2;* prim. *sl. 36;* Horvat, Kocuvan, Logar 1986; Logar 1985).

GEOFIZIKALNE RAZISKAVE

Pri geofizikalni raziskavi na Dolgih njivah na Vrhniki smo v različnem obsegu uporabili geoelektrično upornostno metodo z elektrodno razvrstitvijo metode elektrodnih dvojčkov (*Twin probes, Geoscan RM15*) (*sl. 3A*), magnetno metodo z gradientnim načinom meritev gostote magnetnega pretoka totalnega magnetnega polja (*Geometrics G-858*) (*sl. 3B*) in meritvami magnetne susceptibilnosti vzorcev tal in kamninskega gradbenega materiala (*Kappameter KT-5*), georadarsko metodo z 200 in 500 MHz antenama (*GSSI SIR3000*) (*sl. 3C*) in meritve električne prevodnosti na indukcijski način (*Geonics EM38*) (*sl. 3D*).

Strategija geofizikalnih raziskav je bila pripravljena v skladu z odkritji dosedanjih arheoloških izkopavanj in rezultati geofizikalnih raziskav v podobnih naravnih okoljih na pedosekvencah na glinah (glej: Stritar 1990). Zaradi potencialno slabše ohranjenih suhozidnatih temeljev zgradb na Dolgih njivah smo se odločili za razdaljo 0,5 m med geofizikalnimi profili. V smeri profilov si sledijo meritve upornosti in prevodnosti v oddaljenosti merilnih točk 0,5 m, gostote magnetnega pretoka v razdalji 0,15 m in georadarske sledi v razdalji 4 cm.

Ker dobimo na pedosekvencah na glinah praviloma najboljši kontrast arhitekturnih ostankov z meritvami upornosti, smo geofizikalno raziskavo začeli z geoelekričnim kartiranjem, s katerim ugotavljamo lateralne spremembe v upornosti.

Meritve magnetne susceptibilnosti vzorcev tal in apnenca so dale zelo majhne razlike, kar je napovedovalo slabo kontrastnost temeljev zgradb iz apnenčevih lomljencev na rezultatih prospekcije z magnetno metodo. V takšnih primerih je magnetna metoda usmerjena v odkrivanje ostankov z močnim termoremanentnim tipom magnetizacije, ki je značilen za arhitekturne elemente iz opeke, peči in ruševinskih plasti s keramičnimi strešniki. Teh ostankov z drugimi metodami ne moremo zanesljivo prepoznati.

Georadarska metoda je bila uporabljena za ugotavljanje globine, višine ohranjenosti in medsebojnih prostorskih odnosov arhitekturnih elementov na delih naselbine, kjer je bilo to smiselno glede na rezultate geoelektričnega kartiranja. Georadarska metoda je namreč edina od uporabljenih geofizikalnih metod, ki se uporablja za geofizikalno sondiranje in omogoča natančne 3D prikaze in analize rezultatov meritev. Metoda električne prevodnosti je bila uvedena poskusno na dveh območjih, kjer smo preverjali odzivnost arhitekturnih ostankov in obrambnega jarka. Po pričakovanjih so bili dobljeni rezultati neprimerno koristnejši za arheološko interpretacijo na območju obrambnega jarka. V splošnem velja, da se ta metoda uporablja prav za odkrivanje negativnih struktur in da je njena lateralna ločljivost na mestu visokoupornostnh objektov (npr. apnenčevi temelji) precej slabša od upornostne metode. Ta raziskava je to potrdila.

V nadaljevanju so navedeni nekateri uveljavljeni postopki kvantifikacije, ki smo jih uporabili tudi pri geofizikalni raziskavi na Vrhniki: geofizikalno modeliranje za ustvarjanje arheofizikalnih magnetnih modelov arheoloških objektov in inverzna metoda interpretacije (glej npr.: Mušič et al. 1998; Desvignes et al. 1999, 85-105; Hašek 1999, 25-42; Coskun et al. 2000, 179-186; Tsokas et al. 2000, 17-30; Eppelbaum et al. 2001, 163-185; Kochnev et al. 2004, 64-68; Diamanti et al. 2005, 79-91), simuliranje upornostnih anomalij za oceno globine in širine arhitekturnih elementov (De la Vega et al. 1995, 19-30), izračun navidezne upornosti (Walker et al. 1994), podaljševanje magnetnih anomalij navzgor (*Upward Continuation*) za ugotavljanje virov magnetnih anomalij na večjih globinah, rezidualne magnetne anomalije za prepoznavanje virov magnetnih anomalij na današnji površini ali plitvo pod njo in sintetične gradiente, ki navidezno ojačajo sicer šibke magnetne anomalije (vertikalni gradienti) oziroma učinkovito prikažejo magnetni učinek drobnih železnih predmetov na današnji površini ali plitvo pod njo (horizontalni gradienti) (glej npr.: www.geometrics.com).

V idealnih razmerah bi izbor najustreznejše geofizikalne metode oz. tehnike narekovali izključno ciljni arheološki objekti, ki bi jih želeli odkriti. V realnosti arheološke tarče prispevajo le manjši ali večji delež pri tem izboru, ker moramo vselej upoštevati tudi naravno okolje, v katerem se ti objekti nahajajo. V geofiziki imenujemo anomalijo v fizikalnem polju, ki je posledica prisotnosti arheološkega objekta, "signal", vse nepravilnosti v fizikalnih poljih, ki so posledica številnih drugih okoljskih faktorjev, pa imenujemo "šum". Izbor najustreznejše metode narekuje izključno ocena razmerja med "signalom" in "šumom", ki mora biti za konkretno metodo zadosti visoko, da je kontrast med obema slojema podatkov takšen, da zagotavlja uspešnost prospekcije.

Ker je pogosto težko natančno opredeliti razmerje signal/šum za vsako od številnih metod, se je v arheološki prospekciji uveljavil pristop, ki za oblikovanje učinkovite strategije raziskav izrablja komplementarnost več različnih in neodvisnih metod. S takšno strategijo se izognemo nevarnosti napačne ocene razmerja signal/šum zaradi slabega poznavanja arheoloških in naravnih kontekstov in dobimo hkrati več neodvisnih in komplementarnih podatkovnih slojev, ki izhajajo iz meritev v različnih fizikalnih poljih.

Metoda geoelektrične upornosti

To metodo uporabljamo za geoelektrično kartiranje, ker beležimo vrednosti navidezne upornosti do enake globine, ki je določena z razdaljo med premičnima elektrodama (C_1P_1). Globinski doseg pri razdalji 0,5 m in optimalni vlažnosti tal znaša največ 1,5 m. Poleg razdalje med premičnima elektrodama na globinski doseg znatno vpliva tudi namočenost terena. Pri visoki vlažnosti vrhnjega dela tal je ta globina običajno manjša, ker večina električnega toka steče v smeri boljše elekrične prevodnosti plitvo pod površjem. Ker so bile geoelektrične raziskave na Dolgih njivah izvajane v etapah, so bili namočenost tal in s tem globinski doseg in kontrastnost rezultatov spremenljivi, vendar ne do te mere, da bi pomembno vplivali na rezultate meritev. Geoelektrično kartiranje smo izvajali v mreži 0,5 x 0,5 m in izmerjene vrednosti zgostili z bikubično interpolacijo (Davis 1973, 204-207) na 0,25 x 0,25 m. Raziskana površina znaša 31.500 m^2 (*sl. 3A*).

Rezultati geoelektričnega kartiranja (*sl. 4-6*) so podani kot električni upor (R, Ω) in ne kot upornost (ρ, Ωm), ker nas na arheoloških najdiščih zaradi heterogenosti preiskovanega medija praviloma zanima samo kvalitativna analiza rezultatov, ki temelji na relativnih odnosih izmerjenih vrednosti upora. Upornost (Ωm) je bila izračunana za opredeljevanje naravnega substrata in primerjavo z vrednostmi električne prevodnosti, izmerjenimi na indukcijski način (*sl. 7, 15, 26*).

V literaturi najdemo različne enačbe, ki izhajajo iz bolj ali manj domiselnih izpeljav upornosti za metodo elektrodnih dvojčkov (glej npr. Walker et al. 1994; Clark 1990, 20). Najzanesljivejšo in pravzaprav edino pravilno rešitev predlaga Martinaud (1990, 6). Avtor pri izpeljavi namreč upošteva tudi navidezno specifično upornost tal pod parom oddaljenih elektrod, ki prav tako vpliva na izmerjene vrednosti.

Pri geoelektrični raziskavi na Dolgih njivah se nismo držali tega postopka in smo zaenkrat za izračun upornosti uporabili manj natančno enačbo ($\rho = \pi Ra$, pri čemer je ρ navidezna upornost, R izmerjeni upor in a razdalja med premičnima elektrodama), ki jo predlaga Walker s sodelavci (1994). Rezultati tega izračuna so podani na sl. 7, kjer smo zaradi jasnejšega prikaza generalne razširjenosti navidezne upornosti rezultate prikazali v mreži z velikostjo osnovne površinske enote 2 x 2 m. Iz teh rezultatov je razvidno, da so za negativne strukture (npr. obrambni jarek) značilne vrednosti upornosti nižje od 40 Ωm, za naravno ozadje (glina) med 40 in 50 Ωm, za tlakovane površine (npr. površina trga) med 50 in 60 Ωm in za arhitekturne ostanke vrednosti med 60 in 120 Ωm.

Pri prvih geoelektričnih upornostnih raziskavah na Dolgih njivah, ki jih je z Wennerjevo elektrodno razvrstitvijo leta 1969 opravil Franc Miklič (Geološki zavod Ljubljana), so vrednosti navidezne upornosti razdelili v štiri razrede: 18-26 Ωm (ozadje), 27-35 Ωm (šibke anomalije), 36-44 Ωm (srednje anomalije) in višje od 44 Ωm (močne anomalije) (Mikl Curk 1968-1969; Arhiv Republiškega zavoda za varstvo kulturne dediščine; Arhiv Inštituta za arheologijo ZRC SAZU). Naši izračuni navidezne upornosti kažejo, da so vrednosti, značilne za arhitekturne ostanke, v splošnem višje od 50 Ωm, kar sovpada Mikličevim z razredom močnih upornostnih anomalij. Iz tega zaključujemo, da so naši izračuni navidezne upornosti s preprosto enačbo dovolj korektni za pretvorbo izmerjenih vrednosti upora v "absolutne" vrednosti, ki jasno opredelijo upornostne anomalije zaradi arhitekturnih ostankov in negativnih struktur v podobnih naravnih okoljih na širšem prostoru Ljubljanskega barja.

Metoda električne prevodnosti

V okviru geofizikalne raziskave na Dolgih njivah sta bili z meritvami električne prevodnosti raziskani dve območji (*sl. 3D:* K1 in K2), ki smo ju izbrali glede na rezultate upornostne metode. Območje K1 (*sl. 3D:* K1; *sl. 26:* B1 in B2) je bilo izbrano za preverjanje učinkovitosti metode električne prevodnosti pri odkrivanju visokoupornostnih arhitekturnih ostankov, kar sicer ni najboljša stran te metode. Na območju K2 (*sl. 3D:* K2; *sl. 15:* B1in B2) je bila preverjena odzivnost obrambnega jarka, ki smo ga prepoznali na rezultatih upornostne metode kot 7 m širok pas nizkih vrednosti, ki poteka vzporedno z vzhodnim obzidjem. Ker so obrambni jarki dobri zbiralniki vode in zato dobro električno prevodni, je to za metodo električne prevodnosti pravzaprav idealna tarča.

Navidezno električno prevodnost smo merili z instrumentom (*Geonics EM38*) v vertikalnem položaju (*vertical dipole mode*), pri čemer je bil z daljšo stranico postavljen v smeri profilov. V tej konfiguraciji je občutljivost instrumenta najvišja za globino, ki je enaka razmiku med tuljavama, kar je 1 m. Največja globina dosega je 1,5 m, kar velja tudi za uporabljeno upornostno metodo. Meritve smo izvajali v mreži 0,5 x 0,5 m in jih z bikubično interpolacijo (Davis 1973, 204-207) zgostili na mrežo 0,25 x 0,25 m. Z metodo električne prevodnosti je bila raziskana površina 5.670 m^2 (*sl. 3D:* K1 in K2).

Magnetna metoda

Pri magnetni prospekciji so se bolje uveljavile meritve sprememb v gostoti magnetnega pretoka zemeljskega magnetnega polja na *(psevdo)gradientni način* (nT/m), kot npr. meritve totalnega magnetnega polja z enim senzorjem (nT) (glej npr.: Gaffney et al., 2000). Gradientni način namreč deluje kot filter nizkih frekvenc (*high-pass filter*), ker zelo poudari šibke magnetne anomalije majhnih objektov na majhnih globinah (signal) in odpravi dolgovalovne anomalije, ki so posledica geološkega ozadja (šum).

Magnetometer Geometrics G-858, ki je bil uporabljen v naši raziskavi, dosega ločljivost 0,1-0,2 nT/m pri meritvah gostote magnetnega pretoka totalnega magnetnega polja s hitrostjo odčitavanja 0,2 s. V praktičnem smislu to pomeni, da dobimo pri hitrosti normalne hoje odčitke v smeri profila v intervalih 15 cm. Razdalja med magnetnimi profili je bila 0,5 m, odčitki gostote magnetnega polja pa si v smeri profilov sledijo v razdalji 15 cm. Na magnetogramih (*sl. 8*) so prikazane vrednosti, preračunane na mrežo 0,25 x 0,25 m. Z magnetno metodo smo raziskali površino 24.000 m^2 (*sl. 3B*).

