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Rediscovering the Lost Roman Landscape in the Southern Trieste Karst (North-Eastern Italy): Road Network, Land Divisions, Rural Buildings and New Hints on the *Avesica* Road Station

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Abstract: An interdisciplinary study of the ancient landscape of the Trieste Karst (north-eastern Italy) is presented in this paper. Airborne Laser Scanning (ALS) has been applied to obtain high-resolution topography of the 25 km^2 investigated area in order to identify potential archaeological anomalies. The ALS-derived high-resolution Digital Terrain Models have been visualized and managed using QGIS and Relief Visualization Toolbox. Possible archaeological anomalies have been verified through field surveys and interpreted using a multidisciplinary approach mainly based on the collection of associated archaeological materials and geomorphological and stratigraphic evidence. From a methodological perspective, the elaboration and study of ALS-derived images, and in particular the local relief model visualization, combined with the collection of Roman shoe hobnails, have proven to be effective approaches for the certain identification and dating of Roman roads in karst environments. The obtained results have revealed an almost completely unknown Roman landscape: the investigated area was crossed by important public roads, whose layout has been accurately reconstructed for a total length of over 10 km, and occupied by large country estates, sometimes enclosed within boundary walls perfectly fitting the Roman land division grid. One of the identified buildings could correspond to a road station, perhaps the *Avesica* known from ancient itinerary documents—i.e., the *itinerarium Antonini Augusti*—due to its position and proximity to a major road junction.

Keywords: north-eastern Italy; Trieste Karst; airborne laser scanner; archaeological surveys; Roman landscape; shoe hobnails; roads; road station; centuriation; rural buildings; *Avesica*

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1. Introduction

Airborne Laser Scanning (hereinafter ALS), also known as Light Detection and Ranging (LiDAR), has revolutionized archeological prospections due to its capability to provide high-resolution topographic data of areas covered by vegetation, where other remote sensing methods are generally not effective [1–4].

Recent interdisciplinary and extensive studying of the ancient landscape of the Trieste Karst (north-eastern Italy), mainly based on ALS combined with archaeological surveys and small-scale excavations, allowed to significantly advance our knowledge about the geomorphology, archaeological topography and history of this territory, as well as about early Roman military architecture. This effort, still ongoing under the project called *Karstscape*, has been shading light on Late Prehistoric land divisions and settlement systems (roughly dating back to between the 3rd–18th centuries BC) [5–7], the Roman expansion west of *Aquileia* with the identification of some of the oldest known Roman camps, Roman centuriation, road network and rural buildings (roughly dating back to the Late Republican period, approximately 1st–2nd centuries BC, and to the Imperial period, approximately 1st–5th centuries

AD; [5,8–12]). This paper presents the results of the continuation of such efforts in a large sector north-west of the Grociana piccola Roman camps and surrounding territory (Figure 1), which was thoroughly investigated in the last years [5–12]. The identification of stretches of important Roman routes and land divisions pushed the author to look for their continuation. This paper has, therefore, to be considered as part of the larger *Karstscape* project aiming at identifying and interpreting the complex palimpsest produced over the centuries by the close interaction between man and the environment in the whole Trieste Karst.

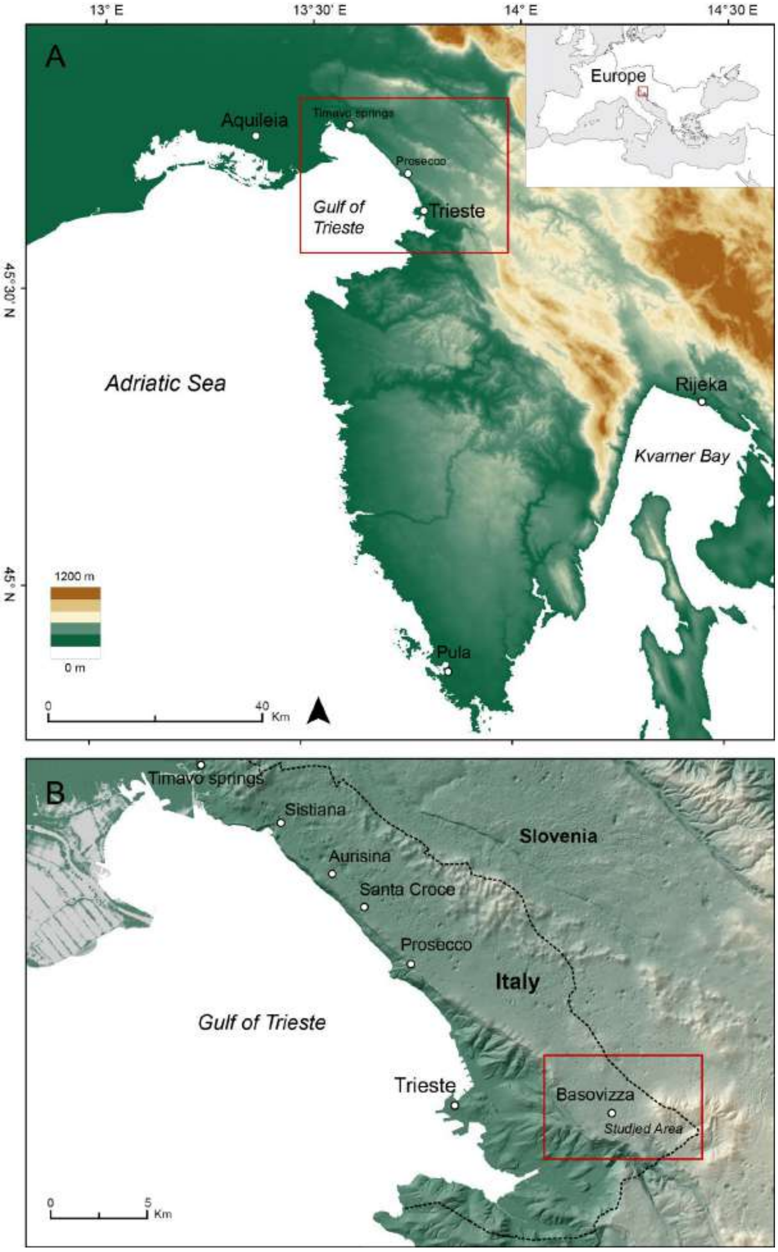

Figure 1. Position of the investigated area (**A**) and main localities mentioned (**B**) in the paper. Figure modified from [9].

The main aim of the paper is reconstructing the past Roman landscape in a large Karst area. To achieve such scope, ALS has been applied to virtually remove the vegetation and to obtain high-resolution topography of the investigated area in order to identify potential archaeological anomalies. The latter have been verified and interpreted using a multidisciplinary approach mainly based on the collection of associated archaeological materials and geomorphological and stratigraphic evidence.

At the same time and on the basis of the new data collected on the ancient road network, I also focused on the long-debated identification of a Roman road station called *Avesica*—mentioned in the *itinerarium Antonini Augusti* [13]—situated along the road from *Aquileia* to *Tarsatica*, today's Rijeka (Croatia).

The *itinerarium Antonini*, one of the few Roman itinerary sources that has survived to this day, is a register of the stations and distances along various roads of the Roman empire. The original drafting of the document dates back to the Late Roman Imperial period, more precisely to the 4th and 5th centuries AD [14,15].

1.1. Geological and Geomorphological Background

The studied area covers a surface of about 25 km^2 (Figures 1 and 2) and is located in the south-eastern part of the Classical Karst Region, where limestone belonging to the Palaeogene sequence of the Adriatic Dinaric Platform outcrops [16] and the geological sequence spans from Upper Cretaceous to Middle Eocene [17]. More specifically, marls and sandstones of the Eocene Flysch formation outcrop just in the south-western sector of the studied area, bioclastic limestone rich in rudists (Upper Cretaceous–Upper Paleocene) outcrops in the north-eastern part, while gray and hazelnut-colored fossiliferous limestone (Paleocene–Early Eocene) outcrops in most of it [17].

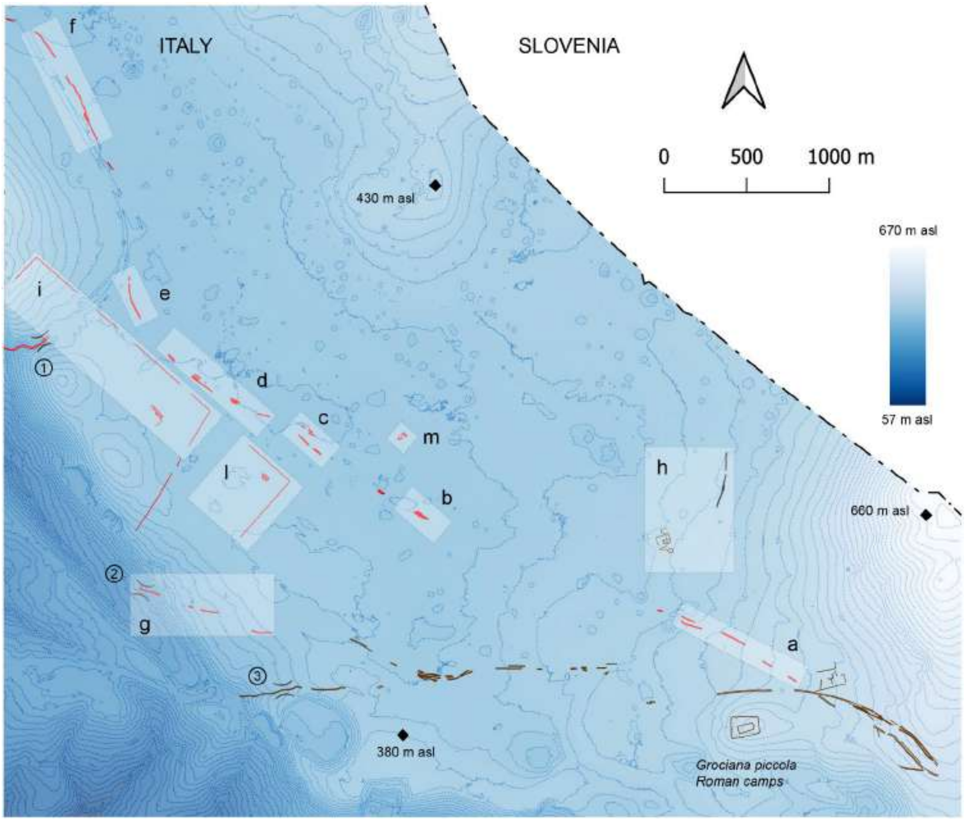

Figure 2. ALS-derived DTM with 10 m-contour lines of the investigated area showing the main identified Roman archaeological features (red lines). Those already detected and studied by Bernardini et al. [9] are shown in dark brown. **1**: Monte Spaccato pass; **2**: point where the road from Grociana piccola to *Tergeste* leaves the Karst plateau; **3**: pedestrian path known as *scala delle vacche*.

The area is dominated by a karst plateau, locally remodeled via modern engineering and architectural structures and trenches of the First and Second World War. The plateau has an average height of about 370 m a.s.l.; the highest elevation is Mt. Cocusso (674 m), while the south-western sector is characterized by steep slopes, dipping towards the Trieste gulf (Figure 2). The vegetation mainly consists of black pine, downy oak and European hornbeam trees mixed with large areas covered with grassland and bushes [18]. No surface water or rivers occur in the studied area besides a few small man-made ponds.

1.2. Archaeological Background

The archaeological topography of the studied area was largely unknown [19] before recent laser-based remote sensing studies [5,8,9]. The latter made it possible to identify the Roman Republican camps of Grociana piccola, a large rural building north of it, land divisions from the Roman era and the remains of an important Roman road, which passes a few tens of meters north of Grociana piccola in an east–west direction and then turns south towards Rijeka in the Kvarner bay. These structures, already published in recent years, are shown in brown in Figure 2.

