

Aquileia: first results from the market excavation and the late antiquity town walls (part one)

Patrizia Basso - Diana Dobрева (eds.)

Between 2018 and 2019 the University of Verona, in collaboration with the Fondazione Aquileia and under licence from the Ministero per i beni e le attività culturali, carried out an archaeological excavation on the former Pasqualis property in Aquileia. The area has been already excavated in the '50s of the last century when two of the town's parallel curtain walls that run along the river and market buildings located south from the basilica were uncovered. This city sector became particularly important from economic and social point of view for Late Antique Aquileia. In this paper (Part one) will be discussed the preliminary analyses of the archival documents and the geophysical survey that took place before the excavation. In the second part (Part two) the results of two years of excavation will be presented.

Introduction

Between 2018 and 2019 the University of Verona's *Dipartimento Culture e Civiltà* carried out an archaeological excavation on the ex Pasqualis site in Aquileia, at the south-eastern edge of town (fig. 1)¹. The excavations, under licence from the *Ministero per i beni e le attività culturali* (protocol 0014409 of 28.5.2018 and 0015991 of 10.6.2019), were financed by the Fondazione Aquileia, in close scientific collaboration with the University.

Between 1953 and 1955 Giovanni Brusin, director of *the Museo Archeologico Nazionale di Aquileia*, partially excavated the site. His excavations uncovered what were believed to be three market buildings with stone paving (the one to the East was the least well preserved)². Two rooms with mosaic floors also came to light in the southeast corner of the central market. Two of the town's parallel curtain walls were uncovered to the south, this side of the River Natissa (figs. 2-3). Apart from the mosaics and the eastern market building (which were backfilled) most of the buildings have remained on display since the '50s: the archaeological park is run by the Fondazione Aquileia and is open daily to the public. A single article was published by Brusin about his excava-

We thank Jim Manning-Press for helping in translation.

¹ The excavations were directed by Patrizia Basso and Diana Dobрева (focussing in particular on the finds record). The site supervisors were Maria Bosco, Marina Scalzeri, Fiammetta Soriano and Andrea Zemignani; the finds supervisors Vittoria Canciani and Sabrina Zago. Site drawings and photography were carried out by Valeria Grazioli and Simone Pedron. Press and publicity were in the hands of Lisa Monaco. Fundamental on site logistics were provided by *SAP Società Archeologica*, in particular by Alberto Manicardi. About fifteen master's degree students took part on site from a university network including the universities of Ferrara, Verona, Modena and Trento. There were also ten undergraduate students from the University of Verona, along with a few students from the universities of Ghent and Barcelona.

² In this paper the two squares still visible to the public are referred to as "western" and "central", the one only partially excavated and then backfilled by Brusin is the "eastern" square. The one excavated by ourselves is the "new" square.

