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Mediterranean Archaeology and Archaeometry
Vol. 21, No 1, (2021), pp. 165-178
Open Access. Online & Print.



DOI: 10.5281/zenodo.4394051

ROMAN LAND DIVISION IN ISTRIA, CROATIA: HISTORIOGRAPHY, LIDAR, STRUCTURAL SURVEY AND EXCAVATIONS

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Received: 27/10/2020

Accepted: 23/12/2020

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ABSTRACT

Many interpretations of the ancient cadastre of the Roman colonies of *Pola* and *Parentium* on the Istrian peninsula in Croatia have been offered recently on the basis of satellite imagery and the Croatian topographic map. This grid, spreading continuously over an area of roughly 1200 km², was identified through numerous structures which correspond to the ancient Roman metric system, but they were never a part of further research. This approach enabled identification of structures that were most often visible in the contemporary cadastre, like modern roads or field boundaries, but gaps were left in areas where the modern cadastre did not reflect the ancient one. Until the commission of airborne laser scanning (ALS or LiDAR), from which our research began, one of these gaps was on the northern side of the Lim bay, in the Municipality of Vrsar. Interpretation of ALS data resulted in detecting different, multi-temporal spatial organisations of the landscape, among which were numerous, previously unidentified, remains of the Roman *limites*. The results of this interpretation guided the field inspection. Different surface manifestations of individual remains were categorized, and it was defined which are the original Roman structures. The results of this structural survey subsequently guided the archaeological excavations. Only with the combination of these procedures it was possible to understand the original construction of the *limites*.

KEYWORDS: Centuriation, Roman landscape, archaeological prospection, LiDAR, structural survey, karstic landscape, Istria, Adriatic coast

1. INTRODUCTION

At the end of the Republic, with the foundation of the Roman colonies *Iulia Pola* and *Iulia Parentium*, an intensive Romanization of the Istrian peninsula in the northern Adriatic began. Today we do not have direct written, literary or epigraphic sources for the deduction of these colonies and so far, conclusions and possible multiple interpretations of this issue are the result of deductive assessment based on the analysis of available written sources and archaeological data (Degrassi, 1954, pp. 61-62, 68-72; Fraschetti, 1983, pp. 97-99; Keppie, 1983, p. 204; Šašel, 1992, p. 663). It is clear that in view of absolute terms the *terminus post quem* for the establishment of the cities should certainly be placed in the mid-1st century BC, but the exact date of the deduction will hopefully be finally resolved only with future epigraphic finds referring to the political act of assigned colonial status. The Roman colonies have become the centre of a wider adjacent area, and besides the demographic, social, economic and cultural transformation they conditioned also a significant transformation of the colonial *ager* (Percival, 1976, p. 157; Suić, 2003, pp. 155-170).

Besides the remains of Roman urban architectural monuments and ancient urban planimetry reflected in today's physiognomy of Pula and Poreč, certain aspects of Romanization are perceived through the visible traces of the Roman land division in the agricultural area within the system of a colony. With the establishment of colonies, the peninsula was inhabited with settlers from Italy (Tassaux, 1992, p. 136), who acted as an instrument of Roman expansion, Romanization and the spread of urban civilization. Bringing in new settlers was not limited only to urban centres, but it largely consisted of the establishment of numerous large agricultural and residential estates – *villae* – on the territory of the colonial *ager*, which represented the economic base of the cities. It is a sort of a paradox that the process of the urbanization in the Roman world in the Late Republican and Imperial period inevitably caused an increase of rural settlements, i.e. the intensive colonization of areas outside the cities which with the urban centres represents an inseparable whole within the economic context. In the colonial *agri* of *Iulia Pola* and *Iulia Parentium* 332 *villa* sites were detected, of which 217 with architectural remains and 115 locations with surface scatters of Roman ceramic finds (Matijašić, 1988; Bulić, 2014, pp. 69-70).

The Roman intervention in the transformation of the environment is mainly related to the distribution

of agricultural land in even lots, i.e. *centuriatio*. The first interpretation of the remains of the centuriation of the *ager* of *Pola* during the late 1850s was carried out by Kandler (Ramilli, 1972-1973, pp. 7-8, 22-24, 52-61). A century later, researchers used RAF aerial photographs taken during WWII for the interpretation of the remains of the ancient land division: Suić (1996 [1955], pp. 357-362) was the first to detect the centuriated *ager* of *Parentium* with the same orientation and modular size of *centuriae* as those that were found around *Pola*; Chevallier (1961 [1957], pp. 14-16) defined that it was the same continuous grid and Bradford, who proposed this innovative method (1947) also identified subdivisions of *centuriae* into four equal parts (Bradford 1957). The modular size of the Istrian centuriation is based on a quadrangle of 20 x 20 *acti*, and its precise morphology is generally defined by Krizmanich's studies by measuring the visible *limites* on topographical maps, whose results show that the azimuth of the *cardo* is 18° and the modular size of a *centuria* is 706.39 m long, with a standard deviation of ± 49 cm (Suić, 1996 [1955], p. 353; Bradford, 1957, p. 161; Krizmanich, 1981, pp. 183-186).