With the exception of some archaeological caves (https://criga.divulgando.eu/, accessed on 20 December 2022) and a short segment of a possible Roman road at the Monte Spaccato pass (Figure 2; [20,21]), no Roman infrastructures or rural buildings were known from the area. For this reason, starting from the known evidence, an attempt has been made to understand how the road system developed from the strategic Grociana piccola crossroad. More in detail, the research tried to understand where the road axis identified to the north of the camps [9] descended from the Karst plateau to reach Trieste. At the same time, from Grociana piccola it seemed logical to expect a direct way towards *Aquileia* and another one, suggested by numerous *caliga* hobnails (nails attached to the soles of Roman shoes; see below) found on the surface [9], directed towards *Emona*, today's Ljubljana in Slovenia, through the Razdrto pass (ancient *Ocra*; [22]).

Considering the available archaeological data and ancient itinerary documents, the Trieste Karst was crossed by two main Roman public roads, leading from *Aquileia* to Trieste (ancient *Tergeste*) and from there to Pula (ancient *Pola*; Croatia), in the southern Istrian peninsula, and to Rijeka (ancient *Tarsatica*) in the Kvarner bay in Croatia (Figure 1). According to most scholars and hard archaeological evidence [23–25], the two roads followed the same route for about 15 km, from the Timavo springs (*Fons Timavi*) at the north-western edge of the Karst to the Prosecco village, where it divided into two forks. One went down to Trieste and from there on towards the Istrian peninsula, while the other one continued to Rijeka through the Karst plateau behind Trieste (Figure 1). Other researchers have speculated that the above road division occurred about 2 km south-east of the Timavo mouth, in correspondence of the Duino village [26], but this hypothesis is not accepted by most scholars [23–25].

An additional road, very likely following a pre-Roman route, branched from the main one in correspondence to Sistiana and led to nowadays central Slovenia passing through the central Karst ridge, probably between Zolla and Monrupino [24,25].

According to the *itinerarium Antonini,* after the road station at the Timavo springs, identified by some scholars with the large residential complex of the so-called Villa del Randaccio [19,27], there was another station, called *Avesica*, indicated along the road to *Tarsatica* at a distance of 12 Roman miles, at the same distance that the itinerary places between the Timavo springs and *Tergeste* on the road to Pula. The location of *Avesica* has been debated since the mid-nineteenth century. Kandler proposed placing it at San Pelagio or Voucigrad (see references in [28]), others in Zolla [26,29]); most scholars have argued for the identification with Prosecco [23,27,30,31]. There are other hypotheses including one placing it in Basovizza (see references in [28]), which lies in the investigated territory (Figure 1).

2. Materials and Methods

Considering that the investigated area is covered by bushes and woods and is mostly part of a karst plateau, ALS has been selected as the most effective and promising method in such a type of environment, where other techniques, such as aerial/satellite photography and UAV structure from motion photogrammetry, are seriously limited by the vegetation canopy [1–4].

2.1. ALS

ALS data, originally provided by Helica Company for the Civil Protection of Friuli Venezia Giulia, were acquired during autumn and spring seasons using a Laser Terrain Mapper (ALTM) Optech 3100 and other instruments mounted onto a helicopter with a flight altitude of 500 m above ground level. The data of the studied area, featuring no less than 16.5 points per square meter with a vertical precision of 16 cm in open fields, were processed using the free open-source software System for Automated Scientific Analyses (SAGA). The LAS files were imported into SAGA as point clouds, from which the points belonging to the ground were extracted and then interpolated to produce 0.5 m-resolution Digital Terrain Models (DTMs). More in detail, the LAS files have been imported into SAGA as point clouds, from which the points belonging to the ground (class 2) have been extracted using the module "point cloud reclassifier, subset extractor". In order to merge different grids, a new grid system, covering the entire investigated area, has been created using the module "grid tools create grid system", and the cell size has been set at 0.5 m. Then, the data have been rasterized using the module "grid gridding, shapes to grid". The raster thus obtained shows numerous empty cells, corresponding to areas not detected by the laser pulses. These cells have been closed through an interpolation process using the module "grid tools, close gaps". This operation produces a continuous raster, the DTM. All DTMs were then processed using the open-source QGIS software and Relief Visualization Toolbox [32,33] to produce a number of different visualizations (multiple and combined shaded reliefs at different light conditions, slope, local relief models and contour maps). The resulting maps, the available historical cartography—in particular, a version of the 19th century Franciscan Cadastral Maps—were managed, visualized and analyzed using QGIS.

Advantages and weaknesses of the available visualization techniques of ALS data are described in detail in several contributions (e.g., [34,35]) and are out of scope here. However, it is worth specifying that in most of the figures, the identified features are illustrated by using multiple-hillshading (number of directions: 16; sun elevation angle: 35°) and simple local relief model (20 m search radius) visualizations associated with the vectorized plan of the structures superimposed onto orthophotos or historical cadastral maps. Hillshading, slope and local relief models are considered some of the best visualization techniques for most circumstances (e.g. [32,34–36]).

All of the main features identified in QGIS were checked on the ground through field walking to verify, when possible, their building technique and degradation and to pinpoint potential stratigraphic relations with other structures and possible associated archaeological materials following the methodology developed in other areas of north-eastern Adriatic (Italy, Slovenia and Croatia) and described in previous contributions [5–12].

2.2. Reconstructing the Ancient Road Network

Particularly useful for the reconstruction of the Roman road network is the methodology developed by Bernardini et al. [9], based on ALS-derived images combined with the collection of Roman shoe hobnails during surface surveys.

Local relief model visualization, setting a local scale of elevation values, allows to enhance small-scale relief variations [32,34], making it an effective tool for the investigation of ancient roads [37].

The shoe hobnails were attached to the soles of shoes so as to increase their durability and improve their grip on the ground. Their underside is often characterized by the presence of marks, generally consisting of lines and/or circular protuberances [9,38–40]. Such artefacts not only allow to confirm the presence of an ancient path or road, but also to date it to the Republican or Imperial Roman phases based on the pattern present on the underside of such tiny artefacts. According to the typology of the hobnails from Alesia, type A does not have a pattern on the underside, type B has several linear signs, type C a series of spaced large dots and type D linear signs and dots. Type E, with numerous circularly arranged small dots, has been additionally defined. Hobnails of Alesia types B, C and D are well attested in Late Republican military sites in the period between Caesar's campaigns in Gaul and the beginning of the Augustan period [9,38,39]. However, Alesia type D hobnails have recently been reported from Lampourdier, the probable battlefield of Arausio (105 BC; [40]). During the middle and late Augustan periods, the dots of type C became smaller and multiplied. Type E hobnails with very small circularly arranged dots probably stand at the end of this development in the 1st century AD ([9], with the relevant literature). Type A was in use for a long time during the Roman period.

3. Results

The elaboration of ALS DTMs made it possible to identify several kilometers of road network, in many cases detectable as large road tracks lower than the surrounding topographic surface and produced by the prolonged passage of carriages. In some areas several sub-parallel tracks, covering tens of meters, are preserved, suggesting they shifted over time (Figure 2e). The existence of such large belts crossed by multiple road tracks in the Karst was already recognized along the road west of the Grociana piccola hill, more precisely, immediately west of the Foiba di Basovizza ([9], supplementary Figure S10).

The evidence collected confirm the strategic importance of the crossroad just north of Grociana piccola hill. Based on the new data, the road identified north of the Roman camps continued almost straight westward and descended towards Trieste at the current village of Longera (Figures 2g and 3; hereinafter conventionally labelled as road 1 or *Tergeste*–Grociana piccola). Still immediately north of Grociana piccola, the road that led from *Tarsatica* to *Aquileia* continued north-west (Figures 2a–f and 3; hereinafter conventionally labelled as road 2 or *Aquileia*–*Tarsatica*). Finally, another route to present-day central Slovenia via the Razdrto pass (the ancient *Ocra*) branched from *Aquileia*–*Tarsatica* in the same area (Figures 2h and 3; hereinafter conventionally labelled as road 3 or Grociana piccola–*Emona*). Very close to the Grociana piccola crossroad a big rural structure was already identified by Bernardini et al. [9].

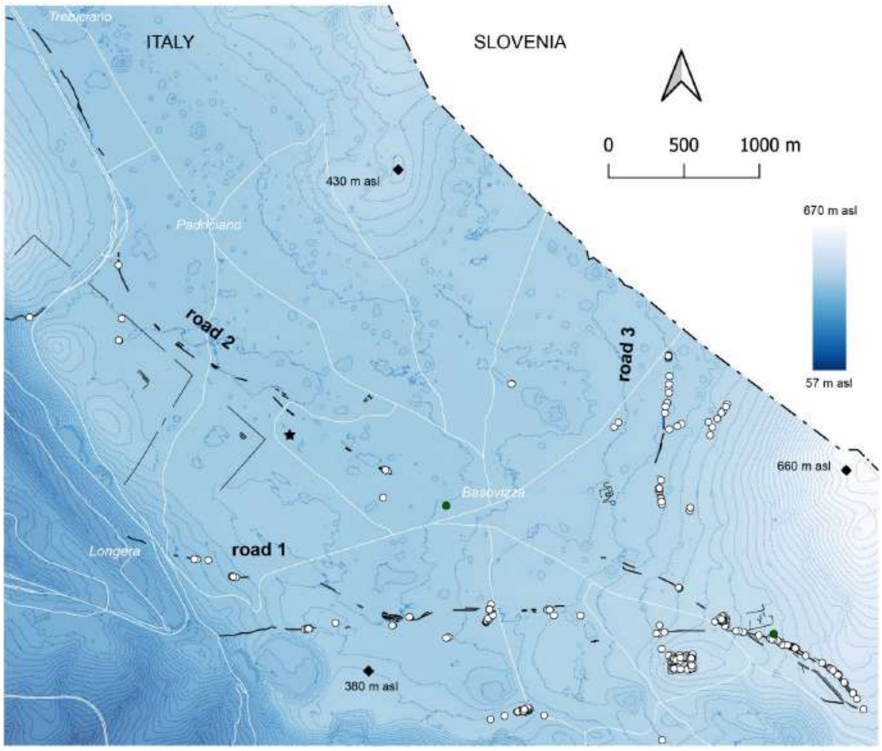

Figure 3. Main archaeological features in the investigated area (black lines) and associated Roman finds: shoe hobnails (white circles); coins (green circles); possible graveyard (black star). Modern roads and locations of modern villages are shown in white.

Two other large structures, probable Roman rural buildings, have been identified in the central-western part of the investigated area (Figure 2i–l). Interestingly enough, both are surrounded by the remains of a boundary wall which probably delimited the pertinent lands. As described below, the north-eastern side of these walls fits perfectly within one of the centuriation axes of the Trieste area ([9], Supplementary Figure S15; [41]).

On the ground, all these features correspond to topographic anomalies such as bumps or ridges covered by grassland and modern land division walls.

The attribution of the road tracks to the Roman period is confirmed by the numerous *caliga* hobnails, collected especially in the A, B and G sectors of Figure 2, stratigraphic evidence, numismatic finds and by the discovery of remains possibly attributable to a graveyard not far from the *Aquileia–Tarsatica* road section (Figure 3). The *caliga* hobnails published here for the first time are added to those collected in the last years [9] in the investigated area for a total of almost 400 artefacts.

The identified features are presented in detail in the next paragraphs together with the associated archaeological artefacts.