Izmerjene vrednosti navidezne susceptibilnosti v plitvih pedoloških vrtinah na Dolgih njivah znašajo od 0,08 do 0,42 x 10^{-3} SI (*Kappameter KT-5*), srednja vrednost je 0,27 x 10^{-3} SI. Višje vrednosti susceptibilnosti so bile izmerjene na delih izvrtanega jedra, kjer so bili prisotni drobci keramičnega materiala. Če upoštevamo samo vzorce brez keramičnega materiala, je srednja vrednost susceptibilnosti 0,21 x 10^{-3} SI. Susceptibilnost apnenčevega kamninskega materiala, za katerega predpostavljamo, da je bil uporabljen za temelje stavb, je 0,1 x 10^{-3} SI. Posledica majhne razlike v magnetni susceptibilnosti med arheološkimi arhitekturnimi ostanki in naravnim okoljem so šibke anomalije inducirane magnetizacije in s tem slaba kontrastnost arhitekturnih ostankov na magnetogramih (*sl. 8*). Na magnetogramih prepoznamo dele obzidja (*sl. 8A:* a,e), objekta 6 in 25 (*sl. 8A:* b,c), domnevno cesto med centralnim delom naselbine in prehodom ob vzhodnem stolpu, (*sl. 8A:* d; *sl. 9A*), na osnovi zelo enotnega ozadja lahko prepoznamo tudi obrambni jarek (*sl. 8A:* f), domnevno delavnico zunaj naselbine (*sl. 8A:* g), dve vzporedni liniji neznanega izvora (*sl. 8A:* h) in večjo površino močnih magnetnih anomalij, za katero predpostavljamo, da je učinek sodobne ploščadi iz armiranega betona (*sl. 8A:* i). Kot je običajno za sodobne kmetijske površine, je bil tudi v tem primeru ugotovljen visok šum zaradi drobnih novodobnih železnih predmetov na površini ali plitvo pod njo. Te močne točkovne magnetne anomalije zanesljivo prepoznamo na magnetogramih, ki prikazujejo sintetične horizontalne gradiente oziroma spremembo gostote magnetnega polja v horizontalni smeri (*sl. 9B, 9C*). Znotraj naselbine je na magnetogramih le nekaj manjših magnetnih anomalij značilnih za vire anomalij s termoremanentnim tipom magnetizacije (TRM). To pomeni, da za strešno kritino niso uporabljali keramičnih strešnikov in niso gradili arhitekturnih elementov iz opeke. Nadalje lahko sklepamo, da znotraj naselbine ni bilo delavnic, kjer so za proizvodnjo potrebne visoke temperature, in da ni bilo niti krušnih peči niti večjega ognjišča oziroma kurišča.

Pri magnetni metodi se za zanesljivejšo interpretacijo pogosto uporabljajo teoretični 2D in 3D arheofizikalni modeli (glej npr.: Eppelbaum et al. 2001, 163-185), ki izhajajo iz interpretacije na osnovi izmerjenih vrednosti magnetnega polja in primerjave z izračunanimi magnetnimi anomalijami za predpostavljene arheofizikalne modele (glej *sl. 31*). Spremenljivke so oblika objektov, njihova velikost, globina ter njihove vrednosti magnetne susceptibilnosti. Poleg tega moramo poznati podatke o inklinaciji (I), deklinaciji (D) in intenziteti Zemljinega magnetnega polja (F) na raziskovanem območju. Glede na podatke *International Geomagnetic Reference Field* (IAGA V-MOD Division) za Vrhniko velja: I = 63,15°, D = 2,10° in F = 47683 nT. Najustreznejši arheofizikalni model je tisti, pri katerem je razlika med izmerjenimi in teoretičnimi oz. izračunanimi vrednostmi najmanjša.

Georadarska metoda

Valovna dolžina elektromagnetnih valov 200 MHz antene, ki smo jo uporabljali pri georadarski raziskavi na Dolgih njivah, je v zraku 1,5 m. V materialu z relativno dielektrično konstanto 15 se ta zmanjša na 0,52 m pri dielektričnosti 25 na 0,4 m itd. (Conyers et al. 1997, 45). Da je bila antena s centralno frekvenco 200 MHz in dvakrat večjo valovno dolžino od 400 MHz antene, ki se sicer najbolj priporoča za arheološko rabo, pravilen izbor, najbolj zgovorno govori arheološka izpovednost rezultatov georadarske raziskave.

Vertikalna ločljivost je najmanjša razdalja, na kateri je možno dva georadarska odboja še obravnavati kot dve ločeni georadarski meji (glej npr.: Jol 1995, 693-709; Piro et al. 1996, 89-105), in je v splošnem določena z valovno dolžino elektromagnetnega valovanja. Zgornja in spodnja meja horizontalnega reflektorja, kot je v arheoloških kontekstih npr. tlakovana površina, bo na radargramu vidna le, če njena debelina presega četrtino valovne dolžine. Pri ocenjeni dielektrični konstanti (15) talnih različkov na Dolgih njivah znaša valovna dolžina 200 MHz antene v teh tleh približno 0,5 m. To pomeni, da lahko na radargramih zanesljivo prepoznamo horizontalne plasti (tlake) debeline večje od 0,15 m.

Pri višji dielektričnosti površinskega materiala je hitrost elektromagnetnih valov manjša in hkrati je ožji snop eliptičnega stožca, ki določa razmerje med globino in ločljivostjo. Eliptični stožec se širi počasneje, če si v globino sledijo plasti z vedno večjo dielektričnostjo, kar je značilno za pedosekvence na glinah v neposredni bližini rek, kjer vlažnost in s tem dielektrična konstanta z globino postopoma narašča. S tem pojavom razlagamo dobro ločljivost arhitekturnih ostankov v časovnem oknu 50 ns, ki ustreza globini približno 1,5 m.

Merjeni parameter pri georadarskih meritvah je dvojni čas potovanja vala, izražen v nanosekundah (10^{-9}s). Ob poznavanju dielektrične konstante in s tem hitrosti širjenja EM valovanja v preiskovanem mediju lahko te čase povratnih odbojev pretvorimo v dolžinske enote oz. globinske sekcije. Delež elektromagnetnega valovanja, ki se odbije na neki meji med dvema različnima materialoma (npr. tla/zid, tla/arheološka plast, ...), je odvisen od kontrasta v dielektrični konstanti (v manjši meri od električne prevodnosti in magnetne permeabilnosti) in razmerja med valovno dolžino EM-valovanja (določena s frekvenco oddajne antene) in debelino arheološkega objekta (Jol 1995, 693-709).

Najbolj razširjen je način prikazovanja rezultatov s t. i. časovnimi prerezi (*"time slices"*), ki pomenijo časovne reze serije vzporednih in praviloma enako oddaljenih radarskih profilov (glej npr.: Goodman et al. 1995, 85-89). Rezultat časovnih rezov je diagram enakih amplitud odbojev v istem časovnem območju povratnih valov. V arheološki praksi to pomeni serijo "tlorisov" na poljubnih globinah (glej *sl. 12, 14, 18, 20, 22, 25, 27, 29, 32, 35*).

Pri tej raziskavi smo uporabili tudi prikazovanje rezultatov na 3D način, kjer dobimo s prerezi preiskovane prostornine tal v poljubnih smereh natančen vpogled v prostorske odnose arhitekturnih elementov, njihovo globino, širino in stopnjo ohranjenosti. Ta postopek je še posebno dobrodošel za interaktivno interpretacijo v 3D okolju, kar v arheološkem kontekstu omogoča prepoznavanje faznosti gradnje (glej *sl. 13, 19, 28, 33*).

Meats (1996, 359-379) je z uvedbo postopka migracije, ki v veliki meri zmanjša subjektivnost interpretacije rezultatov georadarske raziskave, naredil prvi odločnejši korak v smeri 3D prikazovanje georadarskih rezultatov. Na *sl. 10* so ilustrirani postopki obdelave, ki so bili uporabljeni za pripravo časovnih rezov (*time slices*) in 3D prikaze radarskih odbojev (prirejeno po Premrlu 2004, sl. 15-21).

Za georadarsko raziskavo smo na osnovi rezultatov geoelektrične upornostne metode izbrali 9 območij (*sl. 3C:* G1-G9) v skupni izmeri 8.100 m^2. Takšen izbor so narekovale zahteve po dodatnih informacijah glede medsebojnih prostorskih odnosov arhitekturnih elementov, njihove globine in stopnje ohranjenosti arhitekturnih ostankov, odkritih z upornostno metodo. Vsa območja so bila premerjena z 200 MHz anteno, območje svetišča pa tudi s 500 MHz anteno (*sl. 3C:* G 1/1).

Za realističen 3D prikaz arheoloških arhitekturnih ostankov na podlagi rezultatov geofizikalne metode so pomembni način določanja širine zidov, globina, na kateri se pojavijo, in višina ohranjenosti. S kvalitativno analizo rezultatov upornostne metode smo dobili dober tloris arhitekturnih ostankov, kar predstavlja dobro podlago za rekonstrukcijo urbanistične zasnove naselbine. Do kvantitativnih podatkov, potrebnih za 3D prikaz arhitekturnih ostankov, pa smo prišli z izbranim naborom postopkov obdelave radarskih profilov (*sl. 10*) in analizo posamičnih radarskih odbojev (glej npr: Leckebusch 2003, 213-240). Medtem ko so bile širine zidov odčitane iz radarskih profilov po uporabi migracije (*sl. 10:* G) in Hilbertove transformacije (*sl. 10:* H), so bile globine in stopnja ohranjenosti zidov določene s hitrostnimi analizami (Conyers et al. 1996, 25-38) in popravljene s podatki iz izkopavanj (Mikl Curk 1974, 370-386) ter plitvih vrtin. Za testno območje določanja hitrosti širjenja elektromagnetnega valovanja, ki je pomembno za izračun realnih globin, smo uporabili rezultate arheoloških izkopavanj na območju jugovzhodnega stolpa (Mikl Curk 1974, 370-386; Premrl 2004, sl. 22). Pri izkopavanjih so leta 1969 odkrili na globini od 0,5 do 0,75 m vrhnje plasti temelja obzidja iz lomljenega apnenca. Na radarskih profilih jugovzhodnega stolpa se kažejo vrhnje plasti obzidja na globini 18 nanosekund, kar pomeni, da je pri dielekrični konstanti 13 ocenjena hitrost elektromagnetnega valovanja 6,9 cm/ns. Podobne rezultate smo dobili še na več mestih, kjer smo z vrtinami naleteli na zidove na globini od 0,3 do 0,55 m pod današnjo površino. S hitrostnimi analizami je bila na območju zahodnih skladiščnih prostorov ugotovljena hitrost 6,5 cm/s (glej radarski profil na *sl. 23*). Iz tega sledi, da so empirični in analitski postopki določanja globin dali podobne rezultate. Ob tem moramo spomniti na dejstvo, da ne moremo pričakovati povsem enakih hitrosti širjenja elektromagnetnega valovanja na celotni naselbini. Na hitrost močno vpliva vlažnost, ki jo najbolje ilustrirajo vrednosti upornosti (glej *sl. 7*). Hitrost elektromagnetnega valovanja, ki smo jo uporabili za izračunavanje globin, je 6,5 cm/ns, kar pomeni, da 1 nanosekundi na radargramih ustreza razdalja (globina) 3,25 cm. Ker se na vseh prikazih rezultatov georadarske metode navaja čas, ki preteče od oddaje signala do njegove ponovne registracije (dvojni čas!), moramo za izračun globin upoštevati samo polovico zapisanega časa. Za nas je pomembno vedeti, da povratni čas 30 ns ustreza globini približno 1 m (natančno 0,975 m).

OPIS IN RAZLAGA ARHITEKTURNIH OSTANKOV

Obzidje

Potek obzidja je na rezultatih upornosti najbolje viden na vzhodu, slabše pa na jugu (*sl. 4-6*). Širina vzhodnega in južnega obzidja je približno 2 m (*sl. 4-6*), kar pa ni nujno največja širina obzidja. Iz georadarskih rezultatov (*sl. 12-13*) vidimo, da leži vzhodni del obzidja na globinah od 0,6 do 1,3 m.

Razlog za slabše rezultate upornosti na jugovzhodu in jugu naselbine je lahko slabša ohranjenost obrambnih struktur ali lokalno znatno višja vlažnost tal, ki vedno močno zmanjša kontrast med naravnim ozadjem in arhitekturnimi ostanki. Glede na ocenjeno razširjenost vlage na osnovi spremenljivosti ozadja upornostnih meritev (*sl. 7*) in meritev električne prevodnosti (*sl. 3D*: K2; *sl. 15*) vemo, da je skrajni jugovzhodni del naselbine najbolj vlažen. Močno namočenost razlagamo s kombiniranim učinkom obrambnega jarka, ki je sam po sebi zelo dober zbiralnik vlage, in hkrati stekanja meteorskih voda z avtocestnega nasipa na izvozu za Vrhniko. Na rezultatih električne prevodnosti je zaradi visoke vlažnosti območja ob nasipu avtoceste jarek navidezno širši. Tudi na georadarskih rezultatih (*sl. 3C:* G7; *sl. 14*) je visoka vlažnost znatno vplivala na manjšo kontrastnost jugovzhodnega stolpa in obzidja. Vlaga v tleh predstavlja namreč glavni razlog dušenja elektromagnetnega valovanja (Conyers, Goodman 1997, 53), kar se na radargramih odraža v bistveno nižjih amplitudah radarskih odbojev na stiku glinastih tal in temeljev iz apnenčevih lomljencev.