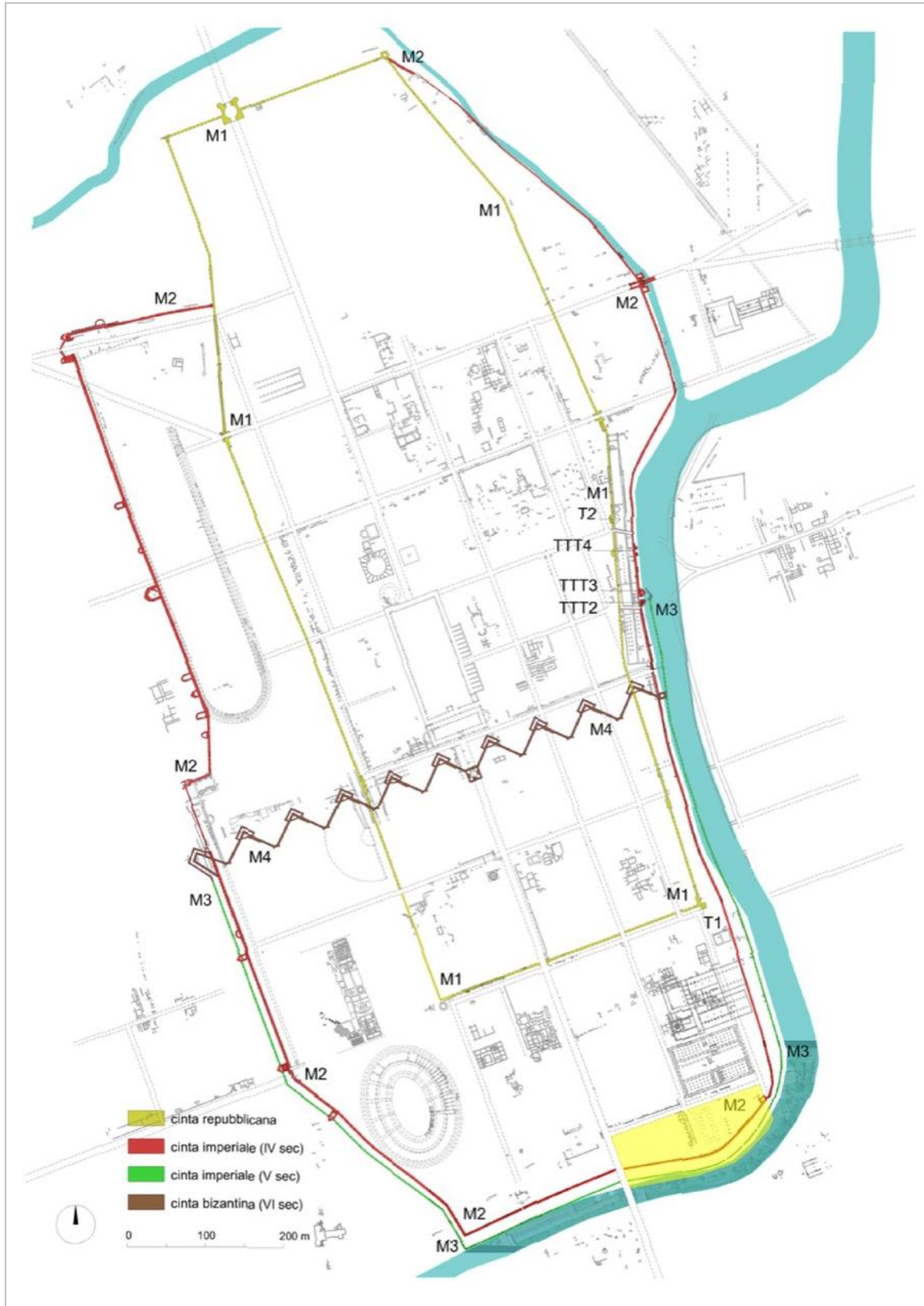


Fig. 1. Aquileia, ex Pasqualis (in yellow): site position on the archaeological town map (from BONETTO 2009, Fig.1, illustration Valeria Grazioli).