3.1. *Aquileia–Tarsatica*

Most of the identified road segments belonging to this route correspond to sectors A–F represented in Figure 2 and are illustrated in the following figures.

Immediately north-east of Grociana piccola and a little further north of road 1, a concentration of dozens of *caliga* hobnails had been identified in an area used as a parking lot [9]. Their presence is due to the fact that the continuation of road 2 in the direction of *Aquileia* should be placed right here. This is demonstrated by the new road sections identified in area A (Figure 4). Along one of them, some *caliga* hobnails without any signs have been found (Figure 5, nn. 1–3), confirming the Roman attribution of the route.

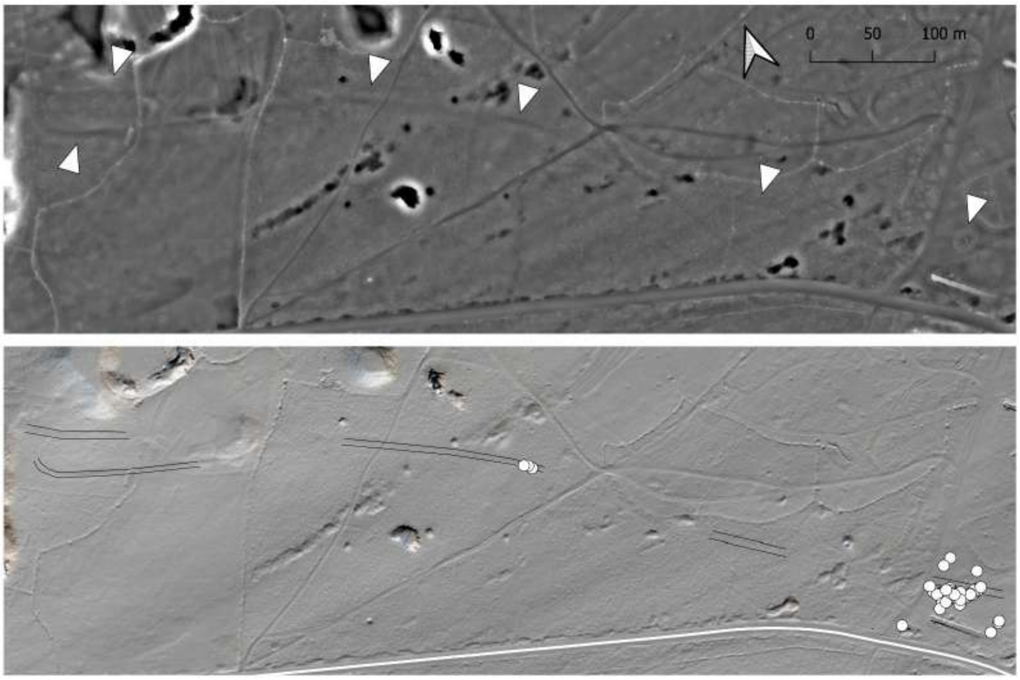

Figure 4. Zoomed view of area A of Figure 2 with the position of road tracks indicated by white arrows in the upper picture (local relief model of an ALS-derived DTM) and by black lines in the lower one (hill-shaded image of an ALS-derived DTM). White circles: *caliga* hobnails; white lines: modern roads.

After an interruption of just over a kilometer, due to the presence of the village of Basovizza, which erased the traces of the road (Figures 2 and 3), its remains have been identified in sector B of Figure 2. Here several subparallel tracks, covering an area about 30 m large, are visible (Figure 6). As most of the features presented in the paper, they are covered by modern land divisions and associated with Roman artefacts. More in detail, three hobnails, two of them of type A and one belonging to type E, have been discovered (Figure 5, nn. 4–6). Additionally, a small iron socketed artefact was found (Figure 5, n. 7).

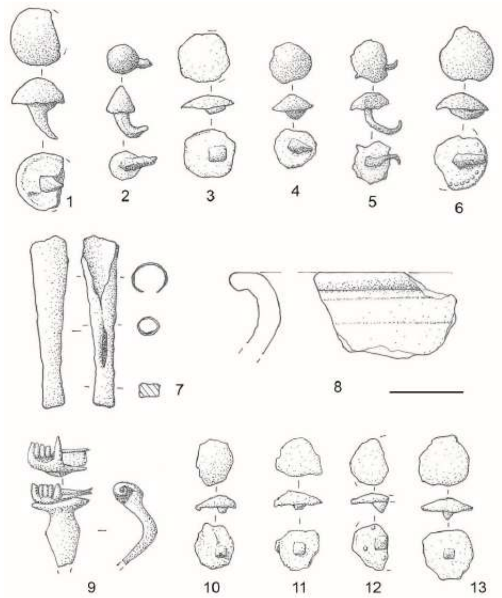

Figure 5. Archaeological materials from road 2 and immediate surroundings. **1**–**3** from area A; **4**–**7** from area B; **8**–**9** found between area B and C (for the finding spot see the star in Figure 3); 10 from area E; **10**–**13** from area I. Scale bar: 2 cm; drawings by A. Fragiacomo.

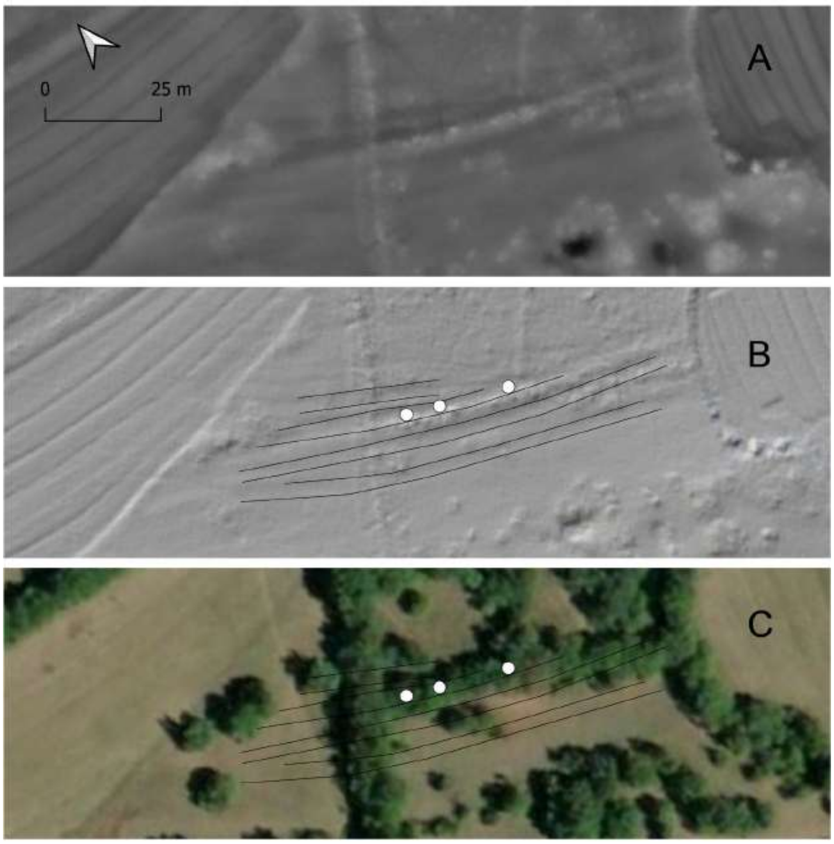

Figure 6. Zoomed view of area B of Figure 2, where several subparallel road tracks have been identified. The position of road tracks is indicated by black lines in pictures (**B**) (hill-shaded image of an ALS-derived DTM) and (**C**) (satellite image). Picture (**A**) is a local relief model of an ALS derived DTM. Associated *caliga* hobnails are indicated by white circles.

Between sector A and B, just west of the center of Basovizza (Figure 3) and very close to the road 2 path, a Bronze As of Tiberius, minted in Rome between 22 AD and 30 AD (*RIC* I^2, [42], p. 99, n. 81; classification by B. Callegher of Trieste University), was found at the beginning of last century by a local inhabitant (Figures 1, 3 and 7).

Figure 7. Bronze As of Tiberius, minted in Rome between 22 AD and 30 AD, found next to the road *Aquileia–Tarsatica* in the village of Basovizza. Private collection.

Another coin, a Bronze As of Gaius/Caligula, minted in Rome between 37 AD and 41 AD (*RIC* I^2, [42], p. 112, n. 58), was found along the same road, just north-east of Grociana piccola ([42], 103).

Continuing west from area B, the remains of the road are again recognizable to the west of the Italian Synchrotron Facility (area C), built exactly above the road. Road sections with slightly different orientations have also been recognized in this area, but the presence of vegetation cover prevented the finding of Roman hobnails and other artefacts (Figure 8). However, in the space between area B and area C and very close to the road (black star in Figure 3), a fragment of a bronze brooch similar to the type Almgren 69 ([43], p. 126, n. 292) and a few pottery fragments were found together. They could be part of a burial datable to the second half of the first century AD based on comparisons with similar brooches (see references in [43]).

After area C, the traces of the road continue in the same direction for about 1 km (area D; Figure 9) and then turn north (area E; Figure 10), maintaining more or less the same elevation above sea level, until the road skirts the internal base of the Karst coastal ridge continuing in the direction of Prosecco (Figure 1). In this area, the coastal chain of the Karst and the offshoots of the more internal elevations delimit a narrow corridor, about 1 km wide, where searches focused on, allowing me to identify a stretch of the road route (Area F; Figure 11). Interestingly enough, even today the modern road network is concentrated within this band.

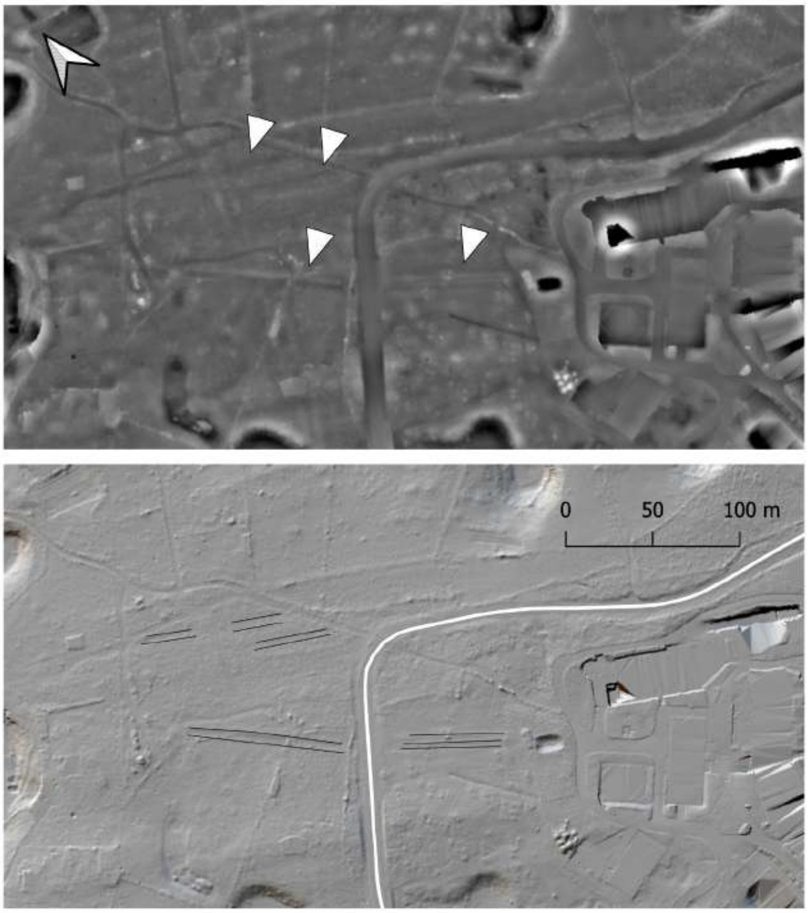

Figure 8. Zoomed view of area C of Figure 2 with the position of road tracks indicated by white arrows in the upper picture (local relief model of an ALS-derived DTM) and by black lines in the lower one (hill-shaded image of an ALS-derived DTM). Modern roads are indicated by white lines.