Iva Mikl Curk je pri izkopavanjih obzidja na jugovzhodnem vogalu naselbine ugotovila širino južnega obzidja malo čez 2 m in širino vzhodnega do 3 m. Temelji obzidja so bili grajeni iz kamnov lomljencev, ki so bili postavljeni v zunanjo in notranjo fronto in prvotno vezani z malto. Vmesni prostor med frontama je bil zapolnjen z ilovico, drobnejšim kamenjem in peskom. V razdalji 2 m so potekali prečni zidci (0,5 m debeline), ki so povezovali obe fronti. Notranjost obzidja so tudi povezovala vodoravna lesena bruna. Podrobnosti strukture so bile najbolje prepoznavne na vzhodnem kraku obzidja (Mikl Curk 1974, 372-376; Horvat 1990, 97-98, 205). Južno obzidje, široko 2 m, je dokumentiral tudi Šmid (*sl. 2*).

Na kontrastnost upornosti med obzidjem in neposredno okolico pomembno vplivata način gradnje in stopnja ohranjenosti ostankov. Konstrukcijske posebnosti vzhodnega obzidja, ki jih je opazila I. Mikl Curk, se verjetno odražajo pri rezultatih meritev upornosti. Povsem jasno prepoznamo samo izraziti notranji oz. zahodni rob obzidja. Mikl Curkova piše, da je bil zahodni rob, ki je meril v širino okoli 0,8 m, skrbno zložen iz lomljencev (Mikl Curk 1974, 372). Zunanji oz. vzhodni rob obzidja ni povsod povsem jasen. Verjetno gre za kombiniran učinek "kasetnega" načina gradnje obzidja, slabše ohranjene zunanje fronte iz apnenčevih lomljencev ter tlakovane površine, ki se z zunanje strani naslanja na obzidje. Čeprav iz rezultatov upornosti ne moremo razbrati konstrukcijskih posebnosti obzidja, pa lahko že iz spremenljive upornosti sklepamo, da ne gre za preprost način gradnje z apnenčevimi lomljenci (*sl. 11*).

Krajšim odsekom obzidja lahko sledimo tudi v zahodnem in severnem delu naselbine. Na severu in severozahodu so funkcijo obzidja prevzele zadnje stene stavb 1-5 in 11-15, ki jih v nadaljevanju razlagamo kot skladišča (*sl. 36, 39*).

Vzhodno od severnega stolpa je linija obzidja na rezultatih upornosti razmeroma slabo vidna, ker je njegova kontrastnost s severne stani zaradi tlakovanih površin in/ali ruševinskih plasti med obzidjem in strugo Ljubljanice nekoliko slabša (*sl. 4-6*). Jasno pa se vidi stik skladiščnih prostorov in linije obzidja. Širino obzidja ocenjujemo na približno 1 m glede na poznano južno linijo, ki predstavlja zaključek skladiščnih prostorov, in glede na robove tlakovanih površin na severni strani obzidja. To se ujema s podatki arheoloških izkopavanj v letih 1934 in 1936. Po Šmidovem načrtu severno in vzhodno obzidje bistveno ne presegata debeline temeljnih zidov skladišč, to je 0,70 m (*sl. 2;* Horvat 1990, sl. 9).

Zahodno od severnega stolpa je obzidje zamaknjeno za 2 m proti jugu. 1 m široko obzidje, ki prav tako predstavlja zadnje stene skladiščnih prostorov, spremlja s severne strani v vsej njegovi dolžini tlakovana površina (*sl. 4-6, 18-19, 36*). Na območju za objektom 7 leži na severni strani obzidja dodaten kamniti zid. Tako na rezultatih upornosti (*sl. 6*) kot georadarja (*sl. 18*) se zid kaže kot izrazita linija, ki je z obzidjem mestoma vzporedna mestoma pa od te usmeritve odstopa (*sl. 36*).

Zahodni rob nasebine leži večinoma že izven območja upornostnih meritev. Šmid je izrisal celoten potek zahodnega obzidja, ki je bilo široko okoli 0,70 m. Ni pa jasno, ali je Šmid obzidje res raziskal v celoti ali pa je potek na načrtu dopolnil na podlagi nekaj izkopanih odsekov. Schulz namreč poroča, da so zidovi na zahodnem robu poškodovani (Horvat 1990, 52, 101-102, 207-208). Na radarski izmeri prostora 12b (*sl. 22, 36*) je verjetno viden odsek zahodnega obzidja, katerega potek se ujema s Šmidovim načrtom.

Stolpi in vhodi

Stolp na jugozahodnem vogalu naselbine leži izven območja naših meritev. Dokumentiral ga je Šmid, dve stranici je izkopala Iva Mikl Curk (*sl. 2;* Mikl Curk 1974; Horvat 1990, 97, 99, 205). Širina temeljev, grajenih iz kamnov lomljencev in prvotno vezanih z malto, je bila 1,5 m, stolp pa je obsegal kvadraten prostor okoli 8 x 8 m (Horvat 1990, 99, 205, sl. 22).

Jugovzhodni stolp je zaradi visoke vlažnosti tal slabo viden (glej zgoraj). V rezultatih upornostne metode (*sl. 4-6*) ga razmeroma jasno prepoznamo ob uporabi filtra nizkih frekvenc (*sl. 6*). Stolp je raziskala že Iva Mikl Curk (Mikl Curk 1974; Horvat 1990, 97-98, 205, sl. 21). Bil je obrnjen diagonalno na južni in vzhodni krak obzidja. Mere zunanjega oboda so približno 7 x 7 m, širina zidov je 1 m, ohranjeni so do višine 0,8 m. Obris stolpa se na horizontalnih rezih radarskih profilov pojavi na globini 0,5 m in sega do globine 1,3 m (*sl. 14*).

Na severovzhodnem vogalu naselbine, kjer so rezultati upornostne metode nejasni, nedvoumni ostanki stolpa niso vidni (*sl. 4-6*). Prav tako ni stolpa opazil Walter Šmid. Vidne so večje površine visoke upornosti, ki predstavljajo učinek dobro ohranjenih tlakovanih površin in/ali ruševinskih plasti neposredno ob notranji strani vzhodnega obzidja (*sl. 4-6, 36:* stavba 1). Na prikazu rezultatov upornostne metode vidimo območje nekoliko višjih vrednosti od ozadja tudi na zunanji strani severovzhodnega vogala obzidja (*sl. 3C:* G5, *sl. 24:* b). Velikost tega območja približno ustreza meram jugovzhodnega stolpa. Vendar pa rezultati niso dovolj jasni, da bi lahko to šibko anomalno območje zanesljivo opredelili kot učinek obrambnega stolpa. Tudi z georadarsko metodo na tem mestu nismo dobili povsem jasnih odbojev, ki bi to predpostavko potrdili.

Na vzhodnem obzidju, južno ob vhodu v naselbino, je stal pravokoten stolp (velikost okoli 8 x 6 m; širina zidu 1 m, globina 0,5-1,3 m), deloma pomaknjen preko zunanje linije obzidja (za 1 m, kolikor znaša širina zidu stolpa) (*sl. 4-6*). Struktura ruševine obzidja, vidna na prikazu rezultatov georadarskih meritev (*sl. 3C:* G6, *sl. 12*), kaže, da je vhod v naselbino ležal severno od stolpa in je bil širok okoli 5,5 m. Na severni strani vhoda je bil postavljen okrepljen del obzidja, velikosti 4 x 2,5 m.

Na območju vzhodnega vhoda je na zunanji strani obzidja ležal 5 m širok tlakovan pas. Podobno tlakovanje je zasledila že Mikl Curkova ob izkopavanju jugovzhodnega stolpa (Mikl Curk 1974, 373, pril. 2), kjer ga naše meritve sicer niso več zaznale. Tlakovanje lahko sledimo vzdolž skoraj celotne vzhodne strani obzidja (*sl. 4-6, 36*).

Na osnovi rezultatov magnetne metode sklepamo, da je od vzhodnih vrat proti notranjosti naselbine vodila 5 m široka pot, ki ni bila tlakovana, ker je na rezultatih upornostne in georadarske metode ni videti. Mislimo, da gre za utrjeno peščeno plast (glej dalje; *sl. 8-9, 36*).

Zidovi severnega stolpa so vidni jasno samo na radarskih slikah (*sl. 3C:* G3; *sl. 18; 36)* in slabše na slikah upornosti (*sl. 4B*). Široki so 1 m, temeljeni 1,6 m globoko (ohranjena globina od 0,8 do 1,6 m). Južna stranica stolpa meri 7 m. Zdi se, da je bil stolp simetričen - kvadratne oblike. V sredini stolpa je bilo zoženje oziroma sta bila zidova dodatno okrepljena.

Severno obzidje prekine s kamni tlakovana pot, ki vodi skozi stolp. Pojavi se na globini 0,6 m in je debela od 0,3 do 0,6 m (*sl. 4-6, 18, 36*). Spremenljiva debelina poti na radarskih profilih je lahko posledica popravil na cesti zaradi posedanja tlakovcev v mehko podlago (*sl. 20-21*).

Rečni breg zunaj severnega obzidja je bil verjetno tlakovan tako kot pas vzdolž vzhodnega obzidja (*sl. 4A, 5, 36*).

Obrambni jarek

Obrambni jarek je potekal vzdolž vzhodnega in verjetno tudi južnega kraka obzidja. Med izkopavanji ga niso opazili (Mikl Curk 1974, 373). Po rezultatih geofizikalne raziskave vemo, da se jarek od naravnega okolja loči po večji poroznosti in vododržnosti.

Polnilo jarka tako predstavlja kolektor vode v sicer slabo propustni glini. Jarek je tako bolje električno prevoden, kar se vidi na rezultatih upornostnih meritev (*sl. 3D:* K2; *sl. 15:* A1in A2) in še bolje na rezultatih raziskav električne prevodnosti (*sl. 15:* B1 in B2). Glede na to, da se jarka ne vidi jasno na rezultatih magnetne raziskave, vemo, da ni bistvene razlike v magnetni susceptibilnosti med polnilom in naravnim okoljem, kar kaže na enak material v polnilu in v neposredni okolici jarka. Ker je položaj jarka znan iz rezultatov drugih metod, ga na magnetogramih prepoznamo samo po magnetno "tihem" ozadju (*sl. 8A:* f).

Na naklon sten jarka sklepamo po nagibu dela tlakovane površine med vzhodnim obzidjem in jarkom (*sl. 13:* h). Iz rezultatov električne prevodnosti (*sl. 15:* B1,B2) pa sklepamo, da je jarek najgloblji na sredini, kar pomeni, da je najverjetneje trikotnega preseka. Oblika in dimenzije jarka so tako določene na osnovi rezultatov metode električne prevodnosti in georadarske metode (*sl. 16*). Jarek je širok 7 m in globok približno 3,5 m (h). V razdalji približno 2,5 m od roba jarka proti njegovi sredini ob globinskem dosegu instrumenta *Geonics EM38* 1,5 m (z) dobivamo nižje vrednosti električne prevodnosti zaradi učinka konsistentnejše in zato slabše namočene gline, v katero je bil jarek vkopan.

Od vzhodnega obzidja je bil jarek oddaljen 9 m. Vzporedno z vzhodnim obzidjem in vzdolž zahodnega roba jarka poteka zid dolžine 12 m, širine 0,5 m in debeline 0,5 m, ki leži približno na globini 0,5 m (*sl. 3C:* G6; *sl. 12-13:* c). Ta zid je lahko utrjeval rob jarka ali pa je bil povezan s prehodom čez jarek.

Trg

Sredi naselbine je ležal s kamni tlakovan prostor v obliki nepravilnega paralelograma (stranice velikosti 75 m x 51 m x 77 m x 59 m; vzhodna meja ni popolnoma jasna), obdan s stebriščem (*sl. 4-6, 36, 39*). Tlak iz kamnitih plošč je opazil že Šmid (Horvat 1990, 54). Na rezultatih upornosti se ostanki tlaka kažejo kot nekoliko višje vrednosti ozadja (*sl. 7*). Na razmeroma slab kontrast poleg poškodovanosti tlaka zaradi oranja vpliva tudi razširjenost vlage v tleh, ki je prav tako posledica spremenjene konsistence tal na nekdanjih ornicah in parcelnih mejah. Parcelne meje so približno vzporedne in potekajo v smeri severovzhod-jugozahod (*sl. 4-6, 7*). Vidne so kot manjše poglobitve v terenu in so v času kmetijske namembnosti površin delovale verjetno tudi kot drenažni jarki. Na upornostnih meritvah se kažejo kot svetlejše linije, kar pomeni nižje vrednosti upornosti zaradi stekanja vode iz relativno višjih njivskih površin. Tehnični razlog za slabši kontrast upornosti je, poleg navedenega, lahko tudi slabša odzivnost upornostne metode na tanke in šibko kontrastne horizontalne plasti. Na radarskih profilih vidimo, da je najmanjša globina tlaka približno 0,5 m. Debelina znaša 0,2 do 0,3 m (*sl. 17*). Spremenljiva globina tlaka na georadarskih profilih je posledica kombiniranega učinka razgibane morfologije današnje površine in, kot predpostavljamo, tudi neravnin v tlakovani površini. Tlakovano površino trga lahko prepoznamo tudi na horizontalnih rezih radarskih profilov kot nekoliko višje amplitude radarskih odbojev glede na ozadje (*sl. 22, 27-28*).