The continuous layout of the grid in both *agri* is a consequence of the fact that the two areas were organized in a single operation throughout the territories of the two neighbouring administrative areas of the colonies, the border presumably demarcated by the natural physical boundaries of the Lim bay and the Lim valley (Chevallier, 1961, pp. 14-15). It is not a common case in the Roman Empire that an identical network of *centuriae* covers two neighbouring colonies.¹

The beginning of the 21st century marked a new milestone in the study of landscape archaeology, and thus of Roman centuriation. The development of geographic, computer-based tools enabled the precise analysis of environmental changes through time. The availability of satellite imagery of higher resolution, as well as digital topographic maps, has enabled an extensive overview of the centuriation traces. In this context, it is necessary to highlight the relatively new research results of Marchiori who interpreted satellite images and recognized the traces of continuous centuriation throughout the Pula and Poreč *agri* except the extreme south of the peninsula, the Cape Kamenjak (Marchiori, 2009, pp. 75-78), the absence being noted also by earlier researchers. The division of the

¹ A similar situation was observed in Campania where the colonies Capua and Catalia, and municipium Atella shared the same centuriation grid, but this was dictated by the specific circumstances of the historical development of

the city of Capua (Panerai, 1983, pp. 222-226). Another example of an identical centuriation network in two administrative units was recorded in Etruria in the *ager* of the colony of Cosa, which was founded in 273 BC and more than a century younger Heba (Attolini, 1983, pp. 218-221).

whole territory in land plots contrasts with the conventional interpretations of the limitations of colonial *ager*. Typically, the *ager* of the colonies consisted of the land which was allotted to the Roman colonists (*ager divisus et adsignatus*) and also non-divided land, that usually comprised forests and pastures (*ager indivisus, ager insolutus*), and was collectively owned by the colonial community. It is usually considered that the indigenous population lived on the non-divided lands in rural settlements organized in the areas outside the centuriated grid of the colonies. In their recent work, based on the interpretation of satellite imagery and LiDAR data, Bernardini and Vinci proposed that the

Roman centuriation extended to central Istria as well as further to the north, between the Mirna and Dragonja rivers (Bernardini, Vinci, 2020).

The study of the planimetry of Roman land division sometimes provides a direct contribution to open historiographical issues. By analysing the remains of *limites* visible on Croatian base map - topographic map in 1:5000 scale, new conclusions have been drawn about the position of the *umbilicus* in the vicinity of the *Parentium* ramparts, as well as the concurrent foundation of these two colonies which opposes former opinions (Bulić, 2012, pp. 61-70).

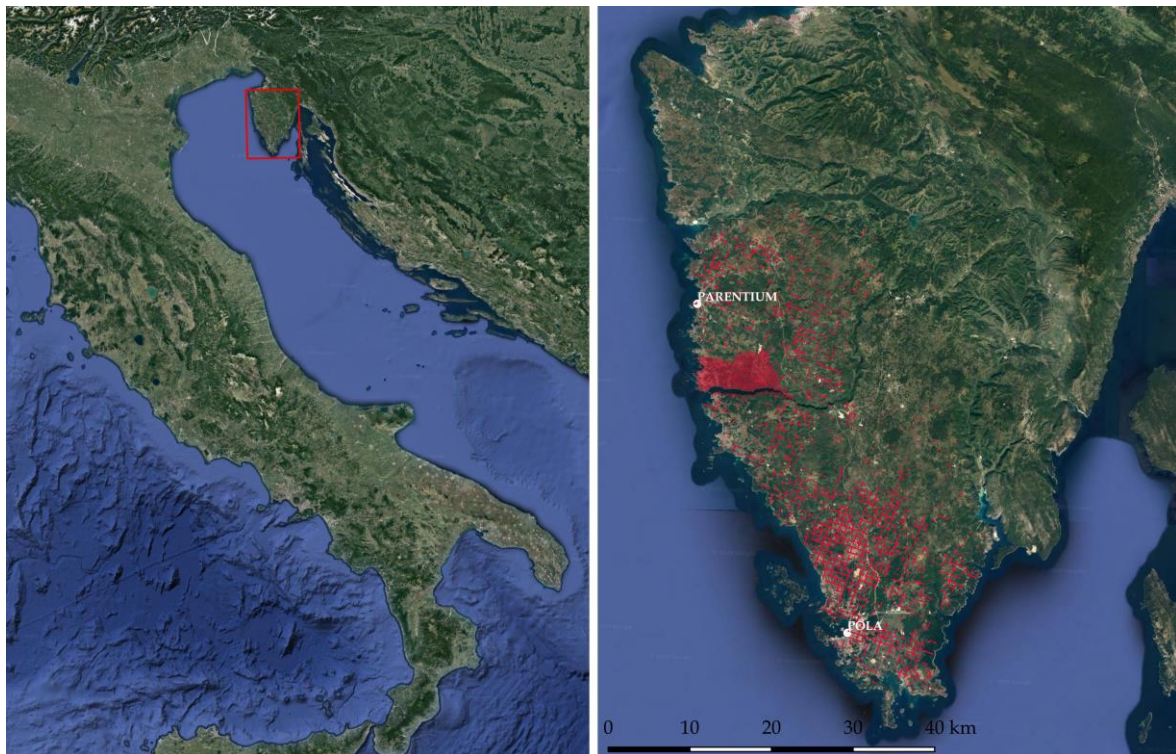


Figure 1. Position of the Istrian peninsula in the Adriatic sea on the left; Position of colonies Pola and Parentium and the remains of the Roman centuriation in Istria on the right. Research area is highlighted.