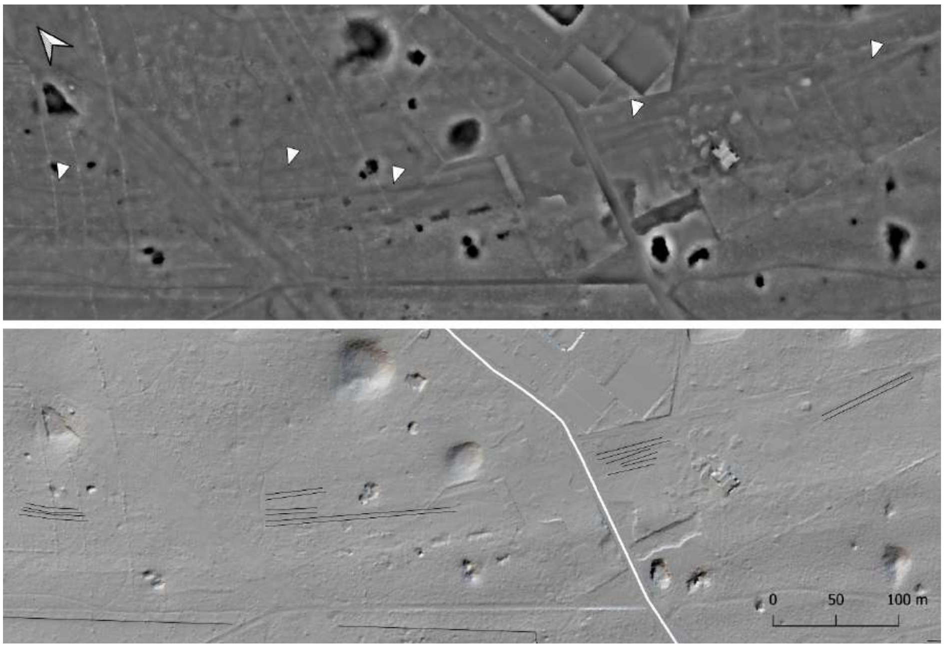

Figure 9. Zoomed view of area D of Figure 2 with the position of road tracks indicated by white arrows in the upper picture (local relief model of an ALS-derived DTM) and by black lines in the lower one (hill-shaded image of an ALS-derived DTM). Modern roads are indicated by white lines.

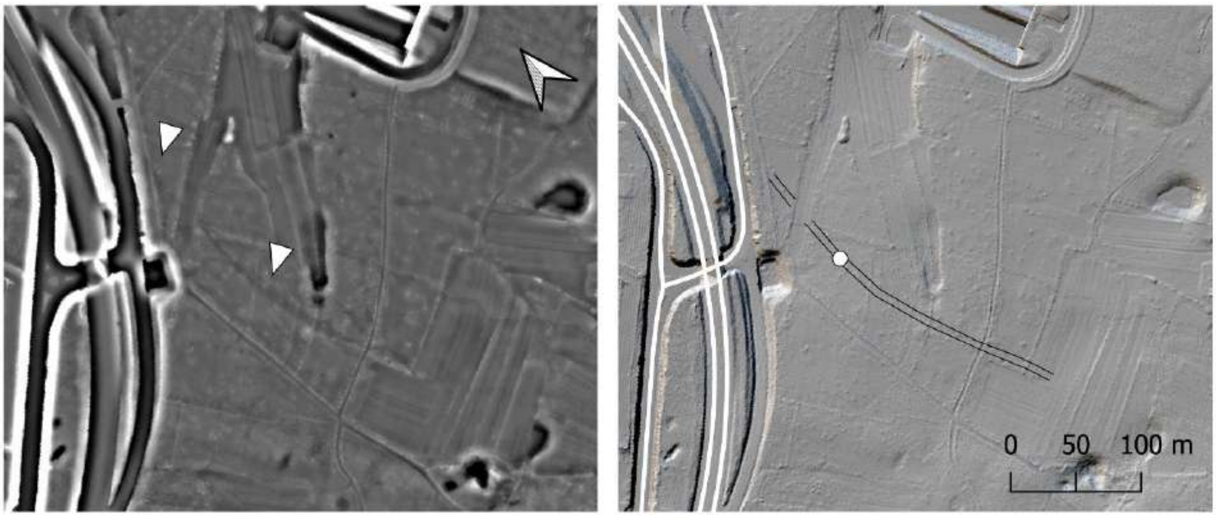

Figure 10. Zoomed view of area E of Figure 2 with the position of road tracks indicated by white arrows in the left picture (local relief model of an ALS-derived DTM) and by black lines in the right one (hill-shaded image of an ALS-derived DTM). Modern roads are indicated by white lines. The white circle: *caliga* hobnail.

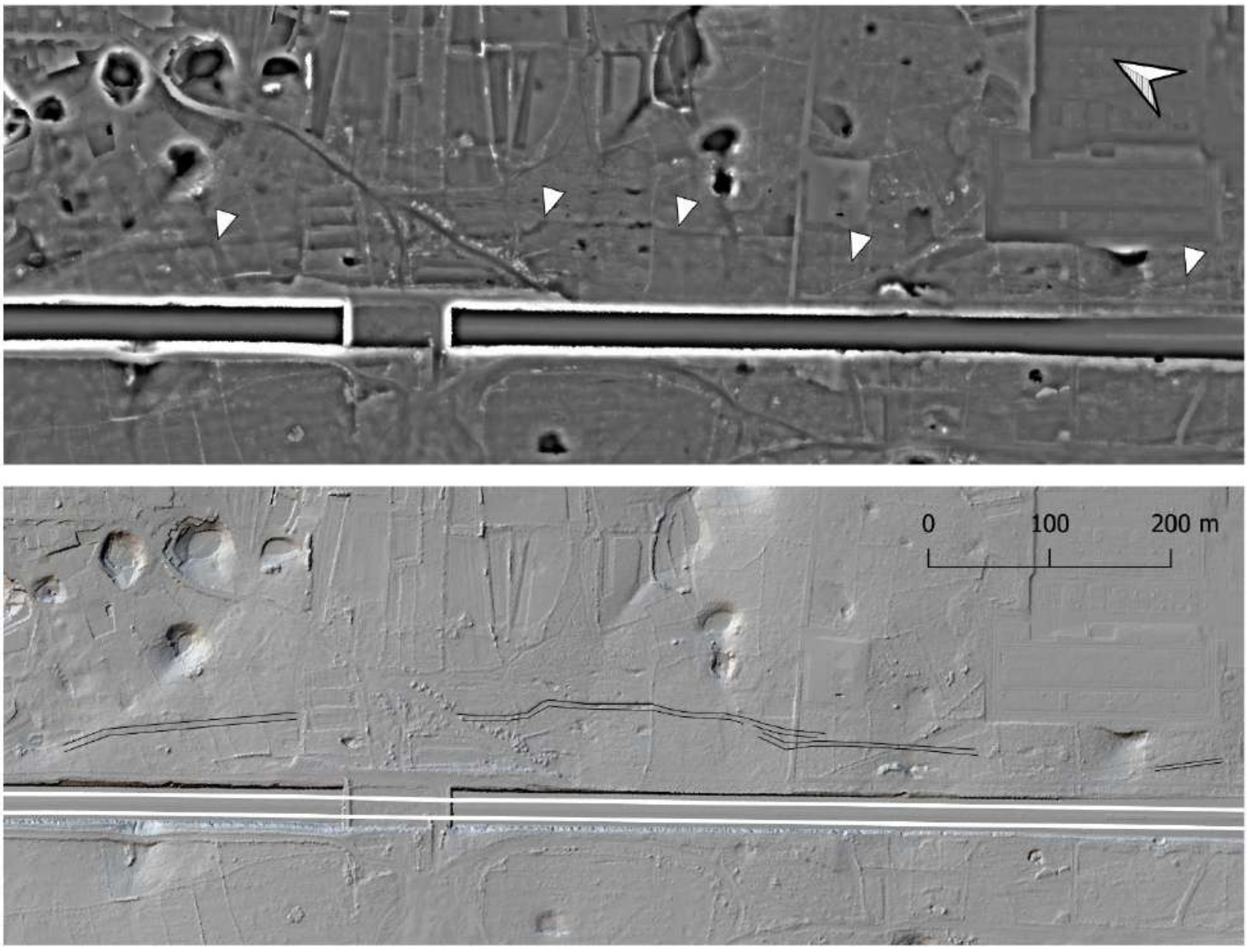

Figure 11. Zoomed view of area F of Figure 2 with the position of road tracks indicated by white arrows in the upper picture (local relief model of an ALS-derived DTM) and by black lines in the lower one (hill-shaded image of an ALS-derived DTM). Modern roads are indicated by white lines.

In area E, a *caliga* hobnail of type A has been found along the road (Figure 5, n. 10).

3.2. Tergeste-Grociana Piccola

Almost 3 km of this route, starting from Grociana Piccola and heading west towards Trieste, were identified and mapped by Bernardini et al. [9], but the data available at the time did not allow them to establish where the road descended from the Karst plateau to reach Trieste (Figure 2). The ALS data have highlighted in the wood a stretch of the ancient route about 10 m wide (area G, Figure 12C, zone I), associated with a very large number of *caliga* hobnails (Figure 13, 1–3, 5–6, 9–15). The latter include types A, C and D, indicating that the route was certainly in use at least from the 1st century BC. The direction of this road segment points towards the village of Longera, where the collected data indicate that the road probably left the Karst plateau following an almost straight path (Figures 2 and 12).