Poti

S trga se odpirajo štirje prehodi (*sl. 36*). Od objekta 24 vodi proti severnemu stolpu 5 m široka debelo tlakovana cesta. Leži na globini 0,6 m in je debela od 0,3 do 0,6 m (*sl. 21*). Cesta se nekoliko dviguje proti severu, kar se vidi na horizontalnih rezih radarskih profilov (*sl. 3C:* G3,G4/1; *sl. 18-20*): najprej izgine na severni strani in šele kasneje tudi na južni strani. Severna cesta je hkrati objekt z najvišjo izmerjeno upornostjo na celotnem najdišču (*sl. 7*). Že na podlagi tega lahko sklepamo, da je tlakovana s kamnitimi ploščami in da je dobro ohranjena. Verjetno gre za najpomembnejšo pot v naselbini, katere trajnost in nosilnost so zagotovili s solidno konstrukcijo. Šele na rezultatih filtra nizkih frekvenc (*high pass filter*), ki močno poudari kratkovalovne upornostne anomalije, so se pokazale parcelne meje/drenažni jarki, ki se "zajedajo" tudi v to cesto (*sl. 6*). Lahko gre za učinek relativnih sprememb upornosti zaradi boljše namočenosti v smeri parcelnih mej kot tudi delnega uničenja ceste v smeri nekdanjih drenažnih jarkov.

Pet metrov široka tlakovana cesta vodi tudi na jug, kjer je moral biti prehod skozi obzidje (*sl. 36*). Na Šmidovem načrtu (*sl. 2*) se konča južno obzidje na mestu, kjer lahko pričakujemo južni vhod. Iva Mikl Curk je na območju južnega roba naselbine odkrila tlakovanje, za katero je domnevala, da bi bilo lahko ostanek poti proti jugu (Mikl Curk 1974, 374). Vendar ležijo ti ostanki preveč vzhodno od območja prehoda, ki ga opazimo na upornostnih meritvah, in jih zato ne moremo povezati s potjo proti jugu. Na rezultatih merjenja upornosti je južna cesta veliko slabše vidna kot severna (*sl. 4-6*). Vrednosti upornosti se nahajajo med vrednostmi za tlakovano površino trga in severno cesto. To pomeni, da je konstrukcija ceste solidnejša kot tlakovanje trga, vendar manj, kot je bilo ugotovljeno za severno cesto. Cesta se konča približno 20 m pred linijo južnega obzidja. Možno je dvoje: da je cesta v nadaljevanju uničena ali pa se njena sestava naglo spremeni, npr. v peščeno nasutje, ki se v upornosti ne razlikuje značilno od okolice. Za to območje nimamo rezultatov georadarske metode in se interpretacija zato opira samo na rezultate geoelektričnega kartiranja.

Pot s trga na vzhod ni bila posebej tlakovana, prav tako ne prehod na zahod (med stavbami 15 in 16) (*sl. 36*). Na rezultatih upornosti (*sl. 4-6*) kot tudi na georadarskih rezultatih (*sl. 3C:* G6; *sl. 12-13*) ob prehodu mimo vzhodnega stolpa ni videti anomalij, ki bi jih lahko interpretirali kot cesto. Na Dolgih njivah so bile ugotovljene magnetne anomalije, ki so značilne za inducirano magnetizacijo arhitekturnih elementov iz apnenca, samo na nekaj mestih, in še to dokaj nejasno. Kljub temu so bili rezultati magnetne metode skrbno analizirani in vključeni v končno interpretacijo na mestih, kjer so bili argumenti dovolj tehtni. Med drugim to velja tudi za nabor dokazov o obstoju ceste, ki vodi do vzhodnega stolpa. Na magnetogramih (*sl. 8-9*) vidimo dve izraziti vzporedni liniji inducirane magnetizacije, ki potekata od vhoda ob vzhodnem stolpu proti notranjosti naselbine. Lahko gre za cesto, zgrajeno iz dobro utrjenega peščenega nasutja, ki se v upornosti in dielektričnosti ne razlikuje značilno od okolice in zato ni vidna na rezultatih upornosti in georadarja (glej *sl. 4-6, 12-13*). Vzporedni liniji na magnetogramu sta posledica znatne lateralne razlike v magnetni susceptibilnosti na kratki razdalji. V tem primeru se lahko ta razlika nanaša na mejo med cesto in medijem, v katerem se nahaja. V prid tezi, da gre dejansko za cesto, je tudi razdalja med linearnima magnetnima anomalijama, ki znaša približno 5 m, kar je enako širini ceste, ki poteka v smeri sever-jug.

Stavbe 2-5, 11-17, 19-20, 22-23 (skladišča)

Okoli trga so v vrste nanizane stavbe z dolgimi, ozkimi prostori in široko odprtimi vhodi, ki smo jih interpretirali kot skladišča (glej dalje). Na severni strani trga ležijo stavbe 2-5, ob zahodni strani 11-15 in ob vzhodni 22-23. Na južni strani trga sta bili zgrajeni dve vrsti stavb: severna s stavbami 16-17, 19-20, ki jih lahko razložimo kot skladišča, in južna s stavbo 21, ki je po obliki najbolj sorodna tabernam (glej spodaj).

Zidovi se zelo dobro vidijo na rezultatih upornostne metode (*sl. 4-6*), na magnetni metodi pa le mestoma kot šibke linije inducirane magnetizacije in zato teh rezultatov nismo mogli uporabiti za dopolnjevanje tlorisa arhitekturnih ostankov (prim. *sl. 8*). Kot veliko uspešnejša se je v tem primeru izkazala georadarska metoda, ki je dala celo vrsto podrobnih podatkov o dimenzijah arhitekturnih elementov, njihovih globinah in stopnji ohranjenosti. Na rezultatih upornosti se npr. dvojni zidovi kažejo kot relativno močnejše in širše upornostne anomalije, pregradni zidovi pa kot relativno šibkejše anomalije (*sl. 4-6*). Na georadarskih profilih se dvojni zidovi jasno ločijo (*sl. 3C:* G1; *sl. 22-23*), enojni in notranji pregradni zidovi pa se kažejo kot relativno tanjši in plitveje temeljeni zidci (*sl. 22*).

Na podlagi izkopavanj vemo, da so posamezne stavbe med seboj ločene z ozkimi prehodi - *ambitus* -, širokimi 0,35 do 0,50 m, kamor se je verjetno stekala voda s streh (dimenzije: Horvat 1990, 55, 110, 212). Podroben Schulzev opis (dvojni zid med stavbama 12 in 13: Horvat 1990, 52, 101-102, 207-208, sl. 24) in Šmidov načrt (*sl. 2*) kažeta, da so bili prehodi v smeri proti trgu zazidani. Zato domnevamo, da so delovali tudi kot odtočni kanali, ki so odvajali kapnico proti reki (prim. *sl. 23*).

Več stavb sestavljata po dva dolga vzporedna prostora (3-5, 12-14, 17, 20), označena s črkami *a* in *b* (*sl. 36*). Objekte 2, 16 in 19 sestavljajo nizi štirih prostorov (a-d). Širine posameznih prostorov so približno enotne in znašajo okoli 6 m. Zunanji zidovi stavb in podolžne stene prostorov so široki od 0,5 do 0,7 m in enako globoko temeljeni (*sl. 23*). Pojavijo se 0,3 m pod površjem in segajo do globine 1 m oziroma največ do 1,3 m.

Dolžina prostorov, vidnih na rezultatih upornosti, je v severni vrsti 23-26 m, v zahodni 22-26 m, v vzhodni okoli 24 m. Na jugu trga so prostori v stavbah 16-20 dolgi približno 24 m (*sl. 4-6*).

Severna in zahodna vrsta skladišč z zadnjimi stenami oblikujeta obzidje. Vhodi so obrnjeni proti trgu in zajemajo celotno širino prostorov. Kaže, da so zaključki zidov ob vhodih večinoma nekoliko razširjeni. V podaljških zidov so bili zgrajeni temelji za stebre portika.

Od zgoraj opisane zasnove odstopajo nekatere stavbe. Stavbi 11 in 15, ki ležita na robovih zahodnega niza, imata samo po en prostor. Ta je pri stavbi 11, ki je umeščena v območje zavoja reke, nepravilne trapezoidne oblike. Po en prostor imata verjetno tudi stavbi 22-23 na vzhodnem delu trga. Prostori 16a-b, 20a-b, 22 in morda tudi 19c so široko odprti z dveh strani - torej imajo dvojne vhode. Stavba 18, z dvema vrstama stebrov, je bila popolnoma odprta proti severu na trg ter proti vzhodu in jugu na cesto oz. ulico.

Nekateri vhodi so bili prezidani s plitveje temeljenimi zidovi: 3a, 5a, 5b, 11, 12a, 13a, 13b, 15, 19d. V notranjosti so bili nekateri veliki prostori dodatno razdeljeni s pregradnimi zidovi, ki so plitveje temeljeni. Pojavijo so na globini 0,6 m, podobno kot baze stebrov portika, in jim sledimo približno do globine 1 m (*sl. 22*). Opazimo jih v prostorih: 2a, 2c, 2d, 3b, 4a, 5a, 5b, 11, 13a, 13b, 14a, 14b, 16c, 17b, 19d, 23. V prostorih 3b, 4a in 4b vidimo tudi manjše tlakovane površine.

Primerjava z načrtom W. Šmida:

Na območju stavb 16-18 se novi tloris močno razlikuje od starega Šmidovega (*sl. 2, 36;* pri Šmidu I/3, 4, 7; Horvat 1990, 101, 207). Šmid je zaznal zahodni zid stavbe 16. Zidove stavbe 16 je opazil kot enojne, tako kakor se zdi tudi na novem načrtu. Opazil je tudi južno steno prostora 16c. Okrepljeni severovzhodni vogal prostora I/7 pri Šmidu je najverjetneje baza stebra ob južni cesti ali jugovzhodni vogal domnevne stavbe 18. Tukaj je na Šmidovem načrtu narisano nekaj, česar nam upornostna metoda ni pokazala (dimenzije tega temelja so po Šmidu 1,7 x 1,8 m; Horvat 1990, 57, 101, 207).

Šmid je opazil samostojno stavbo 22, odprto na obeh straneh. Podaljšal pa jo je preveč proti zahodu, tako da je samostojni steber portika interpretiral kot severozahodni vogal stavbe (*sl. 2, 36;* pri Šmidu VIII; Horvat 1990, 109, 211).

Stavba 21 (taberne)

S pomočjo upornostnih meritev smo zaznali štiri prostore, postavljene v vrsto in ločene z enojnimi zidovi: 21e-h (*sl. 4-6, 36*). Večina območja leži že izven naših meritev. Zelo verjetno pa so se prostori nadaljevali v vrsti proti zahodu, podobno kot severneje ležeči niz 16-18. Tako domnevamo še štiri prostore 21a-d.

Šmid je na območju stavbe 21 (*sl. 2, 36;* pri Šmidu I/2, 6, 5, 7; Horvat 1990, 101, 207) dokumentiral skrajni vzhodni zid stavbe 21, zid med prostoroma 21f in 21g (napačno jih je povezal z zidovi stavbe 18) ter dva zidova, široka čez 1 m, ki potekata vzporedno z obzidjem in sta od njega oddaljena približno 5 m. Po primerjavi z novim načrtom domnevamo, da je mogoče odkril južni zid prostorov 21a-b in 21g-h.

Na osnovi meritev upornosti in izkopavanj v letih 1934 in 1936 bi lahko južni niz stavb rekonstruirali z dokajšno verjetnostjo (*sl. 39*). Verjetno gre za en objekt, ki leži vzdolž obzidja in ga sestavlja niz osmih prostorov. Posamezni prostori so široki okoli 6 m in globoki okoli 8,5 m. Proti severu imajo široko odprte vhode, pri čemer so zaključki zidov okrepljeni. Temelj južnega zidu je močnejši kot ostali zidovi. Na Šmidovem načrtu sta vidni dve okrepitvi na južnem temelju (območji prostorov 21b in 21g), kar bi govorilo za vsaj dva vhoda tudi na južni strani ali za okrepitve zidov v obliki kontraforov.

Stebrišče

Stebrišče, ki je z vseh strani obdajalo trg, je bilo sestavni del skladišč (*sl. 4-6, 20, 22, 36*). Temelji stebrov stojijo v liniji zidov skladišč. Razmak med stebri je približno 6 m, od vhodov pa so odmaknjeni približno 4 m. Temelji so kvadratnega tlorisa z dolžino stranice največ 1 m. Ležijo približno 0,6 m pod površjem in jim na georadarskih časovnih rezih sledimo do globine približno 1 m (enako kot temeljem skladišč).

Na severni strani trga je stalo 12 stebrov (vključno pred stavbo 2) in na zahodni strani 9. Na južni strani, kjer se sicer slabo vidi, pa je na robu trga stalo 7 ali več stebrov. Pokriti prostor pod nadstreškom stebrišča, za razliko od trga, ni bil tlakovan s kamni.

Južno stebrišče se nadaljuje z vsaj štirimi stebri v prehod med stavbama 15 in 16, ki je vodil naravnost do obzidja. Tudi po sredini prehoda med stavbami 16-18 in tabernami 21 je vidna vrsta stebrov.