In the territory of *Pola* and *Parentium* 217 *villae* are known. When the distribution of these sites is correlated with the ancient layout of the cadastre it is obvious that almost all of them are located in individual units except from 11 *centuriae* in which there are two *villae*. Most of them are situated along the coastline and natural geographic properties for accommodating safe ports or jetties played a crucial role in choosing a site for the building of these maritime villas. It cannot be claimed with certainty whether all remains of rural architecture in one *centuria* were parts of the same estate, or adversely, that ones identified in neighbouring units were not a part of the same landholding system which did not change a lot through

time. *Centuriae* do not define the boundaries of the properties and cannot be the criterion for determining ownership relations because holdings enlarged or decreased through buying, selling, inheriting or confiscation (Matijašić, 1998, p. 312). On the other hand, *limites* and *limites intercisi* did constitute boundaries of the property.²

Even before identifying the preserved remains of the Roman land division in the Vrsar area, by just correlating the map of known villa sites and hypothetical axes of the Roman cadastre it was obvious that there is no recognizable distribution pattern. In the research area nine Roman sites are known (Figure 2): eight of them were previously known (Matijašić, 1988, pp. 61-

² For the discussion on the relationship between Roman rural architecture and centuriation, and spatial patterns of

Roman sites in the landscape see Matijašić, 1988, pp. 86-93 and Marchiori, 2013, pp. 186-209.

62; Bulić, 2014, pp. 339-340), and one was identified by surface survey within the ArcheoCulTour project (see acknowledgements). Those situated along the coastline have never been part of any systematic research, except one, in the port of Vrsar, that has been partly excavated in the 1930-ies by Mirabella Roberti (1944, pp. 56-57). He interpreted the room with mosaic as a paleochristian church, but it has recently been convincingly asserted that it was in fact a

Late Roman *villa maritima* (Tassaux, 2003). Today all coastal villas lie in a heavily urbanized area which prevents future research. Four sites situated in the interior are currently investigated by employing different non-invasive techniques as well as excavations in order to understand the character of the sites. However, the spatial distribution of Roman sites cannot be associated with their position in the modular units of the cadastre.

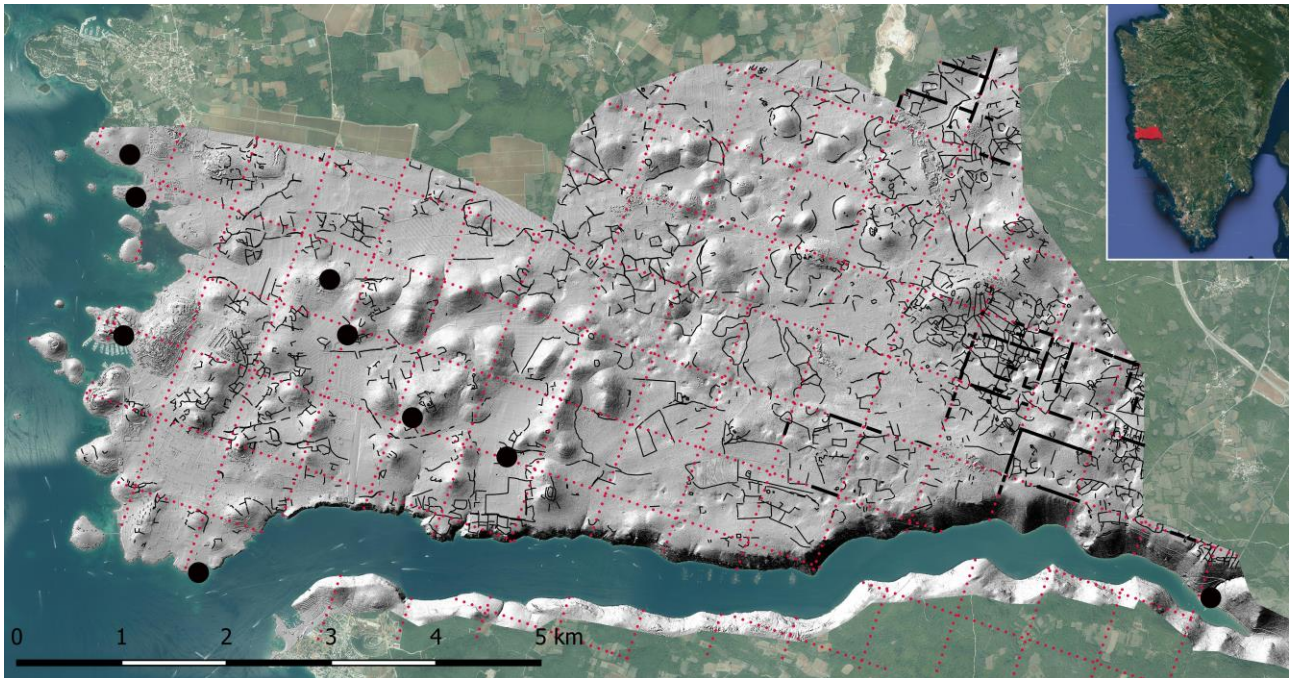


Figure 2. Position of Roman sites and identified limites in the research area (in black), hypothetical axes of the cadastre (in red)

2. ALS DATA AND INTERPRETATIVE MAPPING OF FEATURES IN VRSAR REGION

Until now the detection of the remains of Roman centuriation in Istria was done by interpreting historical aerial photographs, available satellite imagery and topographic maps. With this approach many traces were recognized through structures of the modern cadastre which succeeded the ancient one in the same planimetry. On the other hand, many remains were not detected because they were not part of the contemporary landscape patterns. For the detection of these hypothetically original constructions of *limites* essential proved the use of ALS or LiDAR, a technique which records the surface of the earth using laser scanning from an airborne platform.