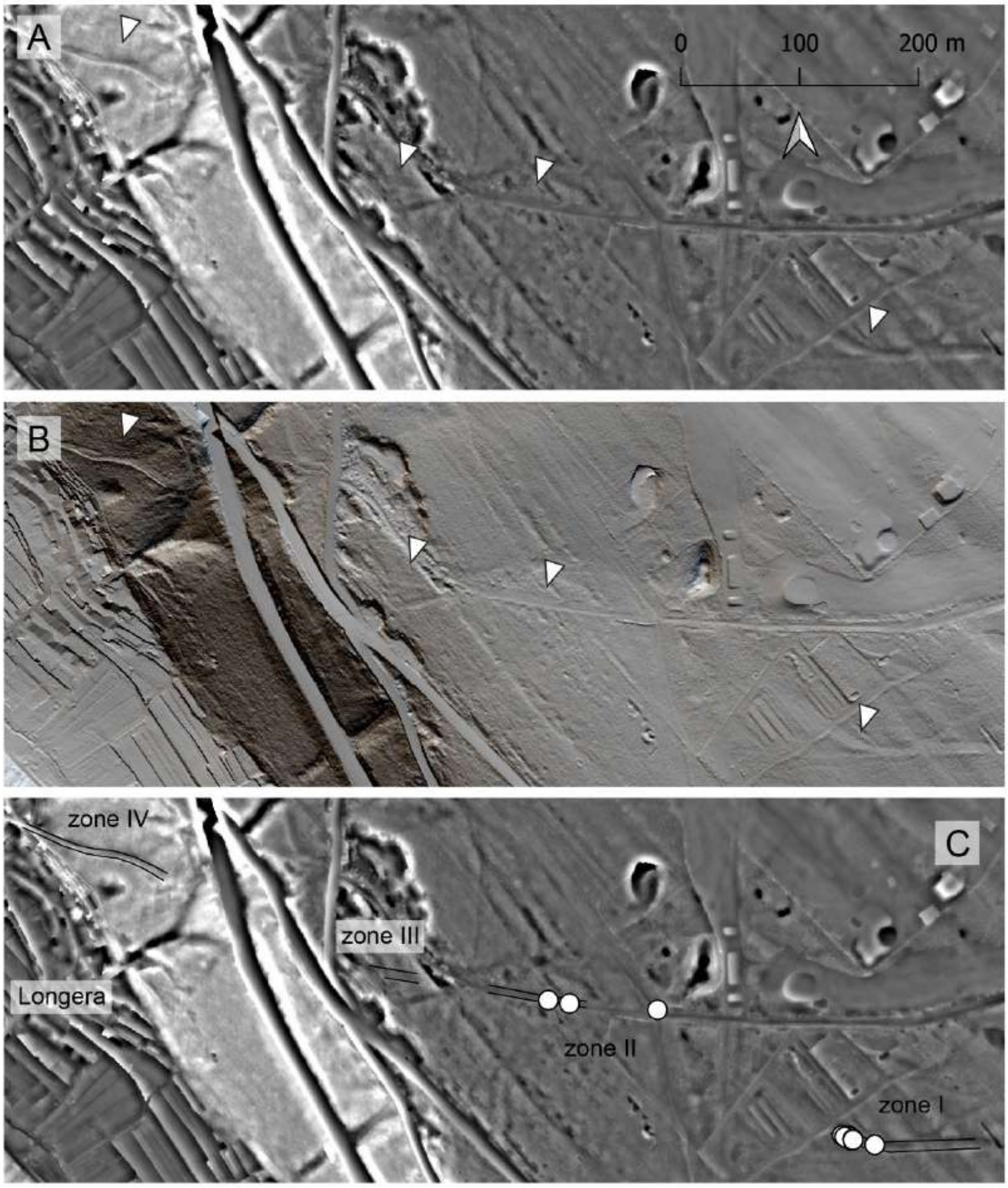

Figure 12. Zoomed view of area G of Figure 2 with the position of road tracks indicated by white arrows in pictures (**A**) (local relief model of an ALS-derived DTM) and (**B**) (hill-shaded image of an ALS-derived DTM) and by black lines in picture (**C**) (again a local relief model of the area). White circles: *caliga* hobnails.

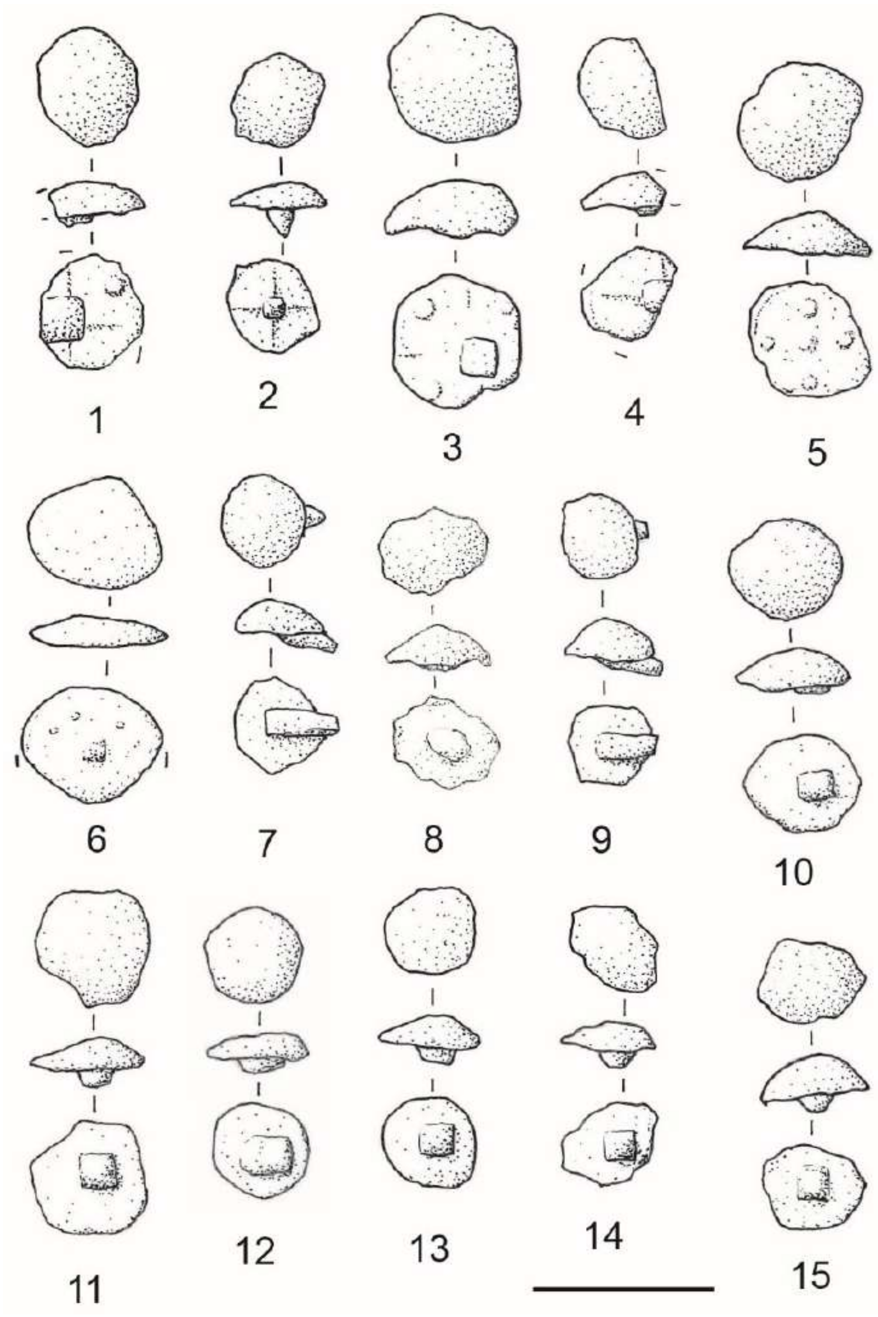

Figure 13. Roman shoe hobnails from area G. Scale bar: 2 cm; drawings by A. Fragiacomo.

A little further west of zone I, described above, the layout of the road probably coincides with a short stretch of path in use in later historical times (zone II of Figure 12C), as apparently demonstrated by some hobnails of type A and D (Figure 13, nn. 4, 7–8), and descended rather steeply following a track partially cut into the bedrock (zones III and IV of Figure 12C) to reach the area of nowadays Longera, thus abandoning the Karst plateau.

3.3. *Grociana Piccola-Emona*

The presence of a route that left the *Aquileia*–*Tarsatica* road to the north of Grociana piccola was already suggested by Bernardini et al. [9] on the basis of the dozens of *caliga* hobnails found in the area. Since then, other hobnails have been found, and some possible road tracks covered by land divisions, documented in the 19th century land register, have been identified (area H, Figure 14).

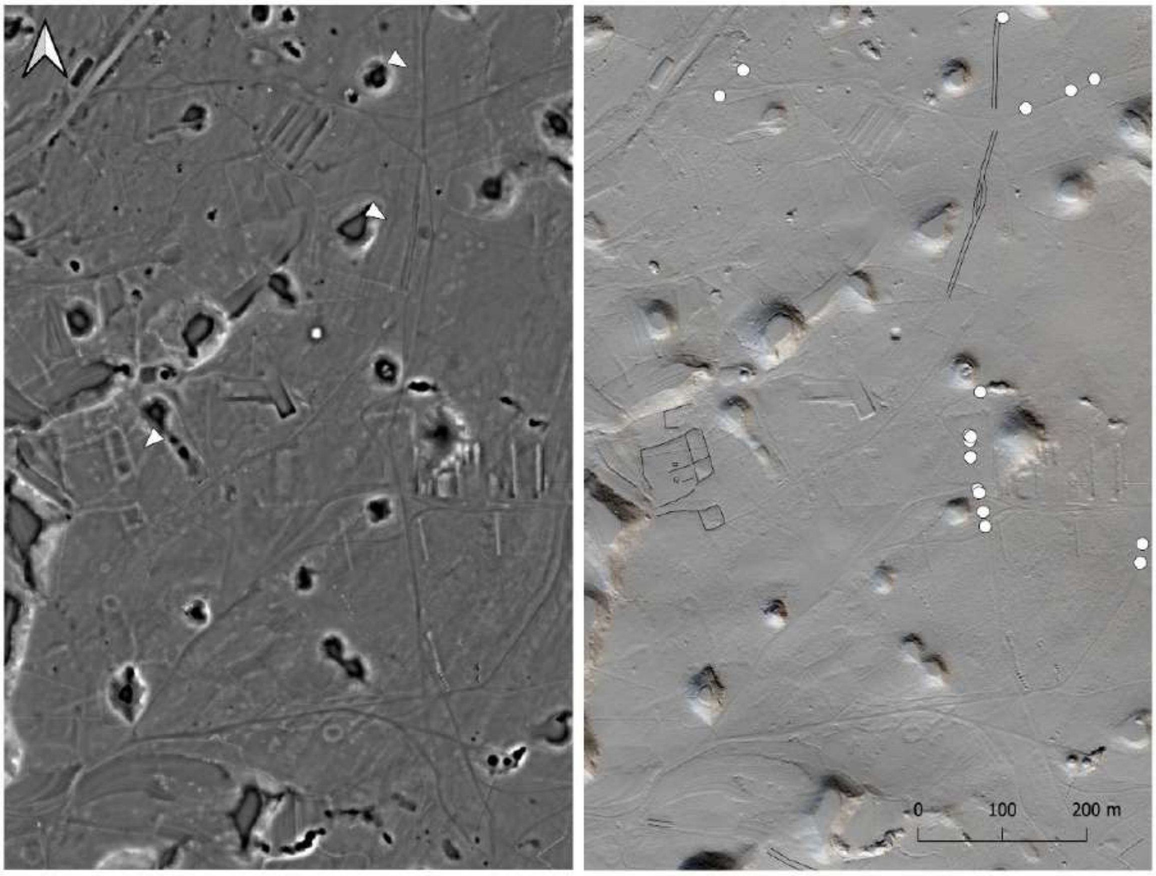

Figure 14. Zoomed view of area H of Figure 2 with the position of road tracks and a large rural complex indicated by white arrows in the left picture (local relief model of an ALS-derived DTM) and by black lines in the right one (hill-shaded image of an ALS-derived DTM). White circles: *caliga* hobnails.

3.4. Rural Buildings

Three rural buildings have been identified in areas H, I and L of Figure 2.

A large complex (about 1 ha), already identified by Bernardini et al. [9] and attributed to the Roman period, is located just north of the Grociana piccola crossroad in area H, and more precisely about 350 m from the *Aquileia–Tarsatica* road and 300 m from the Grociana piccola–*Emona* road (Figures 2, 3, 14 and 15). In the north-eastern part, it shows a rectangular building of about 20 × 60 m containing at least one transversal wall and overlooking a probable courtyard of about 50 × 50 m. A similarly oriented building (i.e., about 75 degrees east of north) of about 20 × 20 m lies approximately 30 m south of the rectangular construction.