Stavba 1

Zidovi stavbe 1 (*sl. 36:* 1) so tako na upornosti kot na georadarskih horizontalnih rezih slabše vidni (*sl. 3C:* G5, *sl. 24-25*), iz česar sklepamo, da gre za manj solidno grajene in/ali slabše ohranjene temelje. Temelji se pojavijo na globini približno 0,6 m in jim sledimo do globine 1 m. Stavba 1 se od sosednjih stavb 2-3 nekoliko razlikuje v smeri, bolj očitno pa v velikosti prostorov (prostor 1a: 13,5 x 6 m; prostor 1b: 14 x 7 m). Dolga vzhodna zidova obeh prostorov se zaključita z razširitvami. Na južni strani stavbe 1 je stal najverjetneje nadstrešek, ker v podaljšku obeh zidov z razširitvami ležita po dva temelja stebrov, v medsebojni oddaljenosti približno 5 m. V notranjosti obeh prostorov vidimo več pregradnih zidov, ki so plitvo temeljeni. Se pravi, da gre za stavbo z razsežnim odprtim nadstreškom, ki se bistveno razlikuje od skladišč (stavbe 2-5, 11-17, 19-20, 22-23). (Stari Šmidov načrt je na tem območju zelo netočen; prim *sl. 2.*)

Stavbi 6 in 24 ter objekt 26

Stavba 24 je bila postavljena na sredini trga. Velika je 14 x 10 m, zidovi so debeli okoli 1 m, ležijo na globini 0,6 m in jim sledimo do globine 1,6 m. V notranjosti sta stala dva stebra, od katerih so se ohranili temelji kvadratnega preseka s stranico velikosti približno 1 m. Stebra sta plitveje temeljena kot obodni zidovi (0,6-1,1 m). Vhod v stavbo je bil morda na severni strani (*sl. 4-6; sl. 3C:* G4/2*; sl. 29; 36*).

Stavba 6 je zelo podobnih dimenzij: obod 14 x 10 m, debelina zidov okoli 1 m, globina temeljev je od 0,5 do 1,5 m. Dva stebra v notranjosti sta podobno globoko temeljena kot obodni zidovi (0,8-1,3 m). Na severni strani ima stavba prav tako globoko temeljen pravokotni prizidek velikosti 5 x 3,5 m (*sl. 4-6, 26-28, 36*).

Tako na rezultatih upornostne metode (*sl. 26:* A1 in A2) kot tudi na georadarskih horizontalnih rezih (*sl. 3C:* G2; *sl. 27*) in 3D prikazih radarskih odbojev (*sl. 3C:* G2 in G2/1; *sl. 28*) vidimo, da je vzhodni zid stavbe 6 skoraj popolnoma uničen. Ker uničenje sovpada s parcelno mejo, sklepamo, da gre za posledico intenzivne kmetijske rabe z relativno globljim oranjem. Plitvo pod površino (0,3 m) se najprej pojavita obrisa objektov 8 in 6 z manjšim pravokotnim prizidkom na severni strani. Objektoma 6 in 8 sledimo do globine 1,5 m. Od dveh notranjih temeljev stebrov se najprej pojavi južni, kar pomeni, da je višje ohranjen od severnega. Obema sledimo skoraj do dna temeljev stavbe (*sl. 27, 28*). Hodna površina v notranjosti je bila verjetno dobro utrjena (*sl. 26:* B1).

Jasno se vidi tudi objekt 26, ki je 2 m oddaljen od južne stene objekta 6 (*sl. 4-6, 26-28, 36*). Gre za globok pravokoten temelj velikosti 2,5 x 3 m, ki leži na globini od 0,6 do 1,3 m. Objekt 26 in stavba 6 sta povezana z zidom.

Temnejše polje (f) v jugovzhodnem vogalu *sl. 27* predstavlja odboje tlakovanega trga. Podobne anomalije zasledimo tudi v območju med stavbama 6 in 8. Po tem sklepamo, da je tudi na tem mestu vsaj deloma ohranjena tlakovana površina, ki je na rezultatih upornosti ni bilo mogoče prepoznati.

Stavba 7

Stavbo 7 predstavlja pravokoten podolgovat obris velikosti 16 x 2 m, ki se prislanja na obzidje. Širina temeljev stavbe 7 je na rezultatih upornostne (*sl. 4, 5, 26*) in georadarske metode (*sl. 28:* g) podobna širini temeljev skladiščnih prostorov in jo ocenjujemo na približno 0,7 m. Poseben zidec povezuje stavbo 7 s severnim prizidkom stavbe 6 (*sl. 26, 36*). Šmidov načrt (*sl. 2*) na tem območju predvideva večfaznost.

Stavba 8

Nova izmera ni zajela celotne stavbe (*sl. 4-6, 36*), tako da je tloris dopolnjen po starih podatkih (*sl. 2, 39*). Stavba ima tri prostore. Severovzhodni prostor, 9 x 6 m, je prvi raziskoval že Schulz, celoto s prizidanima dvema prostoroma je potem izkopal Šmid. Gradbene podrobnosti, ki sta jih opazila oba izkopavalca, na meritvah upornosti niso vidne. Odkriti arhitektonski okras kaže, da gre za stavbo, ki je imela poseben pomen (Horvat 1990, 102-105, 208, sl. 25-29, stavba V po Šmidu). Glede na rezultate upornostne in georadarske metode znaša širina zidov približno 0,5 m (*sl. 26, 27, 36*). Na časovnih rezih radarskih odbojev vidimo, da se temelji stavbe 8 pojavijo na globini približno 0,3 m in zanesljivo segajo do globine 1,1 m, verjetno pa še nekoliko globlje.

Stavba 9

Stavba je razdeljena na dva različno široka prostora. V celoti jo je izkopal Šmid, tako da so rezultati upornostnih meritev (*sl. 4-6, 36, 39*) dopolnjeni po njegovem načrtu (*sl. 2;* Horvat 1990, 103, 105, 208, sl. 30; stavba IV po Šmidu). Velikost vzhodne stranice stavbe 9 znaša 7,5 m po upornostnih raziskavah, širino zidov pa ocenjujemo na 0,5 m.

Stavba 10

Šmid, ki je izkopaval na tem območju, je videl manjši pravokoten prostor (le deloma na območju upornostnih meritev) in dva dolga zidova (*sl. 2, 36, 39*). Južni zid je skupen s stavbo 11, za severni zid pa Šmid poroča, da gre za stebrišče (Horvat 1990, 103, 208, stavba III po Šmidu). Širino temeljev ocenjujemo na 0,5 m po rezultatih upornostne metode.

Tlakovanje ali objekt 28

Na območju stavbe 10 ter med stavbama 6 in 9 so na rezultatih upornosti vidne anomalije, ki spominjajo na zidove ali na tlak (*sl. 4-6, 26-28, 36*). Tudi na rezultatih georadarske metode se kaže zahodno od stavbe 6 območje relativno močnejših radarskih odbojev (*sl. 3C:* G2; *sl. 27; 28:* f). Šmid poroča, da je bila okolica stavbe 9 tlakovana (Horvat 1990, 56, 103, 209).

Stavba 25 (svetišče)

Objekt 25 leži v jugozahodnem delu trga. Sestavljen je iz osrednje ploščadi in obodnega zidu. Zunanji obodni zid zamejuje površino velikosti 18,5 x 17,5 m in je plitvo temeljen (*sl. 4-6; sl. 3C:* G1/1; *sl. 32; 33; 36*). Obodni zid, katerega širino ocenjujemo na 0,3 m, je slabo viden tako na upornostnih kot na georadarskih rezultatih. Na georadarskih horizontalnih rezih je viden na treh straneh in mu sledimo od globine 0,3 do 0,8 m (*sl. 32; 33:* c). Zaradi nižjih amplitud odbojev znotraj obodnega zidu kot na trgu okoli njega sklepamo, da notranjost ni bila tlakovana (*sl. 32:* a). Možno, da je bil trg tlakovan šele potem, ko je bila stavba 25 že postavljena.

V sredini leži ploščad, velika 12,5 x 7 m, ki jo obdaja nizek zidec (*sl. 32: d*). Zahodni del ploščadi, velik 8 x 7 m, je nekoliko višje ohranjen (sega od 1 do 1,3 m pod današnjo površino) kot vzhodni del (od 1,3 do 1,6 m pod današnjo površino), tako da sklepamo na konstrukcijo v dveh nivojih. To lahko pomeni vhodno konstrukcijo na vzhodni strani in osrednji del na zahodu (*sl. 30-33*).

V zahodni polovici ploščadi so vrednosti upornosti znatno višje (*sl. 30:* manjši okvir). Sklepamo, da je v tem delu ploščad debelejša oz. je tlak postavljen v dveh nivojih. Na magnetogramu vidimo, da so bile na območju ploščadi izmerjeni višji gradienti gostote magnetnega pretoka kot v neposredni okolici (*sl. 8*). To pomeni, da gre za material višje magnetne susceptibilnosti od okolice, česar pa ne moremo pripisati apnenčevim lomljencem. Zdi se verjetno, da leži na konstrukciji iz apnenca tanka plast opeke (*sl. 31*).

Objekt 27 (obrtniška delavnica?)

Manjše območje močnih upornostnih in magnetnih anomalij izven naselbine, jugovzhodno od obrambnega jarka, smo opredelili kot možno lokacijo obrtniške delavnice. Upornostna metoda je dala jasen pravokotni tloris objekta z visokimi vrednostmi upornosti (*sl. 4-6, 36*), magnetna metoda pa nekaj izoliranih magnetnih anomalij z jasno izraženo bipolarnostjo (*sl. 34*). Magnetne anomalije ne kažejo enotne usmeritve v smeri severa, ki je v splošnem značilnost dobro ohranjenih objektov s termoremanentno magnetizacijo. Rezultati georadarske raziskave se skladajo z rezultati upornostne metode in jih še nekoliko dopolnjujejo v smislu notranje razdelitve objekta. Notranjost objekta zapolnjuje visokoupornostni material. Lahko gre za kamniti tlak, ruševinske plasti in/ali arhitekturne elemente iz kamninskega materiala (*sl. 35*). Glede na naravo magnetnih anomalij ne moremo povsem izključiti možnosti, da gre za novodobno konstrukcijo.

KRONOLOGIJA NASELBINE PO DROBNIH NAJDBAH

Zgodnjerimska doba

Za večino drobnih najdb iz Šmidovih izkopavanj 1934 in 1936 nimamo podrobnih stratigrafskih podatkov, bolj ali manj natančno pa vemo, kje so bile izkopane. Boljši podatki obstajajo zgolj za prostorsko močno omejena izkopavanja Ive Mikl Curk leta 1969 (*sl. 2*). Druge posege na najdišču težko natančno povežemo z drobnimi najdbami.

Kronološka in prostorska analiza drobnih najdb je že bila narejena pred časom (Horvat 1990, 126-129, 229-232). Na tem mestu samo natančneje interpretiramo prejšnje ugotovitve. Jasno pa je, da so naši zaključki brez sodobnih arheoloških izkopavanj z dobro stratigrafijo in večjimi količinami gradiva zgolj preliminarni.

Za zgodnjerimsko obdobje lahko govorimo o treh časovnih skupinah, v katere smo razvrstili najbolj občutljivo fino keramiko. Opredelitev skupin ne izhaja iz najdišča Dolge njive, saj tukaj niso ohranjeni stratigrafski podatki. Skupine so utemeljene na osnovi oblik keramike s črnim premazom in tere sigilate, ki so datirane na podlagi stratificiranih plasti na Štalenski gori, v Ljubljani in Kranju.

1. časovna skupina

Na Dolgih njivah so prisotne pozne oblike keramike s črnim premazom (*sl. 40*):

- krožniki z vodoravno razširjenim in povešenim ustjem, oblika Morel 1631 (*sl. 40:* 1-5; Horvat 1990, 117, 219-220, t. 1: 9, 7: 5, 14: 1-3);
- krožnik s poševno steno, oblika Morel 2276 c1 (*sl. 40:* 6; Horvat 1990, 116, 219, t. 22: 4);
- skodela, oblika Morel 2654 (*sl. 40:* 9; Horvat 1990, 117, 219, t. 13: 14);
- skodela (*sl. 40:* 7; Horvat 1990, 117, 219, t. 22: 3);
- dno pladnja (*sl. 40:* 8; Horvat 1990, 117, 220, t. 24: 11).

V isti čas postavljamo poznolatensko fino keramiko (*sl. 41;* Horvat 1990, 123-124, 226-227).

Keramika s črnim premazom se ujema s "poroznim izdelkom", ki je bila najden v najstarejših plasteh Štalenske gore, to je v "kompleksu 1", datiranem pred 20 pr. Kr., in v "kompleksu 2", datiranem do 10 pr. Kr. (Schindler 1967; Schindler 1986; Scheffenegger, Schindler-Kaudelka 1977, 55, sl. 9-10: OR/39, Periode 2). Sodi torej v zgodnjeavgustejsko ali celo v predavgustejsko obdobje (zgolj po keramiki, brez dobre stratigrafije se teh dveh obdobij ne da ločiti).

Keramika prve skupine z Dolgih njiv se ujema tudi s fazo II na Gornjem trgu 30 v Ljubljani, v kateri je poleg grobe domače in fine latenske keramike močno zastopana raznovrstna italska keramika. V okviru italske keramike se pojavlja keramika s črnim premazom, medtem ko tere sigilate še ni. Faza je po stratigrafiji datirana v poznorepublikansko oziroma že v zgodnjeavgustejsko obdobje (Vičič 1994, 27-30, t. 1: 6-17, 2, 3: 1-13).

2. časovna skupina

V drugo obdobje sodi italska tera sigilata, značilna za srednjeavgustejski čas (*sl. 42:* 1-11):

- krožnik z visečim ustjem (*sl. 42:* 1; Horvat 1990, 118, 221, t. 5: 5; oblika Consp. 11 - podobno);

- krožnik z enostavno poševno steno (*sl. 42:* 3; Horvat 1990, 117, 220, t. 24: 12; oblika Consp. 1.1);
- krožnik s poševno steno, ki je profilirana na notranji strani (*sl. 42:* 2; Horvat 1990, 117, 220, t. 5: 6; oblika Consp. 1.2; Roth-Rubi 2006, 24, 35: horizont Dangstetten, 2. desetletje pr. Kr.);
- male polkrožne skodelice (*sl. 42:* 5-10; Horvat 1990, 118, 221, t. 3: 7-8, 10: 16, 13: 16-17, 24: 7-10; Schindler, Scheffenegger 1977, 59-61, t. 12b: predvsem kompleksa 2 in 3; Vičič 1994, faza IIIa, t. 4: 18-20);
- polkrožna skodela (*sl. 42:* 11; Horvat 1990, 118, 221, t. 13: 15, 18: 12);
- skleda z razširjenim visečim ustjem (*sl. 42:* 4; Horvat 1990, 117-118, 220-221, t. 13: 18; podobno kot oblike Consp. 5.1, 10 in 13.1; Schindler, Schindler-Kaudelka 1997).