³ There are numerous examples on the use of ALS data in the research of archaeological landscapes, to name a few: Opitz, Cowley, 2013; Mlekuž, 2018, pp. 85-95; Monterroso-Checa, 2017, pp. 16-21; Costa-García *et al.* 2019, pp. 19-36

⁴ This is the case on one hand because, unlike many other countries in Europe, a total scanning of the country's terri-

tory has not yet been done and thus already derived digital terrain models (DTM) cannot be obtained. On the other hand, commissioning laser scanning only for the archaeological purpose poses an unattainable cost for smaller research projects.

so that it was possible to plan the scan date when the vegetation is at its lowest, in mid-February.

The process of strip - adjustment, georeferencing and classification of the ALS points was done by the company from which the scanning was commissioned. After filtering, the result was an average of 24 last pulses per m² and 0.5 m spatial resolution of the final digital terrain model. The data was obtained in standard LAS format divided into first, last and ground points. For the Vrsar dataset the process of terrain modelling, generating different visualisations of relief models and interpretative mapping, was done in the scope of the ArchaeoCulTour project. A digital terrain model (DTM) was derived from LAS files,⁵ as well as a digital surface model (DSM) in which remains of walls and buildings were kept in the terrain. The latter was the source for the interpretation of the data, both on the scale of individual features and of the characterisation of the landscape.

The topography of the Vrsar area is typically karstic. The south-eastern part of the landscape is characterised by a relatively flat plateau with common dolinas and isolated low hills, whereas the north-eastern includes somewhat higher sparse hills. The western part of the territory is characterised by hills organised in a typical polygonal pattern, with star-shaped cockpit depressions among hills. The sides of the Lim bay -which is in fact an old river valley flooded by the sea- become higher and steeper from the western coastline towards the inland, becoming subvertical at the bottom of the bay (which coincides with the end of the study area).

When interpreting ALS data archaeological features can be easily overlooked (due to their size or aspect) if the interpretation is based only on the hill-shaded image derived from DTM. To avoid this, visualisations techniques were developed especially for archaeological purposes. For example, *local relief model* (LRM) which gives better results for identification of anthropic features in the terrain with small elevation differentiation or topography with gentle slopes, and *sky-view factor* (SVF) in more rugged terrain (Kokalj *et al.* 2013). For detection of dry stone structures, the main features of the anthropic landscape on the eastern Adriatic coast, both of these visualisations play a key role. For our study area⁶ SVF and *positive openness*⁷ in combination with *slope* proved to be crucial visualisation for mapping extant structures (predominantly walls - whose width can be easily evaluated due to their sharp edges). LRM

visualisation was invaluable for dilapidated stone features which can now be distinguished from the surrounding terrain only as small differences in height.

The interpretative mapping of dry-stone structures was carried out in GIS environment, followed by verification in the field. Every dry-stone structure visible on the ALS model was mapped in order to unravel the historical depth of the landscape. Consequently, a multi-temporal spatial organisation of the landscape was detected. The walls, as well as paths and hollowways, were mapped by lines because dry-stone structures are not very complex in this study area and are almost always linear. Different properties were added to each line in the attribute table: state of preservation, function, and, where possible, the period in which the structure was erected. Round barrows are less frequent and were mapped by polygons. This map represents the basic tool in reconstructing the diachronic evolution of the anthropic landscape, to be integrated with archaeological and historical data.

3. DIVISIONS OF THE ROMAN CADASTRE

Unlike many examples where different methodologies and approaches are discussed in an attempt to prove the existence of Roman centuriated cadastres (exp. Palet, Orengo 2011), the Istrian example is somewhat straightforward. Among many different built structures detected and mapped from ALS data, those belonging to Roman centuriation were easily identified because of their regular alignment and uniform size of modular units. 5129 meters of structures were detected on the main axes of the presumed cadastre. Different types of structures forming this regular layout could be differentiated by interpreting the ALS data. There are two main groups of remains:

1. The grid consists of present-day anthropic features - e.g. modern field boundaries that follow the ancient layout (Figure 3). These are standing walls whose sharp edges can be recognized on ALS.
2. The grid consists of structures which do not have any reference with the modern cadastre (Figure 4). Hypothetically, these are remains of the original Roman *limites* which were not subjected to major changes. They can be detected on LRM visualization as 3 - 4 meters wide features without sharp edges.

⁵ We would like to thank dr. Dimitrij Mlekuž for providing us with the software he developed for this purpose.

⁶ For the Vrsar study area different visualisations of the DSM were derived using Relief Visualisation Toolbox (Zakšek *et al.* 2011; Kokalj, Somrak 2019).

⁷ Doneus (2013) stresses the importance of openness as an additional visualization technique because it is not subject to directional bias and is useful for delineating both convex and concave features.