The other two rural buildings are surrounded by a wall which probably delimited the land belonging to them (Figures 16–19). The wall is not present on the south-western side where the natural slope made it unnecessary, while, on the opposite side, it fits perfectly within one of the axes of the Karst centuriation, perhaps the *decumanus maximus* (Figure 17; [41]), oriented about 42 degrees east of north. The extension of this centurial axis north-west roughly coincides, indeed, with the stretch of the *Aquileia–Tarsatica* road between Prosecco and Aurisina (Figure 1B). The term centuriation refers to the method with which the Romans divided public land into *centuriae*, regular square plots measuring about 710 m per side (20 × 20 *actus*), in order to be able to assign it to new colonies. This land division system was based on a grid consisting of *limites*, comprising perpendicular roads called *decumani* and *cardines*. The main roads were called *decumanus maximus* and *cardo maximus* [41].

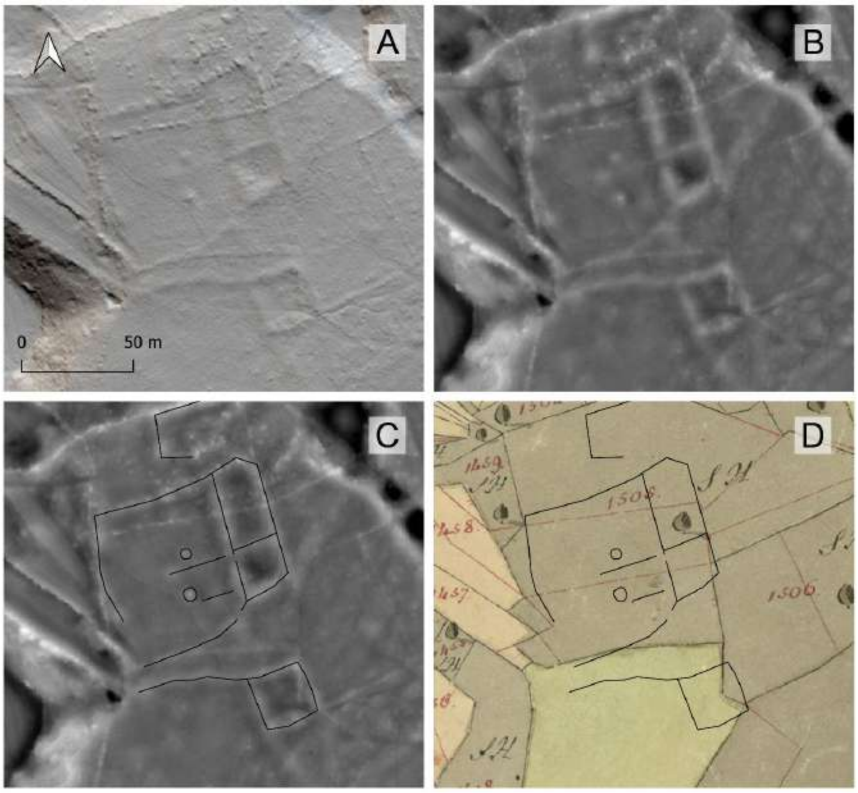

Figure 15. Zoomed view of the rural complex of area H: hill-shaded image (**A**), local relief model (**B**), interpreted local relief model (**C**) and digitized features superimposed onto a 19th century cadastral map (**D**).

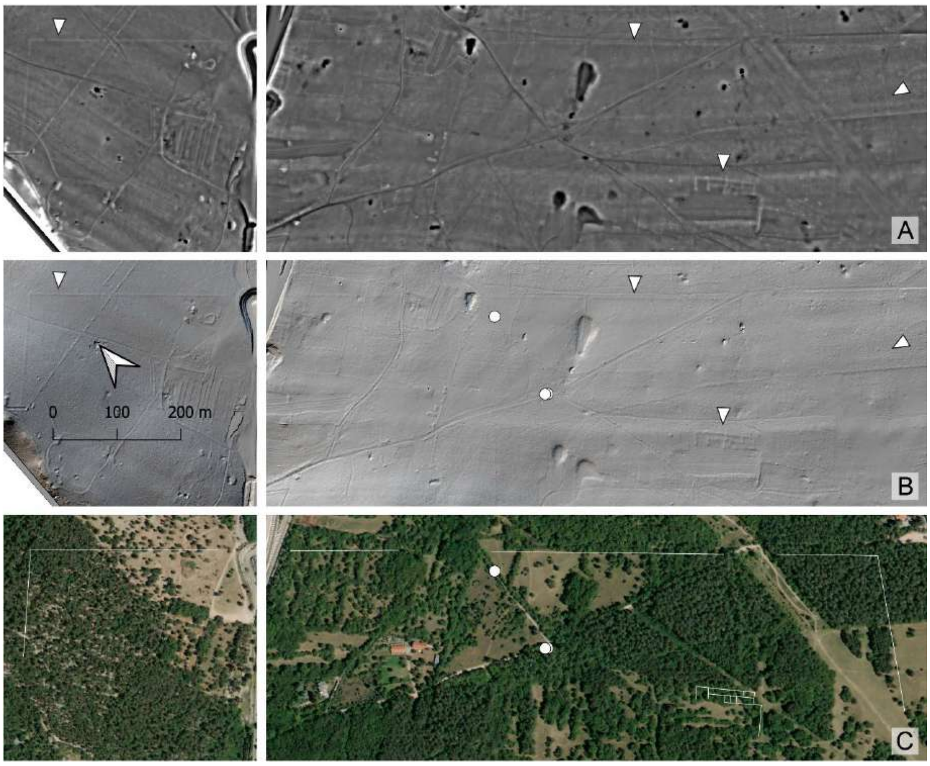

Figure 16. Zoomed view of area I of Figure 2 with the position of a rural building surrounded by the remains of a boundary wall indicated by white arrows in pictures (**A**) (local relief model of an ALS-derived DTM) and (**B**) (hill-shaded image of an ALS-derived DTM) and by white lines in picture (**C**) (satellite image). White circles: *caliga* hobnails.

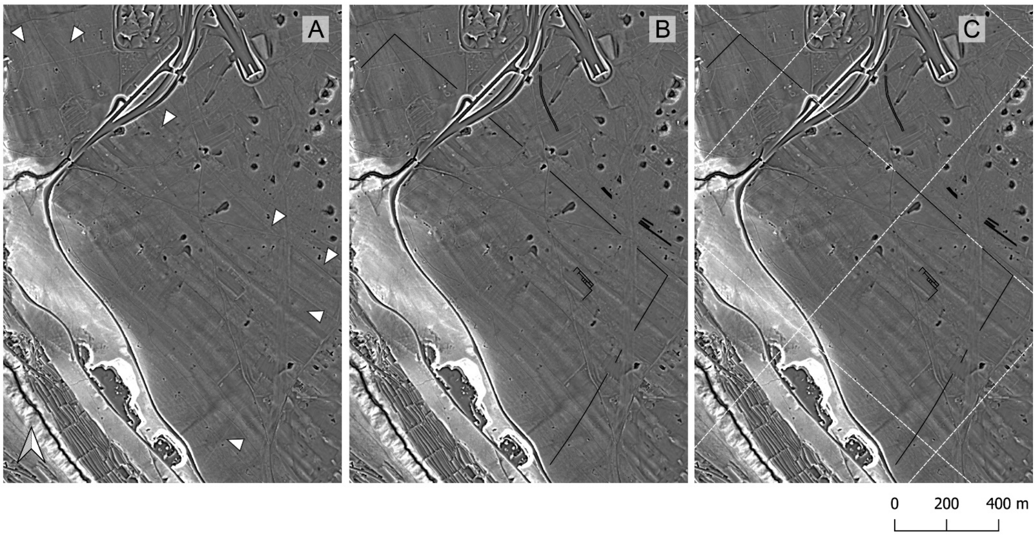

Figure 17. The rural complex of area I with the boundary walls indicated by white arrows and black lines (pictures (**A**,**B**) and compared with the Roman centuriation grid of the Karst (dotted white lines in picture (**C**)) built fitting the main preserved *limites* in the Slovenian and Trieste Karst. Local relief model of an ALS-derived DTM.

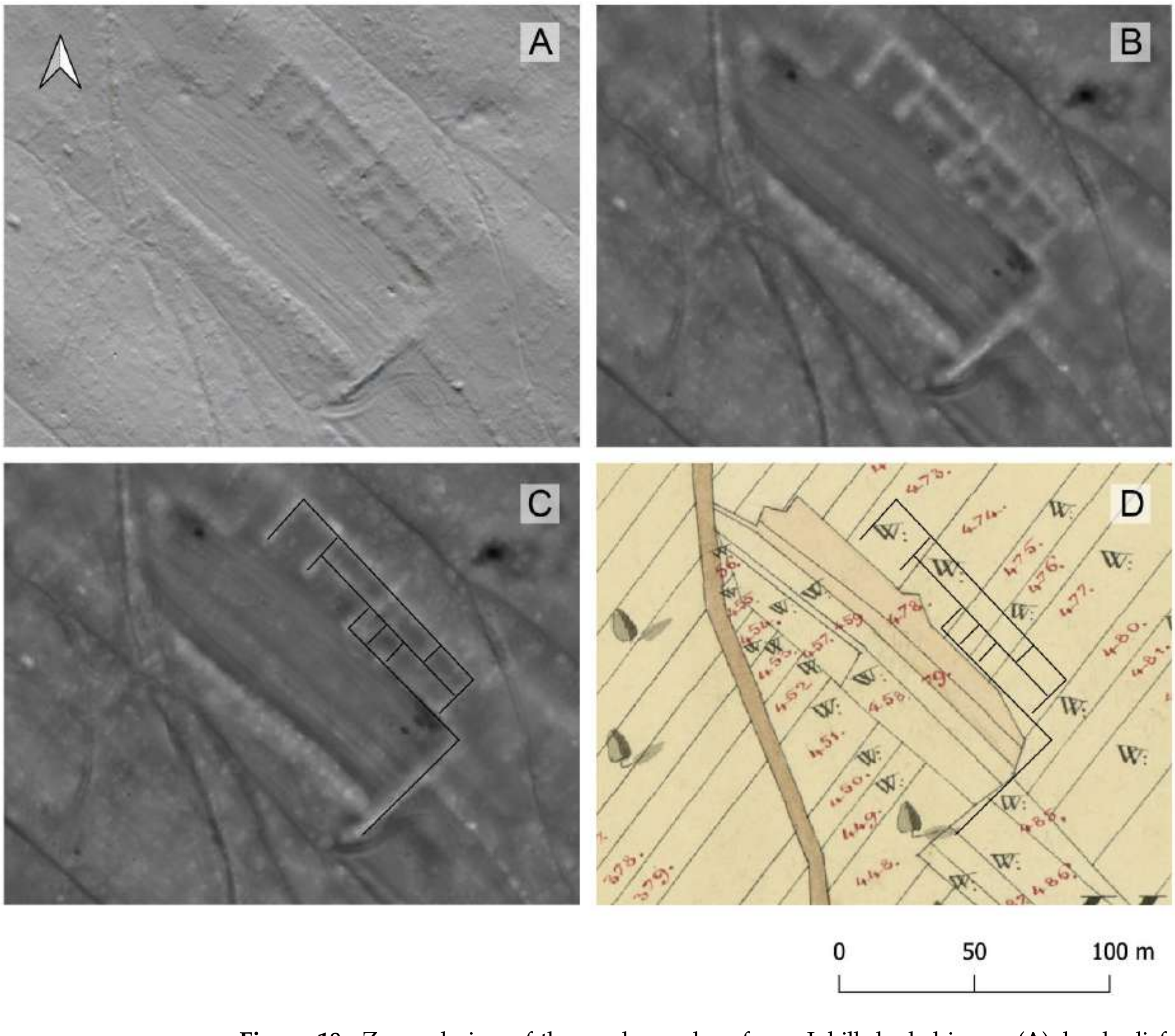

Figure 18. Zoomed view of the rural complex of area I: hill-shaded image (**A**), local relief model (**B**), interpreted local relief model (**C**) and digitised features superimposed onto a 19th century cadastral map (**D**).