To obdobje je približno sočasno z najstarejšim naselitvenim horizontom na Kočevarjevem vrtu, to je na najdišču, ki sodi v okvir Navporta in leži na levem bregu Ljubljanice, nasproti Dolgim njivam. V najstarejši plasti se pojavlja italska sigilata oblik Consp. 11, 12 in 14. Zraven so bili odkriti redki fragmenti keramike s črnim premazom - krožniki ali skodele s preprosto poševno steno. Fina latenska keramika ni bila prisotna (izkopavanja 2005, neobjavljeno; prim. Horvat, Mušič 2007).

Našo drugo skupino lahko primerjamo tudi z gradivom iz Ljubljane, ki je bilo odkrito na dobro stratificiranem najdišču Gornji trg 30 v fazah IIIa in III (Vičič 1994, 30-34), ter z glavnino gradiva na Gornjem trgu 15 v Ljubljani (Vičič 1993). Za ta čas so značilne oblike tere sigilate Consp. 12 in 14, medtem ko se keramika s črnim premazom (krožniki z enostavno poševno steno) pojavlja samo sporadično (prim. Vičič 1993, 160-162, t. 3: 8-9, 8: 1,3,4-5). Podobno keramiko najdemo tudi v zgodnjerimski naselbini v Kranju (Sagadin 2003).

Našteto gradivo iz Vrhnike, Ljubljane in Kranja ustreza horizontu Dangstetten - Oberaden, torej ga lahko uvrstimo v srednjeavgustejski čas (Roth-Rubi 2006; Schnurbein 1991).

3. časovna skupina

V tretje obdobje uvrščamo samo poznoavgustejske skodelice (*sl. 42:* 12-13; Horvat 1990, 118-119, 221-222, t. 5: 9, 9: 8).

Večino keramike in drugih predmetov z Dolgih njiv lahko le okvirno datiramo v zgodnjerimsko oziroma v avgustejsko obdobje, na da bi mogli ločiti med zgodnje-, srednje- in poznoavgustejskim obdobjem (Horvat 1990, 112-132, 215-235). Med posamičnimi najdbami rimskih novcev najdemo 17 republikanskih in 25 avgustejskih, kar kaže predvsem na obstoj postojanke v avgustejskem obdobju (Horvat 1990, 87-89, 195-197).

Med izkopavanji jugovzhodnega stolpa ter južnega in vzhodnega obzidja so dobili gradivo, ki izvira iz polnila med temeljnimi kamni obzidja, iz hodne površine in iz ruševine. Odkrita je bila keramika s črnim premazom, tera sigilata, značilna keramika tankih sten in poznolatenska keramika, okvirno torej najdbe naše 1. in 2. skupine (*sl. 43;* Horvat 1990, 128, 231, t. 21; Mikl Curk 1974, 373-374).

V kanalih (*ambitus*) med stavbami 1 in 2, 2 in 3, 12 in 13 ter 13 in 14 je bilo odkrito predvsem gradivo iz 1. in 2. časovne skupine ter težje opredeljivo zgodnjerimsko gradivo. Zelo malo je poznoavgustejskega gradiva. Tudi druge najdbe (keramika, novci) ki izvirajo z različnih območij stavb 1-5, 11-18, 21, kažejo enak časovni razpon ter enaka razmerja (Horvat 1990, 126-129, 229-232). Zaklad keltskih srebrnikov (23 majhnih in en velik srebrnik) je bil najden v kanalu med zidovoma stavb 4 in 5 (Horvat 1990, 89-90, 106, 197-198, 209). Veliki keltski srebrnik je bil odkrit v stavbi 8 - severovzhodni prostor (Horvat 1990, 87-88: 1; 103; 195-196: 1; 208).

Iz tega sledi, da lahko datiramo gradnjo obzidja in stavb v vseh delih naselbine (vsaj stavbe 1-5 in 11-15) najpozneje v zgodnjeavgustejsko obdobje. Življenje naselbine pa je trajalo vsaj do konca avgustejskega obdobja (Horvat 1990, 126-129, 229-232).

Pozna antika

Poznoantične najdbe z območja Dolgih njiv niso bile odkrite med sistematičnimi izkopavanji stavb ali obzidja. Gre za površinske najdbe ali za najdbe brez natančnih podatkov.

Zažigalna sulica: na območju stavb 4-8 (Horvat 1990, 106, 209, 269, sl. 32a; prim. Horvat 2002, 146, sl. 6: 8, t. 21: 1).

Noga križne fibule: na območju stavb 1-3 (Horvat 1990, 271, kat. št. 169, sl. 32 b: 2).

Galijenov novec: območje stavb 11-12 (Horvat 1990, 88-89: 53; 127; 196-197: 53; 230).

Novec Konstantina I.: območje stavb 4-5 (Horvat 1990, 88-89: 54; 128; 196-197: 54; 231).

Novec Konstancija II.: območje trga, pred stavbama 4 in 5 (Horvat 1990, 88-89: 55; 196-197: 55).

Novec iz druge polovice 4. st.: severni del naselja (Horvat 1990, 88-89: 60; 127; 196-197: 60; 231).

Zaklad novcev, zakopan leta 270 in najden leta 1914 "med Vrhniko in Verdom". Točno mesto zakopa ni znano, vendar je mogoče, da zaklad izvira z Dolgih njiv (Horvat 1990, 82, 93-94, 190, 201-202).

Gostota poznoantičnih najdb priča o izrabi prostora v pozni antiki. Ne vemo pa, ali jih še lahko povezujemo z naselbino na Dolgih njivah. Intenziven promet po Ljubljanici je potekal do pozne antike, prav tako je do 4. st. živelo naselje na levem bregu reke (Horvat, Mušič 2007). Torej bi lahko predmete 3. in 4. st. povezali tudi z dogajanji na reki in na nasprotnem bregu.

INTERPRETACIJA ARHITEKTURE

Lega, utrdba in pristanišče

Naselje, ki je imelo obliko nepravilnega pravokotnika, je z dveh strani oblivala reka Ljubljanica, na vzhodni in verjetno tudi na južni strani pa je bil skopan obrambni jarek, napolnjen z vodo.

Lego Navporta lahko dobro primerjamo z umestitvijo rimskih mest v severnoitalskem nižavju, ki so pogosto postavljena v bližino vode, celo v okljuk reke. Brežine rek so utrjene, postavljeni so pomoli, v bližini stojijo različne stavbe, povezane s pristanišči, med drugim tudi skladišča. Vodni tokovi okoli naselij imajo različne pomene: so plovne poti, predstavljajo obrambo mesta, lahko pa gre tudi za izsuševalne jarke. Regulacijska dela in izkope novih kanalov lahko sledimo od 2. st. pr. Kr. dalje. Akvileja je bila tako verjetno v celoti obdana z vodami (Uggeri 1990; Rosada 1990, 370-372; Conventi 2004, 234-235. *Aquileia:* Carre, Maselli Scotti 2001; Carre 2004. *Altinum:* Tirelli 1999, 12-18; Tirelli 2001. *Opitergium:* Cipriano, Sandrini 2001).

Obzidje Navporta ima kvadratne stolpe, ki izstopajo iz zunanje in notranje stene obzidja. Takšne stolpe srečamo v obzidjih rimskih mestih republikanskega in zgodnjecesarskega obdobja (npr. Nîmes: Varène 1992, 149-151; Cosa: Fentress, 2003, sl. 2; Aosta, Torino: Mansuelli 1971, t. 7, 9; Emona: Plesničar Gec 1999, 45-60; Gurina: Gamper 2004, 159-163).

Severna vrata v obzidju so bila oblikovana kot stolp s prehodom, širokim okoli 5 m. Sorazmerno majhne dimenzije stolpa, domnevno kvadraten tloris in masivna notranja podpornika bi lahko kazali na to, da je bil prehod v celoti pokrit in nad njim še eno nadstropje. Torej gre za posebno obliko pokritega vhoda skozi stolp, ki se kot ena od več možnih različic vhodov pojavlja predvsem v 1. st. pr. Kr. (Brands 1988, 29-33: *Kammertore;* Kader 1994, 337-338). Tipološko je blizu vhodom v obliki stolpa z odprtim notranjim dvoriščem - *cavaedium,* ki so v rabi od 3.

st. pr. Kr. dalje (Gros 2002, 32, 37-39; Brands 1988, 16-33; tudi Rosada 1990, 379).

Vzhodna vrata so nesimetrična. Na južni strani stoji večji votel stolp, na severni manjši masiven. Pogosto vrata varujeta po dva enaka ali podobna stolpa, vendar zgodnjeantična mesta poznajo tudi vrata z enim stranskim stolpom (npr. Brands 1988, 22, 82-84, 126-128). Vzhodni vhod v Navport lahko tudi približno primerjamo z zahodnimi vrati v Akvilejo, ki so datirana v 2. st. pr. Kr. Ta vrata z notranjim dvoriščem so nesimetrična, z masivnim pravokotnim (podolgovatim) stolpom samo na eni strani in posebnima manjšima kvadratnima okrepitvama na obeh zunanjih straneh (Bertacchi 1965, 7-8, sl. 2).

Preprostost in izrazita uporabnost utrdbe Navporta imata torej korenine v utrjevanju rimskih mest v republikanski Italiji. To se ujema z datacijo gradnje v predavgustejsko ali v zgodnjeavgustejsko obdobje, ki izhaja iz kronološke opredelitve keramike.

Rečno pristanišče je ležalo severno ob naselbini. Skozi severna vrata je na breg Ljubljanice vodila tlakovana pot. V njenem podaljšku so bili v rečni strugi v dveh širokih vrstah na gosto zabiti leseni koli - verjetno ostanek pravokotnega lesenega pomola, velikosti 6 x 4,5 m (Logar 1985). Ob pomolu je bil rečni breg še dodatno utrjen s posameznimi lesenimi koli (neobj., dokumentacija v Narodnem muzeju Slovenije). Na sliki upornostnih meritev vidimo, da je bil pas med obzidjem in reko tlakovan, opazimo še območja možnih ruševin (*sl. 2-4, 36*). Hkrati pa kaže poškodovani zid v bregu reke na obstoj zidanih objektov tik ob Ljubljanici (Horvat 1990, 49, 171).

Trg

Trg v Navportu nima kanoničnih značilnosti rimskega foruma, ki je pravokotne oblike in obdan s stebriščem, z dominatnim svetiščem in baziliko, torej z elementi, ki opredeljujejo forum kot versko in upravno središče avtonomnega mesta (prim. Gros 1990; Gros 2002, 207-234). Ima obliko nepravilnega paralelograma obdanega s stebriščem. V primerjavi z mestnimi forumi ni velik, vendar zavzema okoli 30 % površine naselbine (okoli 5.500 m^2, s portikom), kar je veliko več, kot je običajno v rimskih mestih. Stavba 25, ki jo razlagamo kot svetišče (glej spodaj), leži v kotu trga in je sorazmerno majhna. Čeprav je postavljena približno v osi ulice, ki vodi z vzhoda, nima izrazite dominantne pozicije. Par stavb 22 in 23, ki leži na vzhodni strani trga, ima sicer dokaj izpostavljeno lego, ki bi lahko kazala na posebno funkcijo, hkrati pa je zelo podoben tistim stavbam, ki jih razlagamo kot skladišča (glej spodaj).

Torej se tudi v obliki trga kaže status naselbine, poznan iz literarnih in epigrafskih virov (Šašel Kos 1990) - to je vikus z minimalno avtonomijo, ki ne potrebuje večjih verskih in upravnih stavb. Trg, ki ga obdajajo skladišča in taberne, kaže na izrazito ekonomsko vlogo naselbine, kar je tudi značilnost republikanskih forumov severnojadranskega prostora (Zaccaria 1999, 76-78). Tako je npr. v poznorepublikanskem obdobju obstajalo v Juliju Karniku (danes Zuglio), ki je imel takrat status vikusa, odprto tlakovano območje - najverjetneje trg pred vrsto stavb s podolgovatimi prostori. Pozneje so ga zgradili kot forum (Zaccaria 1999, 77; Maggi 2003, 235-236, op. 54, sl. 5).

Skladišča (stavbe 2-5, 11-17, 19-20, 22-23) in taberne (21)

Največjo pozidano površino znotraj naselbine zavzemajo stavbe z dolgimi ozkimi prostori v vrstah in portikom, ki zavzemajo okoli 30 % prostora oziroma približno 5.500 m^2 (stavbe 2-5, 11-17, 19-20, 22-23; brez portika). Primerjave s podobnimi zgradbami na drugih rimskih najdiščih kažejo, da so bila to verjetno skladišča.

Rimska civilna skladišča so bila grajena na dva načina. Prevladujejo skladišča, grajena kot enotna stavba, v kateri so manjši pravokotni prostori (dolžina največ 15 m) razporejeni okoli osrednjega dvorišča oziroma redkeje vzdolž hodnika. Takšna skladišča so stala npr. v Ostiji in Rimu (Rickman 1971, 15-122). Arhitektonski tip dvoriščnih skladišč so Rimljani prevzeli iz grškega sveta, morda že v 2. st. pr. Kr. (Rickman 1971, 153-155; Virlouvet 1995, 90).