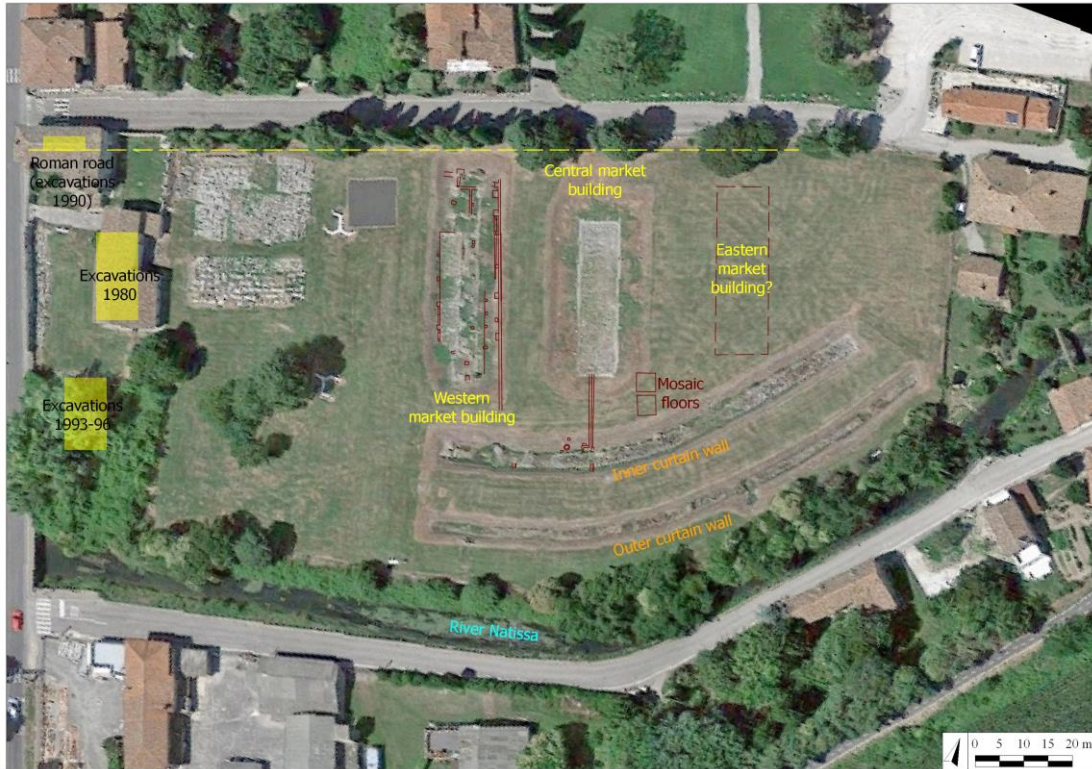


Fig. 2. Photo of the site from a drone, where the remains brought to light during archaeological excavations carried out in the 1950s and in the 1980s-90s can be seen (Explora s.r.l. drone survey, illustration Valeria Grazioli).



Fig. 3. Aquileia, ex Pasqualis: panoramic photograph (by archives of Fondazione Aquileia).

tion³. In it he dates: 1. the construction of the market to “the later centuries”, without going into details; 2. the inner wall to the third century CE; and 3. the outer wall to the fifth century CE. Apart from the published report, the written, drawn and photographic record of the excavation is housed in the archives of the *Museo Archeologico Nazionale di Aquileia*. The first part of the project concentrated on reading and interpreting Brusin’s documentation (see below §1.1)⁴. This documentation also proved a useful cross reference during our excavations.

This preliminary analysis of the archival documents also takes into account the documentation of other archaeological excavations carried out in the 1980s and ‘90s at the extreme western edge of the site, where the Pasqualis house and stables stood. Records of these excavations are also housed in the museum archives (see below §1.2 and §1.3).

Prior to our excavations all that was known about the paved surfaces and town’s curtain walls was from Brusin’s publication⁵. This had left many questions unanswered. Above all, part of the complex had remained unexcavated beneath a vineyard that the owner had not wanted to give up. On top of this, the soil removed numerous trial trenches had been piled up along their sides. This meant that the underlying stratigraphy went untouched. The uncovered ruins had been only vaguely dated; this data vacuum has never been filled given that finds from the site appear to have gone missing over the years. This, in spite of the fact that they were from the amply discussed in the written record. By reopening the site there was a hope of clearing up these questions. Attention was to focus on a zone of Aquileia that was right at its heart in Late Antiquity, a period of the town’s history still little documented.

Prior to reopening the area, it was mapped photographically with a drone⁶ (see fig. 2). On top of this, two geophysical surveys were carried out⁷. The interesting results that the latter provided influenced the decision over where to position our three sites⁸ (fig. 4). During the 2019 excavation four cores were sunk close by the southern walls, providing important information as to the course of the river in ancient times and its relationship with the walls themselves⁹ (see fig. 4). The project is still in progress. There will be further excavations and the results of various analyses are yet to be seen. However, it is hoped that a preliminary presentation of the data so far available may be useful. This paper (Part one) focuses on the archival research and other activities that took place prior to excavation. In the second part (Part two) the results of the first two years of excavation will be presented.