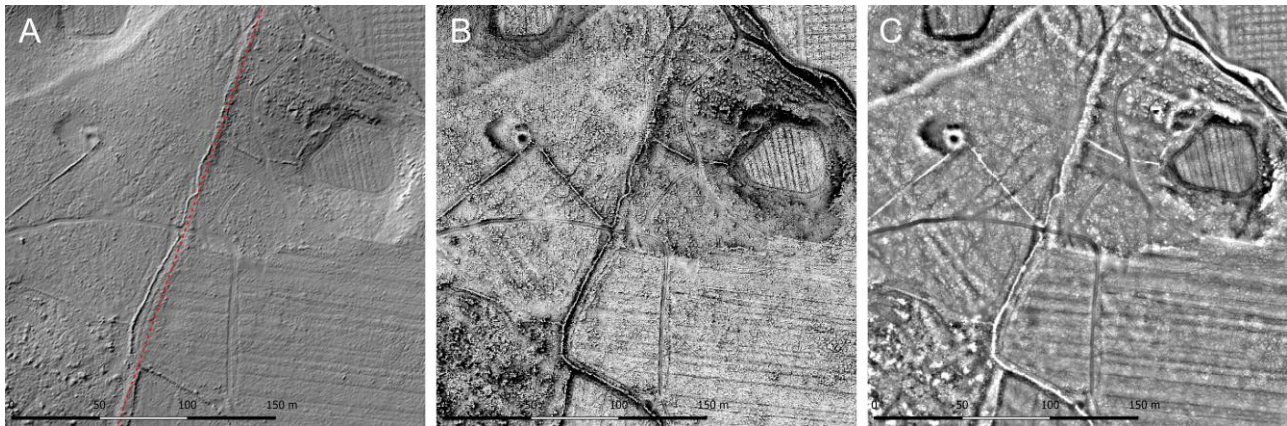


Figure 3. Example of *limites* visible through modern structures on ALS: A - hillshade, B - SVF visualization, C - LRM visualization

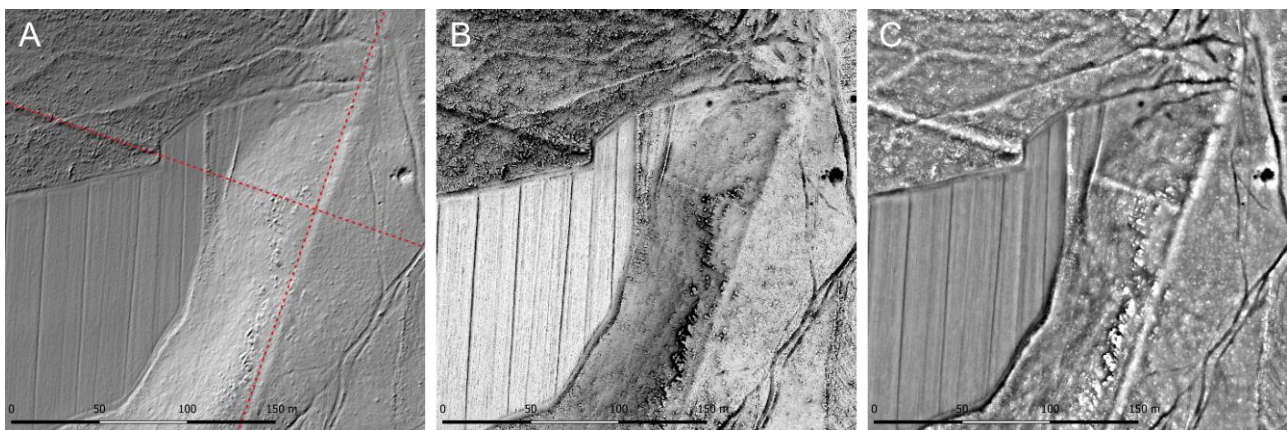


Figure 4. Example of remains of original *limites* on ALS: A - hillshade, B - SVF visualization, C - LRM visualization

Limites are best preserved in the eastern part of the study area, as alignments situated NE of the village of Kloštar and by another cluster of lines north of the village of Begi on the northern edge of the research area (Figure 2). The reason for variations in preservation state of Roman cadastre features in different parts of the study area is due to different land use history.

3.1. Subdivisions

Besides many detected structures on the main axes of the Roman cadastre, there are numerous ones (2643

meters) which do not deviate from this regular grid but do not coincide with the main axes, therefore are possible subdivisions. However, they are not uniform in size or alignment. There are four modular units where both subdivisions and structures on the main axes of the cadastre are (partially) preserved (Figure 5). In each of them the inner division was not positioned in the same way.