Na Dolgih njivah srečamo drugo obliko rimskih civilnih skladišč, za katero so značilni zelo globoki prostori (20 m in več), ki so postavljeni v vrsto. Rickman tudi za to obliko domneva, da se je razvila na helenističnem vzhodu (Rickman 1971, 153). Na Masadi (danes Izrael) sta bili, verjetno v letih 37 do 31 pr. Kr., zgrajeni dve skladišči s prostori v vrsti (Rickman 1971, 153-154, sl. 34). V rimskem svetu se je ta tip uveljavil predvsem v pristaniščih, tako da so bili vhodi skladišč v vrsti pogosto odprti na pristaniške pomole. Srečamo jih v raznih delih imperija, v časovnem razponu od 1. st. pr. Kr. do 2. st. po Kr.

V Valentiji (danes Valencia v Španiji) je bila odkrita stavba iz poznorepublikanskega obdobja, interpretirana kot skladišče: štirje globoki prostori (širina 6 m, globina čez 15 m) so postavljeni v vrsto in široko odprti na stebrišče (Ribera i Lacomba, Calvo Galvez 1995, 20-21, sl. 1).

V Vieni (danes Vienne v Franciji), pomembnem prometnem križišču v Galiji Narbonensis, je bil odkrit velik skladiščni kompleks, datiran v drugo četrtino 1. st. po Kr. Na levem bregu Rhône so bile postavljene vsaj štiri skupine skladiščnih prostorov v dvojnih vrstah, ki zajemajo ogromno površino, skupaj okoli 4 do 6 ha. Na rekonstruiranem tlorisu ene od skupin vidimo dve vzporedni vrsti, ki imata po 21 prostorov, ločenih z 12 m široko ulico. Skupno velikost ene skupine ocenjujem, po objavi, na 340 x 80 m. Velikosti posameznih prostorov so, po objavi sodeč, približno 12/15 x 30 m. Vhodi so široko odprti na srednjo ulico (Helly-Le Bot 1989).[1]

V delno potopljenih pristaniških četrtih v Puteoliju (danes Pozzuoli v Italiji) so vidni razsežni skladiščni kompleksi, v katerih prevladujejo dolgi prostori v vrstah. Posamezne stavbe niso natančno poznane in datirane. Veliki predeli pristanišča Puteoli so bili zgrajeni v avgustejskem obdobju, pristanišče pa je živelo do pozne antike (Camodeca 1994, 112-113, t. 1).

V pristaniščih, oziroma v bližini, sta stali tudi skladišči iz Patare in Mire (antična Likija, danes v Turčiji), ki ju je leta 128 dal postaviti Hadrijan in sta verjetno povezani z zbiranjem anone (Rickman 1971, 137-140). Skladišče iz mesta *Cuicul* (danes Djemila v Alžiriji), datirano v leto 199, sicer ne leži v pristanišču, je pa tudi povezano z anono (Rickman 1971, 140-144).

Skladišča v vrstah, kjer pa globine prostorov ne presegajo 15 m, srečamo v Klavdijevem pristanišču v Portu [Italija; Keay et al. 2005, 278, sl. 5.9, 5.10 (*Foro Olitorio*); sl. 5.13, 5.14 (okoli notranjega pristanišča)], v Trajanovemu pristanišču v Portu (Rickman 1971, 123-132; Lanciani 1888; Keay et al. 2005) ter v severskem pristanišču v Lepcis Magni (danes v Libiji; Rickman 1971, 132-136).

V vojaških taborih v srednji in zahodni Evropi je bila v rabi večinoma drugačna skladiščna arhitektura: prevladujejo žitnice z dvignjenimi tlemi, ki so samostojne oziroma zidane v parih, pri večjih kompleksih postavljene v skupine (pregled: Rickman 1971, 213-250; Johnson 1987, 162-179). Samo v nekaterih vojaških postojankah so bile odkrite oblike, ki so podobne skladiščem iz Navporta. V Numanciji - v Scipionovem taboru na Castilleju (okoli 134 pr. Kr.) je bilo odkrito skladišče, v katerem trije večji prostori tvorijo celoto. Prostori (17,80 x 5,60-6,80 m) so ločeni s prehodi. Imeli pa so dvignjena tla, tako da gre očitno za žitnico (Rickman 1971, 251-252).

Izredno pomembna primerjava za arhitekturo z Dolgih njiv je vojaška oskrbovalna postojanka, odkrita v Melunu ob Seini (Francija) in datirana v drugo desetletje po Kr. Izkopani

[1] Na desnem bregu Rhône v Vieni (današnji Saint-Romain-en-Gal) so v drugi polovici 1. st. postavili veliko skladišče dvoriščnega tipa (Laroche, Savay-Guerraz 1984, 85-90).

sta bili dve vrsti lesenih stavb, interpretirani kot skladišča. V najbolje ohranjeni vrsti stoji na dolžini 140 m 21 prostorov, velikosti 22 x 6 m, ki imajo obliko paralelograma. Prostori so bili široko odprti na obeh ožjih straneh, na obeh straneh jih spremlja dvojni portik (skupna širina 34 m) (Galbois, Petit, Reddé 2006). Dvojne vhode opazimo tudi v Navportu, pri stavbah 16, 20 in 22.

Dolge ozke skladiščne prostore, ki so odprti na dve strani, srečamo še v Rimu, v *horrea Lolliana*. Tloris teh skladišč, ki jih je dal postaviti M. Lollius, konzul leta 21 pr. Kr., poznamo samo iz severskega marmornega načrta Rima. Gre za skladiščne prostore, razporejene okoli dveh dvorišč. Štirje prostori ob dvorišču b so daljši kot ostali, dolgi okoli 21 m in široki okoli 3 m, ter odprti hkrati na dvorišče in ven iz stavbe (Virlouvet 1995, 98, 108-113, sl. 11; Rickman 1971, 108-112, sl. 23).

Po primerjavah sodeč gre na Dolgih njivah za skladišča v vrstah. Temelji stavb se ujemajo s tem arhitektonskim tipom po razporeditvi in dimenzijah prostorov, po spremljajočem portiku in po legi ob pristanišču. Imajo pa nekaj posebnosti. Del prostorov je zidanih v parih (stavbe 3-5, 12-14, 17, 20), za kar ne poznamo dobrih primerjav. Vhodi so široki, tako kot običajno pri tabernah in redko v skladiščih, kar kaže na prepletanje funkcij skladiščenja in trgovanja (DeLaine 2005, 39-45; *Horrea Agrippiniana* v Rimu: Astolfi, Guidobaldi, Pronti 1978; Melun: Galbois, Petit, Reddé 2006). Nekatere stavbe imajo široke vhode z obeh ožjih strani, kar je sorazmerno redek pojav (glej zgoraj). Izpostavljeni stavbi 22 in 23 na vzhodni strani trga sicer nekoliko odstopata od arhitekture ostalih skladišč, vendar ju ne moremo povezati z drugačno funkcijo.

Po drobnem gradivu sodimo, da so bila skladišča postavljena v zgodnjeavgustejskem ali celo v predavgustejskem obdobju, sočasno z obzidjem (glej zgoraj).

Dolga ozka stavba z osmimi prostori (21) se po obliki in dimenzijah - 6 x 8,5 m - vključuje v arhitekturo tabern (Baratto 2003; DeLaine 2005, 32-35).

Stavba 25 - svetišče

Stavba 25 stoji na jugozahodnem območju trga, vendar ni usmerjena po nobeni od stranic nepravilnega trga in tudi ne leži točno v osi ulice, ki vodi od vzhodnega vhoda. Sklepamo torej, da stavba ni bila načrtovana in grajena sočasno s trgom, skladišči in obzidjem. Ne vemo pa, ali je starejša ali mlajša.

Zanesljiva interpretacija arhitekture na podlagi geofizikalnih raziskav ni mogoča, vidijo pa se nekatere pomembne značilnosti. Pravokotna ploščad v dveh nivojih spominja na tempelj na podiju s stopniščem na vzhodni strani. Obodni zid, ki je plitveje temeljen kot ploščad, bi lahko predstavljal zamejitev temenosa. Po dimenzijah in po tem, da vzhodni rob ploščadi sega do obodnega zidu, pa bi v njem najlažje videli zunanji zid obhodne galerije. Oblika in velikost temeljev iz Navporta spominjajo na obhodna svetišča, pri katerih se pojavi kombinacija keltske tradicije obhodnega svetišča z rimskimi "klasicističnimi" elementi. Okvirno jih lahko primerjamo s svetišči: Celje - obhodno svetišče 3 (Krempuš, Gaspari, Novšak 2007, 42-43, sl. 3: poznotiberijsko), Augst - Sichelen 2 (v rabi od sredine 1. st. dalje), Kornelimünster - svetišče F 1 (zgrajeno v času Vespazijana), Trier - Marsovo svetišče na Irminenwingertu (okvirno 2. st.), Trier - Altbachtal, obhodno svetišče 2 (prvih sedem desetletij 3. st.) (Trunk 1991, 80-85, 172-173, 204-206, 226-230; Gros 2002, 199-203).

Stavbi 6 in 24 ter objekt 26

Stavbi 6 in 24 se ujemata po velikosti, po debelini zidov (okoli 1 m), po globini temeljev in po dveh središčnih stebrih. Najverjetneje sodita v isti gradbeni program, medtem ko njun odnos do zgodnjerimskih skladišč, trga in utrdbe ni popolnoma jasen.

Stavba 6 je bila postavljena v "prazni" vogalni prostor med severno in zahodno vrsto skladišč. Njen položaj odstopa od linije vhodov v skladišča 2-5 oziroma od linije stebrišča na severnem robu trga. Sklepamo, da najverjetneje sodi v mlajšo gradbeno fazo kot skladišča, hkrati pa se vsaj deloma še ozira na starejšo arhitekturo.

Globoki temelji konstrukcije 26 se zdijo v smiselnem odnosu s stavbo 6 in jih tako tudi postavljamo v isto gradbeno fazo.

Stavba 24 je umeščena skoraj točno na sredino trga in je usmerjena tako kot svetišče (stavba 25), ki se mu sicer zelo približa. Od nje vodi tlakovana cesta skozi severna vrata do reke. Tlak na območju ceste je debelejši kot tlak trga. Za stavbo 24 domnevamo sočasnost s stavbo 6 in preko tega na mlajšo gradbeno fazo. V povezavi s stavbo 24 je verjetno tudi močna konstrukcija ceste proti severu.

Stavbi 6 in 24 (skupaj z objektom 26 in tlakovanjem severne ceste) sta torej najverjetneje nastali v obdobju, ko so skladišča in utrdba še obstajali ali pa so bili njihovi ostanki še dobro vidni. Položaj stavbe 24 na sredini trga kaže na njen poseben pomen.

Zastavlja se vprašanje, ali so temelji stavb 6 in 24 dovolj značilni, da bi lahko nudili kakšno oporo za datacijo.

Dve zelo podobni stavbi, izmed katerih ima ena dva podporna stebra, druga pa ne, sta bili odkriti v Porečki reki, na južnem bregu Donave v Džerdapu (Srbija). Stavbi sta bili postavljeni ob trdnjavico vrste *quadriburgium* ter za zaporni zid, ki je pregrajeval dolino, po kateri vodi pomembna prometna pot od Donave proti jugu. Na podlagi izolirane lege, izredne debeline zidov (1,5-1,8 m), debele izolacije poda ter številnih ostankov amfor in dolijev sta stavbi interpretirani kot skladišči. Bili sta v rabi istočasno kot trdnjava in zaporni zid - v obdobju Konstantina Velikega, verjetno pa je bil celotni kompleks konstruiran v obdobju tetrarhije kot oskrbovalni center vojske na limesu (Petrović 1977; Petrović 1980; Petrović 1982-1983).

Da gre v Porečki reki res za skladišča, bi nakazovala npr. podobnost z enim od skladišč, odkritih v vili 1 v Montani v Spodnji Meziji (Bolgarija). Dolga ozka stavba z oporniki na zunanjih stenah ima v sredini vrsto štirih stebrov. Vila je bila postavljena v 2. st., po uničenju v poznem 3. st. obnovljena in živa do konca 4. st. (Mulvin 2002, 95-96, sl. 45).

Skladišča manjših dimenzij, z zunanjimi oporniki ali brez njih, z dvignjenim podom ali brez, so sestavni del mnogih vojaških utrdb na prostoru Djerdapa v celotnem antičnem obdobju (Petrović, Vasić 1996, 25, sl. 5). Po površini bi se lahko stavbe iz Porečke reke in Navporta ujemale tudi z najmanjšimi skladišči iz nekaterih vojaških utrdb (npr.: Gentry 1976, 41; Kortüm, Lauber 2004, 395-399, sl. 180).

Stavbi iz Navporta lahko torej primerjamo s skladišči v širšem pomenu, ne moremo pa ju uvrstiti med žitnice. Manjkajo namreč dokazi za nekatere pomembne elemente, kot so dodatni oporniki zidov, dvignjena tla, zračenje in po možnosti ostanki žita (Rickman 1971). Temelja stebrov na sredini bi bila lahko teoretično opora dvignjenim tlem (največji možni razpon stebrov za dvignjena tla v žitnicah je 4-5 m, npr.: Rickman 1971, 241, sl. 51 - Hüfingen). Lahko bi tudi nosila sleme strehe ali pa kažeta na višjo stavbo z zgornjim nadstropjem.