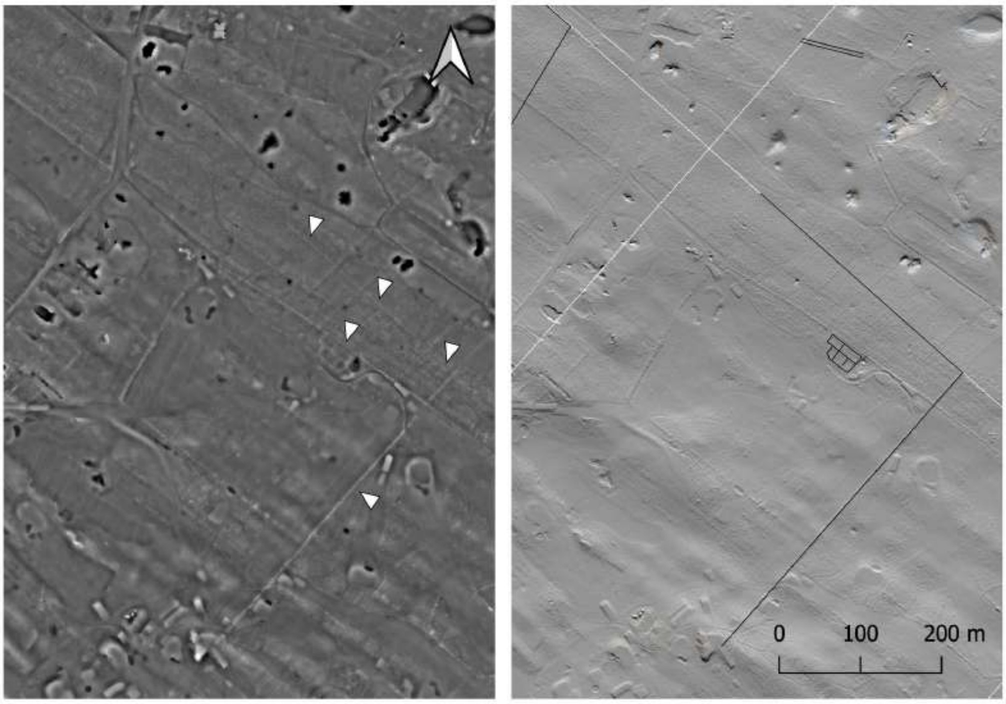

Figure 19. The rural complex of area L with the boundary walls indicated by white arrows in the local relief model (**left**) and black lines in the hill-shaded image (**right**). The north-eastern boundary wall perfectly fits the Roman centuriation grid of the Karst (dotted white lines) built fitting the main preserved *limites* in the Slovenian and Trieste Karst.

Both buildings, located about 300 m south-west of the *Aquileia–Tarsatica* road, are covered by modern land divisions and show approximately the same centuriation orientation, but the one within area I (Figures 16–18) is larger than the one in area L (Figures 19 and 20) (90 × 18 m vs. 43 × 20 m respectively).

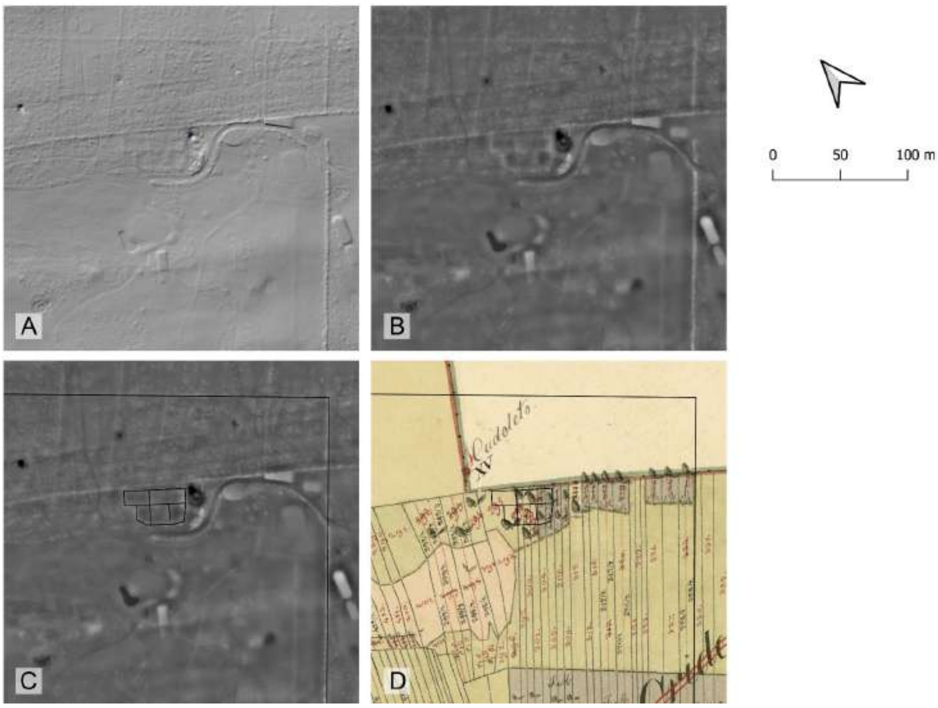

Figure 20. Zoomed view of the rural complex of area L: hill-shaded image (**A**), local relief model (**B**), interpreted local relief model (**C**) and digitized features superimposed onto a 19th century cadastral map (**D**).

Finally, some orthogonal features have been identified in area M, but they can be only hypothetically attributed to ancient times in the absence of stratigraphic relations with modern structures and archaeological materials (Figure 21).

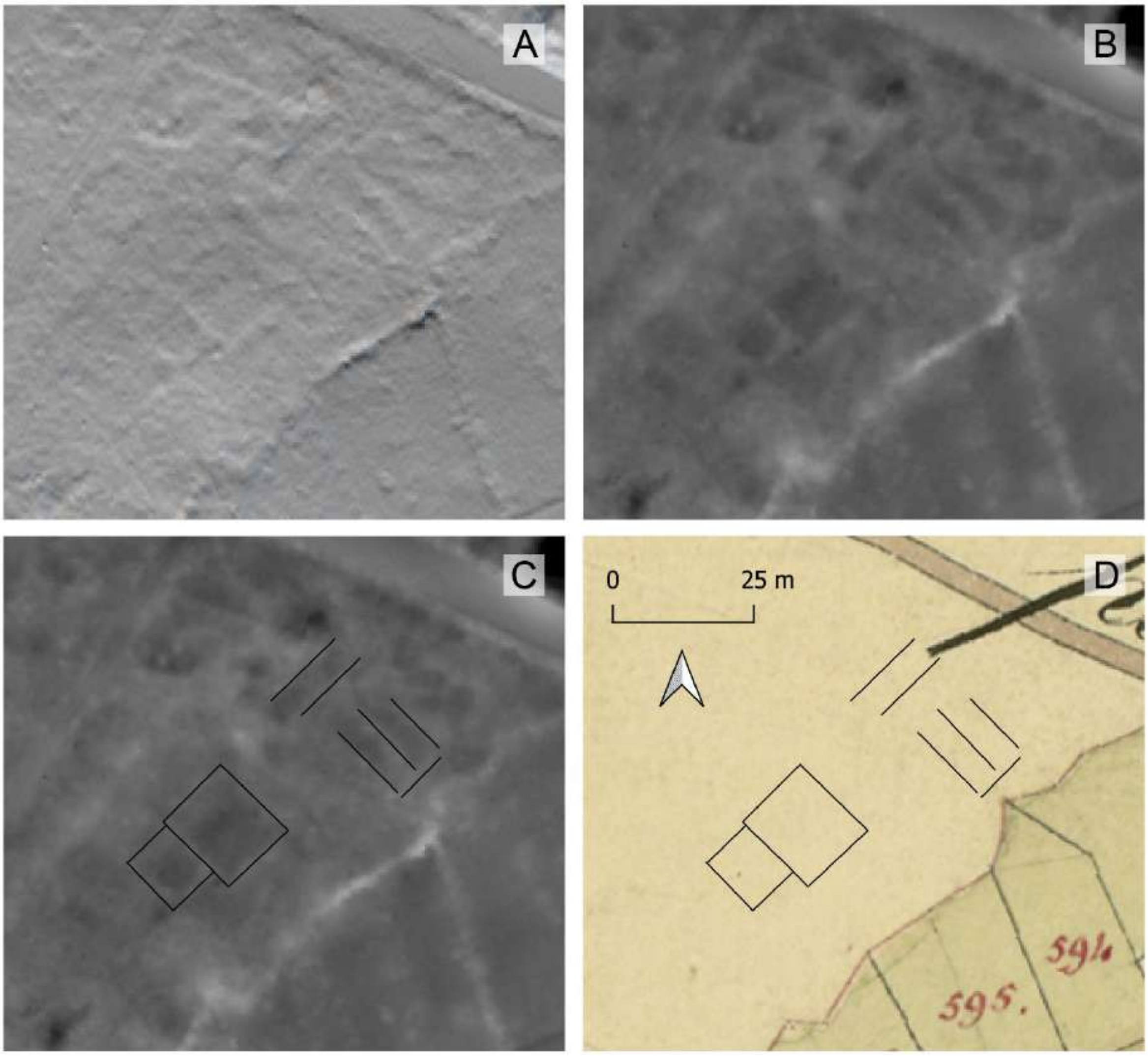

Figure 21. Zoomed view of possible archaeological features in area M of Figure 2: hill-shaded image (**A**), local relief model (**B**), interpreted local relief model (**C**) and digitized features superimposed onto a 19th century cadastral map (**D**).

4. Conclusions

The study of high-resolution ALS terrain models, associated with field surveys, the geomorphological and stratigraphic study of superimposed landforms and the collection of archaeological artefacts, has made it possible to rediscover the lost Roman landscape in the investigated area with an unprecedented level of detail: over 10 km of road routes, some large rural buildings next to them, sometimes enclosed within land divisions perfectly aligned with the centurial grid of the Karst.

The southern part of the Trieste Karst was crossed by a series of important road axes which met a little further north of the Roman camps of Grociana piccola. Here passed the road that led from *Aquileia* to *Tarsatica*, from which the paths leading north, towards *Emona*, and west, towards *Tergeste*, separated (Figures 22 and 23). The camps of Grociana piccola were in fact built in a strategic spot, from which the main communication routes could be controlled. The origin of the important road junction can, indeed, already be dated to the late Republican era, as demonstrated by the Alesia type D hobnails found along the *Aquileia*–*Tarsatica* road, but also along the other routes.