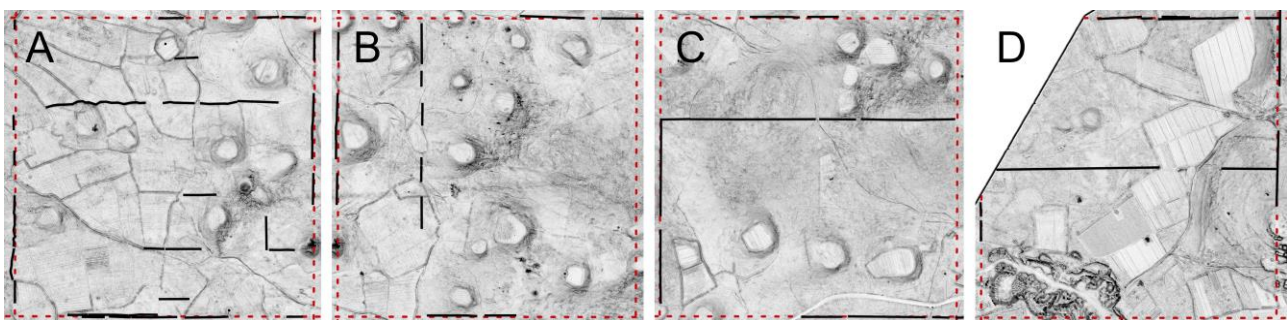


Figure 5. Examples of subdivisions



Figure 6. Surface manifestations of *limites*

In the first case (Figure 5A) few longitudinal (oriented E-W) subdivisions are preserved but are not regularly spatially distributed. First longer structure (preserved as consecutive modern field boundaries) spreads almost the entire length of the *centuria*. It is exactly 200 m distant from the main northern axis. Other parallel E-W structures in this *centuria* (ruins of stone walls) are 415,7 m and 545 m distant from the same main axis. In the first adjacent modular unit (Figure 5B) only one structure is parallel to Roman land division layout. This transversal (oriented N-S) construction is 198,5 m distant from the main eastern axis. There is no observable trace of any structure that could indicate the existence of other subdivisions in this unit. The same situation recurs in two other modular units. In each of them there is only one longitudinal structure dividing the *centuria* in two parts. In the third example (Figure 5C) the structure is 238 m distant from the northern axis. The fourth example (Figure 5D) is the only one where the unit is divided into two almost equal parts. The structure is 355,2 m distant from the north axis, and 352,5 m from the south axis.

There are two more modular units which have remains preserved on the main axis of the land division. They present no traces of any inner divisions even though the units are positioned in areas of mainly thin soils (without traces of ploughing) which means that they could have had a greater probability to be preserved.

4. GUIDED STRUCTURAL SURVEY

After the interpretation of ALS data, remains of the Roman *limites*⁸ were inspected in the field. The terrain was systematically surveyed, every day covering certain parts of the study area by guided approach. This implies targeting features previously identified and mapped.⁹ The majority of the structures on the Roman land division axes would not be recognized in the field without this approach: linear structures usually differ only slightly in height from the surround-

ing terrain, and dense vegetation does not favour direct observation. A GPS track was recorded while walking and photographs were also taken with spatial information attached which enabled importing the collected data into the GIS database. While conducting the structural survey, again because of the dense vegetation, remains could not be followed along their entire length so the type of structure was documented where it could be approached. Later, a certain length of line was associated with the attribute of type in GIS.

While documenting in the field, special attention was paid to *limites* which are not modern field boundaries, but features associated with 'original' structures of Roman *limites*. All of them appear uniform on ALS data and are visible as 3 – 4 meters wide ridges without sharp edges (Figure 4). However, structural survey carried out in the field showed that they differ in surface manifestation.

Most structures are preserved in zones (today often naturally re-afforested) of rock outcrops interspersed with thin soils, which separate widespread dolinas where soils are obviously thicker. In these areas the *limites* are marked by stone structures, which can be divided into three categories according to their state of preservation:

- Individual stones – only scattered stones can be observed on the surface. The linear structure cannot be detected in the field because it is not elevated above the surrounding territory.
- Ridge with visible stones (Figure 6A) – the linear feature can be detected in the field – once identified in the DSM – because it is slightly raised above the surroundings. Individual stones are also visible on the surface. This is the most common type of documented structure.
- Linear stone barrow (Figure 6B) – the structure is slightly raised from the surrounding terrain as a low linear stone barrow. Alt-

⁸ All identified built structures were recorded during the structural survey, as well as natural features which could have been used by people in the past (e.g. caves and sink-holes).

⁹ This was possible by loading the ALS data in kmz format into handheld GPS devices.

though the stone pile is visible, without excavations it cannot be defined as built because the two faces of the wall are not visible. For now, a linear barrow is detected only in one location – not on the main axis but on a subdivision line of modular unit.

In only very few instances *limites* remains identified on ALS cross cultivated areas or are located on their border. These structures were defined as earthworks in the field.

- Earthwork (Figure 6C) – linear soil barrow (covered with dense grass), clearly elevated

above the surrounding terrain. There is presumably a built wall under the soil,¹⁰ but stones are not visible on the surface. Even though these fields are not cultivated today (traces of former cultivation are visible on ALS and in the field) they are still not reforested and therefore these structures can be followed in their longest lengths.

The information on the type of structure gathered in the field was attributed to the GIS drawing of Roman *limites*. Structures identified on ALS that could not be recognized in the field, as well as examples where the structure could not be approached because of dense vegetation (Figure 7) were also marked.