V obzidja poznoantičnih utrdb so vključeni stolpi s podobnim podolgovatim tlorisom, ki imajo včasih še dva močna osrednja stebra (npr. Capidava; Lander 1984, 218-221, sl. 227). Pravokotne stolpe z dvema stebroma srečamo tudi v sklopih utrjenih pristanov ob Renu in Donavi iz 4. st. (Zullestein, Verőce, Tahitótfalu; Soproni 1978, 74-75, 78, t. 78:1, 81; Lander 1984, 284-289, sl. 295, 296).

Stavbi 6 in 24, objekt 26 in tlakovanje severne poti torej sodijo v eno gradbeno fazo, ki se zdi mlajša kot faza gradnje trga in skladišč ter mlajša od gradnje svetišča. Po drugi strani pa primerjave s podobnimi stavbami, predvsem iz Porečke reke, nakazujejo datacijo v poznorimsko obdobje, torej na veliko časovno vrzel med gradbenimi fazami. Če tipološka datacija stavb 6 in 24 drži, potem se poznoantične drobne najdbe iz Dolgih njiv vežejo prav na to gradbeno fazo.

ZAKLJUČEK

Z geofizikalnimi raziskavami smo dobili zelo natančen tloris postojanke na Dolgih njivah, ki ga lahko, ob dodatni pomoči rezultatov iz predhodnih arheoloških izkopavanj, dokaj dobro razložimo.

Na Dolgih njivah je v zgodnjerimskem obdobju stalo osrednje poselitveno jedro Navporta. Lega naselbine v okljuku reke in na robu močvirja je bila odlična tako za delovanje rečnega prometa kot tudi za obrambo. Obenem pa je bila za promet po kopnem, ki je potekal mimo Navporta po nasprotnem bregu, precej neugodna. V času, ko so Rimljani gradili na Dolgih njivah, je očitno prevladala želja po dobri obrambi, ki se kaže tudi z obzidjem, stolpi in obrambnim jarkom. Postojanka je bila torej z vseh strani obdana z obzidjem in z vodo. Ob reki, severno od pozidanega območja, je ležalo tudi pristanišče.

Skoraj tretjino površine postojanke je zavzemal trg, obdan s portikom. Večino stavb predstavljajo skladišča (2-17, 19-20, 22-23) in niz tabern (21), ki zajemajo skupaj 33 % površine naselbine oziroma 6.400 m^2 skladiščne površine. Štiri manjše stavbe (7-10) v severozahodnem vogalu naselbine so verjetno imele drugačno funkcijo, ki pa je samo iz tlorisa ne moremo razpoznati. Na trgu je stalo keltsko-rimsko obhodno svetišče (25). Zunaj naselbine je bila verjetno umeščena obrtniška delavnica, v kateri so bile v rabi peči (27).

Drobne najdbe iz plasti, ki se vežejo na utrdbo in skladišča, kažejo, da je bila večina naselbine zasnovana in zgrajena po enotnem načrtu v predavgustejskem ali v zgodnjeavgustejskem obdobju. Stavbe so bile v glavnem načrtovane vzdolž dveh orientacijskih smeri, ki sledita vzhodnemu in južnemu obzidju ter oblikujeta kot 100°. Odklon vzhodnega obzidja je 5° zahodno. Večina skladišč in taberne (4-23) imajo tako obliko paralelograma, trg pa obliko nepravilnega petkotnika z zalomljeno severno linijo.

Svetišče (25) za malenkost odstopa od smeri trga in stavb, zato domnevamo, da je nekoliko mlajše kot prva faza naselbine.

Zasnova celotne naselbine in posameznih stavb, skladišč in tabern, se veže na vzorce iz poznorepublikanske severne Italije in na arhitekturo pristanišč v širšem prostoru imperija. V arhitekturi se jasno odraža prevlada ekonomske vloge naselbine, ki je bila trgovska, prometna, skladiščna in prekladalna postojanka ter rečno pristanišče.

Naša datacija začetka naselbine na Dolgih njivah v predavgustejsko ali zgodnjeavgustejsko obdobje temelji na analizi drobnih najdb in se približno ujema z datacijo epigrafskih spomenikov iz Navporta, ki jih Marjeta Šašel Kos postavlja okvirno v cezarijanski ali najpozneje v oktavijanski čas (Šašel Kos 1998; Šašel Kos 2000, 294-297). Dokaj verjetno so ti spomeniki vezani na naselbino na Dolgih njivah. Napisi omenjajo gradnji portika in svetišča lokalni boginji Ekorni, torej zgradb, ki bi jih morda lahko razpoznali tudi na novem tlorisu Dolgih njiv. Seveda povezava med ostanki arhitekture in gradbenimi napisi nikakor ni dokazana.

Drobne najdbe kažejo na zaton naselbine na Dolgih njivah v prvi polovici 1. st. po Kr. (Horvat 1990). Sorazmerno kratek čas njenega razcveta potrjujejo tudi rezultati nove raziskave, saj ne zasledimo večjih prezidav v stavbah. Prekinitev na Dolgih njivah sicer še ne pomeni zatona Navporta v celoti. Izkopavanja na nasprotnem bregu Ljubljanice, na območju Breg, so namreč pokazala kontinuirano poselitev od konca 1. st. pr. Kr. do 4. st. po Kr. (Horvat, Mušič 2007).

Ozka časovna zamejenost naselbine na Dolgih njivah v predavgustejsko in avgustejsko obdobje je gotovo odraz širšega dogajanja v jugovzhodnoalpskem prostoru (Šašel Kos 1997; Šašel Kos 2000). V 1. st. pr. Kr. so pomembne akvilejske trgovske družine preko osvobojencev nadzorovale vikus in tudi tranzitni promet na dolge razdalje, ki je potekal čez Navport (Šašel Kos 1990). Strabon poroča, da so iz Akvileje tovorili blago z vozovi do Navporta, tam pa so ga preložili na ladje in vozili po rekah do Donave (Strabon 4, 6, 10; Šašel Kos 1990, 17-21, 143-148). Navport je bil za Akvilejo tako pomembna postojanka, da se je akvilejsko mestno ozemlje kot krak raztegnilo 100 km daleč proti vzhodu, vzdolž Jantarjeve poti, in ga zajelo (Šašel Kos 2002).

V 1. st. pr. Kr. prodirajo rimski trgovci po vseh pomembnih poteh v noriško kraljestvo in v južno Panonijo. Ob poti čez prelaz Ploče (Monte Croce Carnico, Plöckenpass, na meji med Italijo in Avstrijo) v Noriško kraljestvo je v poznorepublikanskem obdobju zrasel vikus *Iulium Carnicum,* ki so ga obvladovale trgovske družine iz severne Italije. Sredi vikusa je stal odprt tlakovan prostor - trg. Nadaljnji razvoj je potekal drugače kot pri Navportu, saj je bil v avgustejskem obdobju ustanovljen municipij oziroma že takrat kolonija. Trg je bil prezidan v pravi forum (Šašel Kos 2000, 289-291; Zaccaria 2001; Vitri 2001). Na noriški strani prelaza v Ziljski dolini so italski trgovci imeli postojanko v Gurini že v poznorepublikanskem obdobju (Jablonka 2001; Gamper 2004). Najpomembnejše oporišče italskih trgovcev je bilo v središču Noriškega kraljestva na Štalenski gori. Zgodnja faza foruma na Štalenski gori, ki sodi še v poznorepublikansko in zgodnjeavgustejsko obdobje, se zdi nekoliko podobna kompleksu na Dolgih njivah. Forum obdajajo manjše stavbe - "kleti"- in dolge stavbe v vrsti, v katerih so bili železarski obrati. Forum pa se razlikuje od trga na Dolgih njivah med drugim po tem, da na njem stoji bazilika (Piccottini 1991; Dolenz 1998, 15-35). Dolge njive Dolenz primerja z ostanki v Šmihelu na Gosposvetskem polju (St. Michael am Zollfeld, Avstrija), ki leži na prometni točki pod Štalensko goro. Tu so bile odkrite velike stavbe - domnevno skladišča iz zgodnjerimskega, verjetno avgustejskega obdobja. Nekateri prostori so dolgi in ozki, v obliki paralelograma oziroma rahlo trapezaste oblike, torej podobni skladiščem iz Navporta. Vse skupaj pokriva svetiščni kompleks iz Hadrijanovega obdobja (Dolenz 2005, 41, 45-46, 49-50, sl. 6, 8, 10).

Tudi s prostora južno od Norika poznamo več postojank italskih trgovcev. Na prelazu Okra (danes Razdrto pod Nanosom), ob poti, ki povezuje Akvilejo z Navportom, je takšna postojanka nastala že na koncu 2. st. pr. Kr. in je bila na začetku izrazit tujek v staroselskem okolju (Bavdek 1996; Horvat 2002, 142-143, 159). Trgovska postojanka z močnimi italskimi elementi je stala najpozneje v zgodnjeavgustejskem obdobju tudi v Emoni, pomembnem križišču poti v osrednji Sloveniji (Vičič 1993; Vičič 1994; Šašel Kos 1998, 104-105; Šašel Kos 2000, 294-297). V srednjeavgustejsko obdobje sodi naselbina v Kranju, ki je bila utrjena s kamnitim obzidjem in pravokotnimi izstopajočimi stolpi, podobno kot vrh Štalenske gore oziroma Dolge njive v Navportu. Kranj stoji ob poti, ki je povezovala območje osrednje Slovenije s Koroško (Sagadin 2003 in neobj.; prim.: Dolenz 2004, 123; Dolenz 2007, 66, sl. 1).

V primerjavi z drugimi zgodnjimi rimskimi postojankami v vzhodnih Alpah je glavna značilnost Navporta položaj na meji med kopnimi potmi, ki so vodile iz severovzhodne Italije in Istre, in vodno potjo proti vzhodu. Posebnost so tudi velika skladišča, omejena predvsem na avgustejsko obdobje. Gre torej za prekladalno postajo, preko katere sta potekala tranzitni promet in trgovina na dolge razdalje. Razsežnost kompleksa pa kaže na izjemno količino prometa in tovorov prav v avgustejskem obdobju.

Za časa Cezarja se je konsolidirala rimska oblast na severovzhodni meji Italije, rimski vpliv se je sistematično širil v vzhodne Alpe in Ilirik (Šašel Kos 2000). V oktavijanskem in avgustejskem obdobju je prišlo do dokončne rimske okupacije vzhodnih Alp, srednjega Podonavja in zahodnega Balkana: Oktavijanove vojne na zahodnem Balkanu (35-33 pr. Kr.), mirna aneksija Norika (15 pr. Kr.), panonska vojna (14-9 pr. Kr.) ter panonsko-dalmatski upor (6-9 po Kr.) (Šašel Kos 1997). Verjetno je to zgodovinsko ozadje ključ za obstoj velikih skladišč na Dolgih njivah v avgustejskem obdobju. V tej luči postane razumljiva tudi skrbna obramba postojanke.

Čez Navport so, poleg navadnega trgovskega prometa, potekali tudi vojaški premiki in oskrba vojske. V skladiščnem prostoru 4a je bil verjetno odkrit zaklad svinčenih želodov za pračo (Horvat 1990, 106, 209, t. 9: 5-7). Materialni sledovi vojaških transportov so vidni v številnih najdbah orožja in vojaške opreme iz reke Ljubljanice, ki so skoncentrirani v avgustejski dobi (Istenič 2006). Nižje ob Savi, v Brežiških vratih na vhodu v Panonsko nižino, je bila odkrita cela vrsta vojaških taborov avgustejskega časa (Guštin 2002; Mason 2003), ki še dodatno potrjujejo vojaški pomen plovne poti Navport-Ljubljanica-Sava-Donava. Menimo, da je Navport - konkretno stavbni kompleks na Dolgih njivah - moral igrati pomembno vlogo v oskrbi legij na prostoru srednjega Podonavja in severnega Balkana (Egri 2006). Nadalje je popolnoma verjetno, da je bila v rokah akvilejskih trgovcev, ki so nadzorovali Navport, tudi oskrba legij (Whittaker 1989, 69-73; Whittaker 1994, 99-112).

Postojanka na Dolgih njivah je bila opuščena v mirnem obdobju v 1. st. po Kr. Težišče poselitve se je v 1. st. po Kr. preneslo na prometno ugodnejše območje Breg, ki leži ob rimski cesti zahodno od Ljubljanice. Cestna povezava med Akvilejo in Emono je bila najverjetneje zgrajena za časa Avgusta (Festus, Breviarium, 7; Šašel 1975-1976, 604-606). Na Bregu so v drugi polovici 1. st. in v 2. st. stala velika skladišča, vendar drugačnega arhitekturnega tipa kot na Dolgih njivah in brez sledov obrambnih struktur (Horvat, Mušič 2007). Pomen rečnega prometa po Ljubljanici se je bržkone obdržal skozi vse antično obdobje (prim. Šašel Kos 1990, 29, 155; Šašel Kos 1994), vendar pa prenos težišča poselitve kaže na povečan pomen cestne povezave in delno spremembo vloge naselbine.

Širše območje Vrhnike je v poznorimskem času ponovno pridobilo velik strateški pomen v obrambi severovzhodnih prehodov proti Italiji. Morda sta bila že konec 3. st. postavljena kastel na Gradišču in bližnji opazovalni stolp, v 4. st. so zgradili po okoliškem hribovju dolg obrambni zid (Ajdovski zid), ki je zapiral poti na zahod (Šašel, Petru 1971, 75-81; Horvat 1990; Pröttel 1996, 138-139). Do 4. st. je še živel naselbinski predel na Bregu v ravnini ob Ljubljanici (Horvat, Mušič 2007). Ponovno uporabo prostora Dolgih njiv na desnem bregu Ljubljanice v pozni rimski dobi nakazujejo površinske drobne najdbe in morda tudi dva izolirana objekta (6, 24) s tlakovano severno cesto.

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