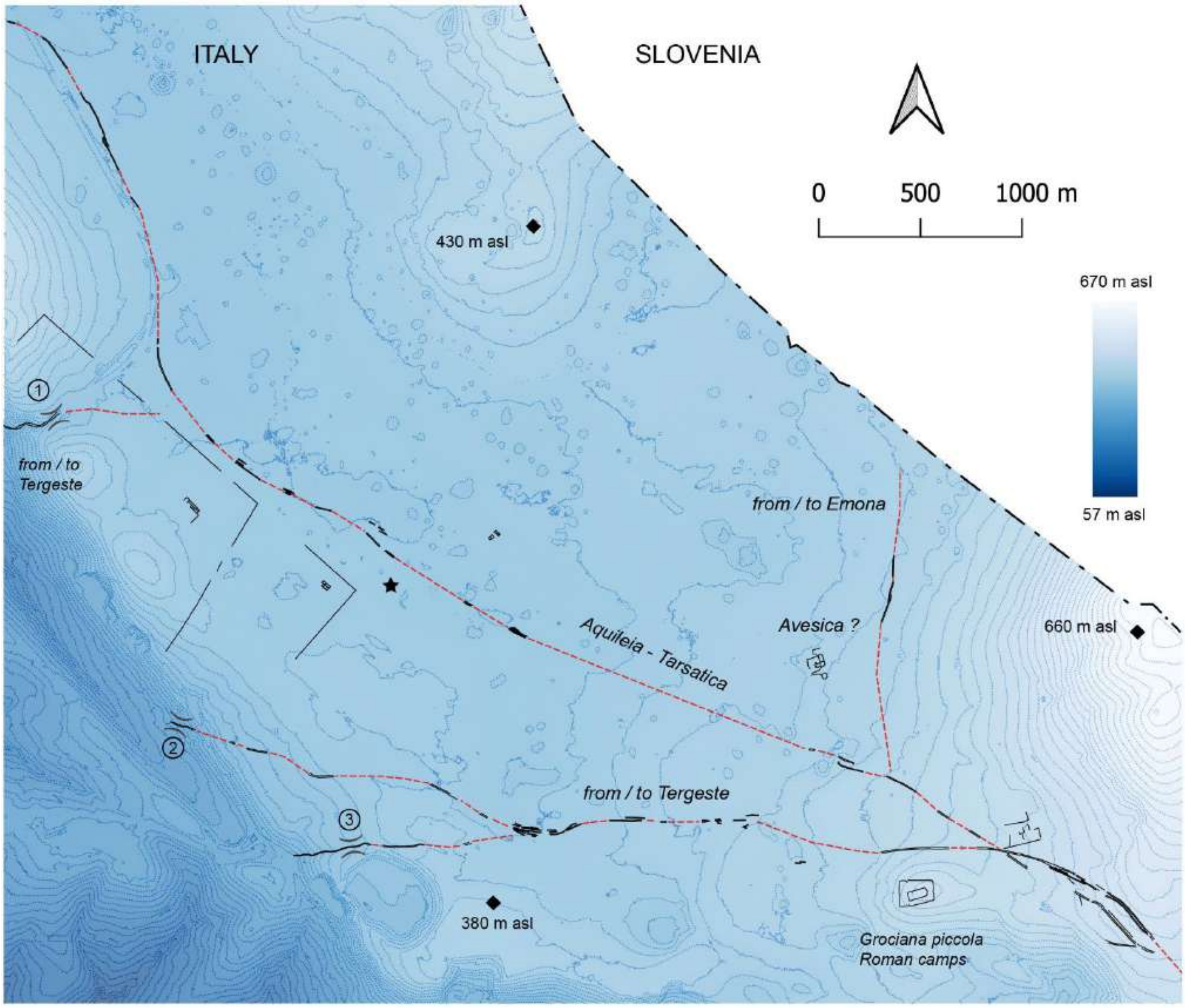

Figure 22. Reconstruction of Roman landscape with the road network and main archaeological sites. 1: Monte Spaccato pass; 2: point where the road from Grociana piccola to *Tergeste* leaves the Karst plateau; 3: pedestrian path known as *scala delle vacche*.

Based on the data collected, the main route that led to *Tergeste*, after having abandoned the *Aquileia*–*Tarsatica* road, passing a few tens of meters north of Grociana piccola, continued westward in an almost straight direction to descend towards *Tergeste* at the current village of Longera.

On the contrary, the origin and chronology of the road layout that reached the Karst plateau at the Monte Spaccato pass (Figures 22 and 23) is not clear. Although its attribution to the Roman period dates back to the end of the 17th century ([20,21] and references in there), unfortunately there is no direct evidence to date its construction with greater precision. The archaeological surveys did not allow for the collection of Roman hobnails, but this could depend on the strong washout that characterizes its steep route, nor did the study of the terrain models reveal any ancient road route at its outlet on the Karst plateau. Any traces may have been cancelled by the earthworks carried out for the construction of the modern road network.

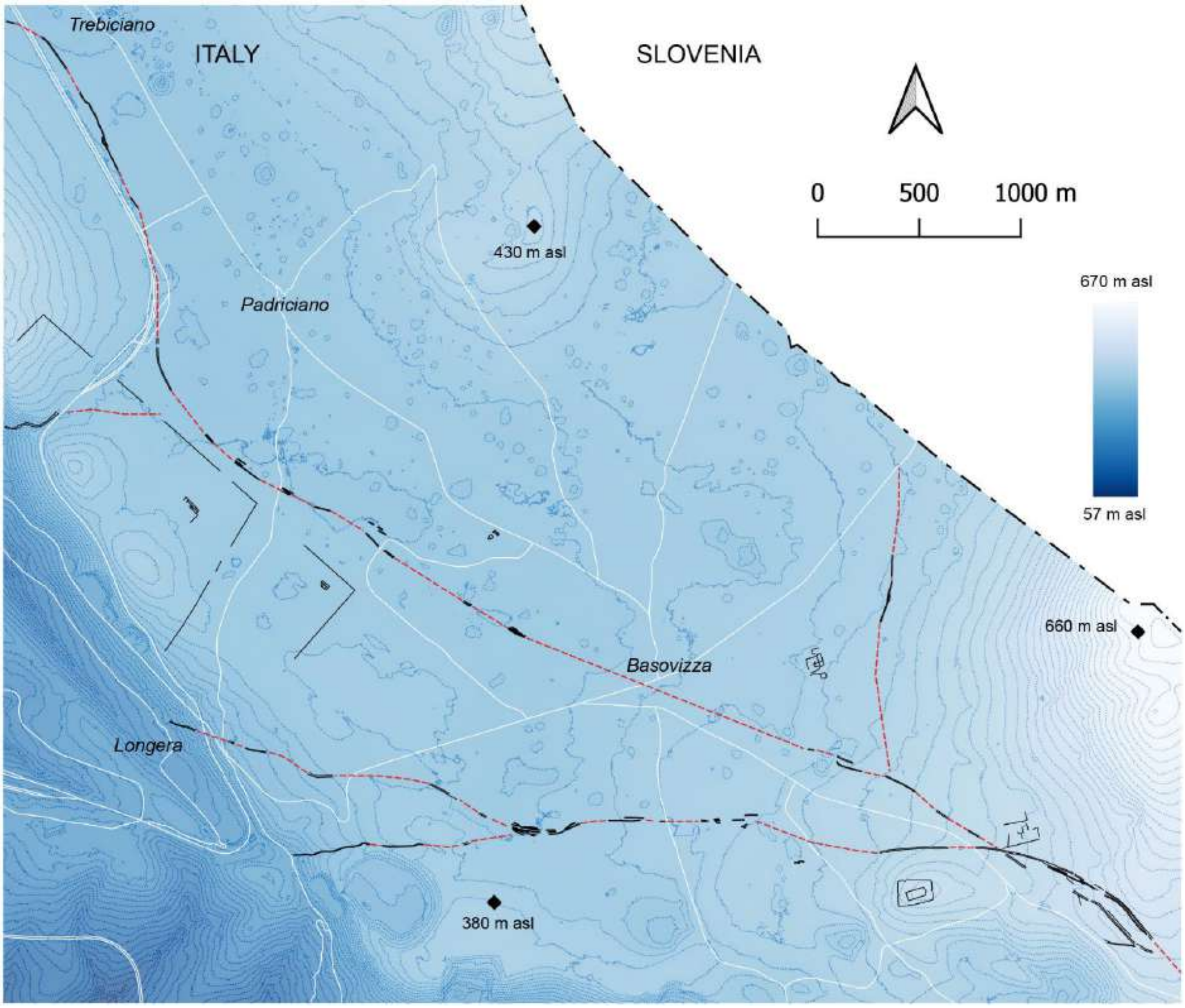

Figure 23. The Roman road network and landscape compared to modern roads indicated by white lines and position of modern villages.

However, another aspect to take into consideration is that such a route probably had to cross, at least in some periods, the space delimited by the wall which surrounded the rural building in area I. This boundary wall shows three interruptions along the north-eastern side, of which the westernmost and easternmost are certainly modern, while the central one could be ancient, but the wall could have alternatively disappeared due to historical and modern agricultural practices. However, in correspondence with this last passage, one would expect to recognize ancient road traces associated with abundant *caliga* hobnails, while none have been discovered.

The three large rural buildings identified are within easy reach of one or more road routes. The structures in areas I and L of Figure 2 are located about 300 m south of the *Aquileia–Tarsatica* road, while the structure in area H of Figure 2 is located about 500 m from the Grociana piccola crossroad and is bordered to the east by Grociana piccola–*Emona* road and to the south by *Aquileia–Tarsatica* one. Therefore, all the structures are adjacent to the *Aquileia–Tarsatica* road, which proceeded straight from Sistiana and followed for a long stretch one of the main axes of the centuriation along the inner edge of the Karst ridge (Figure 1B). After reaching Prosecco, where the road to *Tergeste* branched off, the *Aquileia–Tarsatica* road continued south-east to reach the investigated area (Figures 1B, 2, 22 and 23).

As mentioned in the archaeological introduction, along this route the *itinerarium Antonini* places a road station, *Avesica*, 12 Roman miles from the one at the Timavo springs, corresponding to about 18 km. The same itinerary places *Tergeste* along the way to Istria at the same distance, which, however, is about 25 km away. Interestingly enough, the studied area is located approximately at the same distance that separates *Tergeste* from the *Fons Timavi*.

It should also be noted that the ongoing study of the ALS DTMs of the area between Prosecco and Basovizza has not led so far to the identification of any other Roman rural structure of large dimensions similar to those of areas H, I and L. This is significant because the Karst landscape is conservative and relatively well preserved along this route with the exception of the Prosecco village and some other spots. As an example, it is enough to recall how ALS made it possible to clearly identify even temporary structures such as the external military camp of Grociana piccola [9].

On the basis of these considerations, and discarding the identification of *Avesica* with Prosecco on the basis of Bosio's considerations [26], it is legitimate to ask whether one of the structures identified near Basovizza could correspond to *Avesica*.

According to Bosio's hypothesis [26], which the author of this paper shares, since the *itinerarium Antonini* places *Tergeste* and *Avesica* at the same distance from *Fons Timavi* (i.e., 12 Roman miles), they cannot be located along the same route. Being located along the way to *Tergeste*, Prosecco cannot correspond to *Avesica*.

Among the buildings identified in the investigated area, the structure of area H could most likely correspond to *Avesica*, above all due to its proximity to the strategic road junction which made it possible to reach *Aquileia*, *Tarsatica*, *Emona* and *Tergeste*.

Although the planimetric characteristics of the road stations (*mansiones*) are difficult to distinguish from those of important rural buildings or villas [44], the presence of large buildings overlooking a large courtyard is compatible with the proposed identification. It goes without saying that this hypothesis will have to be tested through stratigraphic excavations, which are necessary for defining the nature and chronology of archaeological structures.

Whether or not the proposed identification is correct, the collected data show the long-term strategic importance of the Grociana piccola area, from the installation of the camps in the Republican period (between the 1st−2nd centuries BC), probably connected to the first road construction, to the presence of a fundamental crossroad in use for hundreds of years. In the post-Roman period the here described Roman road system was abandoned, but the role of important road junction played by this territory was preserved, with the formation and repositioning of a new crossroad about 1 km westward by the town of Basovizza (Figure 23).

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Data Availability Statement: The data that support the findings of this study are included within the paper.

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