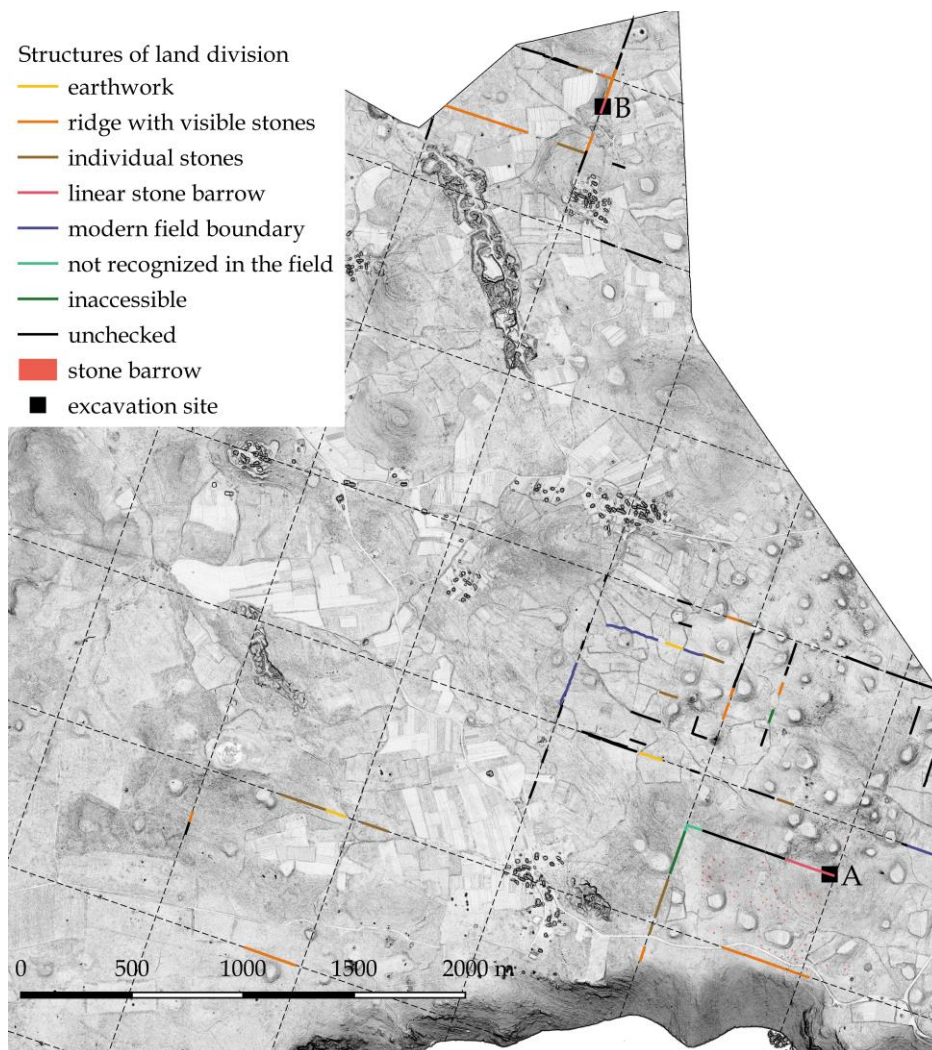


Figure 7 Types of structures on land division axes

5. EXCAVATIONS OF *LIMITES*

Two test excavations were carried out following the results of structural survey, in order to verify how

Roman *limites* were constructed. The first chosen location was not on the main axis of the Roman land division, but on a subdivision line where remains of a

¹⁰ This can be concluded because in a place where the earthwork is cut by modern ploughing a stone clearance pile is built.

linear stone barrow were likely to 'hide' better preserved remains of the original structure (Figure 7A). This barrow extends continuously for 700 meters, almost exactly the length of one Roman *centuria*, and it does not continue into neighbouring modular units, neither east nor west. It is perfectly aligned with the cadastre, at a distance of 238.6 meters (measured from the centre of the structure) or 80.6 Roman feet from the nearest northern main axis. On the western end it bends sharply southwards along the main NE-SW axis, forming a 90 degrees angle (clearly identifiable on ALS data). This perpendicular structure also ends here and does not form the NE corner of the main modular unit.

The test excavation was situated where the eastern end of the structure lies over the top of a low hill covered with dense young wood and included an area where one face of the wall was possibly marked by some outcropping stones. The faces of the original dry-stone wall and of its infill of smaller stones were founded directly on the bedrock (Figure 8). The whole

feature is 1.6 m wide and 2-3 rows of stones are preserved *in situ* over a height of 0.5m. Considering the volume of the collapsed stones, the original wall could not have been higher than 0.8-1.0m. The wall collapse spreads more to the south, where the slope of the hill is steeper and favours the accumulation of the collapsed parts. To the north, the collapse stones were lying on a thin reddish-brown soil or directly on the bedrock, whereas on the southern side the soil was somewhat darker and deeper.

A surprising number of pottery fragments were found in soil deposits, but also in the cracks of the bedrock, on both sides of the wall. North of the wall there were 56 small fragments (from which 10 were extracted from bedrock cracks) and on the south side 20 sherds (from which 7 were extracted by breaking the geological substrate). All pottery fragments are of the same type – coarse ware which can be tentatively ascribed to the Bronze Age. Two fragments of the rim of a bowl found on the south side of the wall could be dated to the Middle Ages, testifying to repeated land use of this territory.

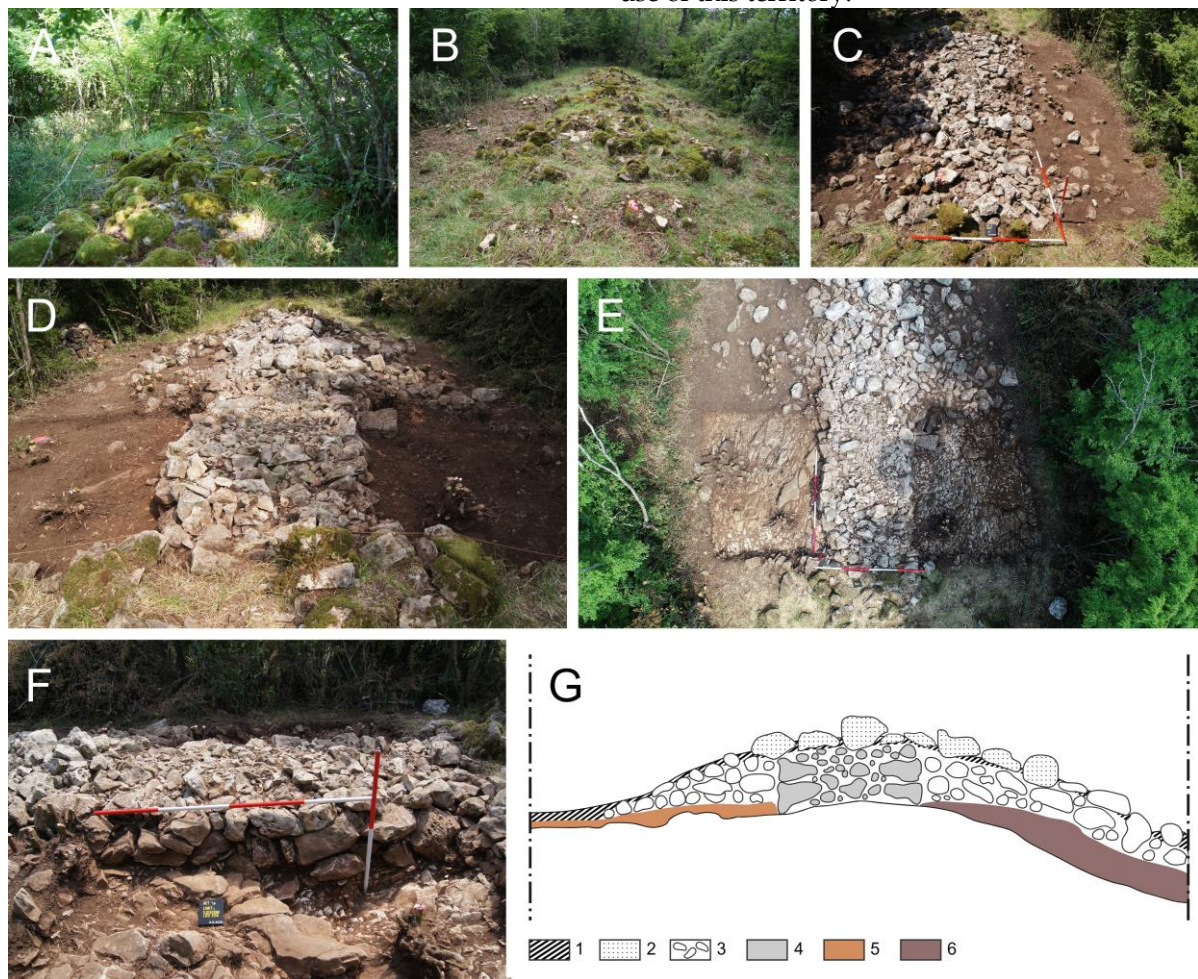


Figure 8. Excavation of limites. A: Excavation area before clearing; B: after clearing; C: after vegetation and topsoil removal along a 20m-long portion of the feature; D: structure defined after removal of the collapse; E: vertical view after the excavation of soil; F: northern face of the dry-stone wall; G: profile through the wall; 1: topsoil; 2: recent stone clearing blocks; 3: collapse; 4: original wall; 5: reddish soil; 6: dark soil. North is to the left.

The second test excavation was located on the main axis of the Roman cadastre north of the village of Begi (Figure 7B) where 440 m of continuous linear structures were detected by interpreting ALS data and structural survey. The feature, raised above the surrounding terrain, was easily identifiable in the wood. After removing vegetation, topsoil and a small stone barrow originated by recent clearing, the remains of a 3.8 m wide wall were put into light. However, the feature was not preserved well enough to understand its original structure. Some stones on the western side of the structure were placed more or less regularly on the bedrock, possibly representing the first row of the wall face. The eastern face could not be detected, and no artefacts were found in the excavated sediment.

6. CONCLUSION

A combination of techniques and procedures was employed in the territory of Vrsar municipality in Istria, within the framework of the ArchaeoCulTour

Project, in order to improve our understanding of the Roman cadastral system, as well as of the constructions of single *limites*. Until now, the layout of ancient land division was most often indirectly visible through structures of the modern cadastre, such as the modern field boundaries and roads. ALS data proved to be essential to detect traces of centuriation in wooded areas and where the modern cadastre does not follow the ancient features. By integrating ALS data, field survey and excavation tests it was ascertained what structures are remains of the original Roman *limites*. Even though all these features are identical in LRM visualisation, structural survey in the field showed different preservation states – from indistinct remains to evident linear stone structures. It can be concluded that the remains of all *limites* are linear dry-stone features and that in this study area only one wall marks the boundary between two neighbouring *centuriae*.

ACKNOWLEDGEMENTS

The current three-year project “The Archaeological Landscape in a Sustainable Development of Cultural Tourism in the Municipality of Vrsar – ArchaeoCulTour” started in 2018. The aim of the project is the identification of the historical landscape and the assessment of its potential for further research and presentation. The project is part of the Croatian Science Foundation's ‘Partnership in Research’ programme and is financed by the Foundation, the Vrsar municipality, Vrsar Tourist Board and Maistra tourist company. It is conducted by the Juraj Dobrila University of Pula; the project director is prof. Robert Matijašić.

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