1. Archive research

1.1 Giovanni Brusin’s excavations

Brusin’s site documentation, as mentioned above, is housed in the Aquileia Museum archives. It consists of: 1. a pencil plan of the area on a piece of paper 1.25 metres by 1.07. This more or less documents the structures that are still visible; 2. thirty somewhat repetitive black and white photos; and 3. three site diaries, filled by one of Brusin’s assistants. The written text is accompanied by sketches of the structures and various finds drawings¹⁰.

The first thing that the diaries and some of the photos bring to light is that Brusin opened numerous trial trenches across the site (fig. 5). Their precise location is not documented. Only one thing is clear, that the excavation did not cover the western part of the site, leaving the vineyard untouched on its owner’s insistence.

At the end of the excavation Brusin published an interpretative breakdown of his finds. Here it will be analyzed and data added from the archival documents which contain greater detail than the published report.

³ See BRUSIN 1957.

⁴ Special thanks go to the director of the Museum Marta Novello and the archives supervisor Adriana Comar for kindly allowing us to study Brusin’s documentation, and for help in finding it. Authorization ns. prot. 940 dd. 22. 04. 2020.

⁵ All the subsequent bibliography was based on this: see GHEDINI, BUENO, NOVELLO (a cura di) 2009 (and in particular TIUSSI 2009: 77 and 81; BONETTO 2009: 87-90; MASELLI SCOTTI, RUBINICH 2009: 108; VENTURA 2013: 94-99).

⁶ Work carried out by Esplora s.r.l.

⁷ See below §2.1-2.2.

⁸ See part two of the article in BASSO, DOBREVA (eds.) *forthcoming*.

⁹ *Ibid.*

¹⁰ See Archive n. 302 (drawing), 3105, 3115, 3117, 3126-3142, 3170-3175, 3181, 3184, 3202, 3304, 3313, 4684 (photographs), 2066-2068 (site diaries). Seven photographs had already been published by Brusin (BRUSIN 1957, figs. 1-7).



Fig. 4. The position of the three sites 2018-2019 and of the four cores 2019 (Explora s.r.l. drone survey, illustration Valeria Grazioli).



Fig. 5. General view of Brusin's excavation. Open trenches can be seen over all the eastern side of the site (Courtesy of Museo Archeologico Nazionale di Aquileia archives, negative 3136).



Fig. 6. The central market building during the Brusin's excavation
(Courtesy of Museo Archeologico Nazionale di Aquileia archives, negative 3115).

Brusin's report¹¹ starts by pointing out that, just like in the rest of town, over the centuries the site had been robbed of much of its building materials. This had left the walls badly damaged. He also talks of sarcophagus fragments found on the surface. These may have come from the cemetery of the demolished Church of San Felicità. The published article does not mention the discovery of two graves, while the site diary records two skeletons found 0.9 metres down in the "central" square, dated to a late phase of the complex¹². It also fails to report a 0.6 metres wide east/west wall built over the paving slabs in the western square, visible in a photograph¹³. The wall was demolished in April 1954, given that it was out of phase with the other structures. It, and the graves, provide strong evidence that the site continued to be occupied, though this period is yet to be fully pieced together¹⁴. In the article the Roman Period starts with the "central" market building. It is 32.5 metres long and 8.5 metres deep, running north/south¹⁵ (see fig. 2). The well-preserved paving slabs of the northern part are of Aurisina limestone. Those to the south are a very poor quality sandstone, prone to flaking and crumbling (fig. 6). The drainage channel that runs the whole way around the paved area of the northern part of the square suggests that this was a "meat and fish market", foodstuffs with a frequent need to be washed down. Brusin also records a dozen or so pieces of stone masonry reused as paving stones. Working from the site diary and photographs, they seem, for the most part, to be fragments of funerary monuments. For Brusin the fact that they had been violently torn from stone memorials on burial grounds is a sure sign that the market buildings had

¹¹ BRUSIN 1957: 5.

¹² Ms. 2066, dates 26.11.1953 and 1.4.1954.

¹³ Neg. 3139.

¹⁴ On these phases, see also BASSO, DOBREVA (eds.) *forthcoming*.

¹⁵ BRUSIN 1957: 5-7.

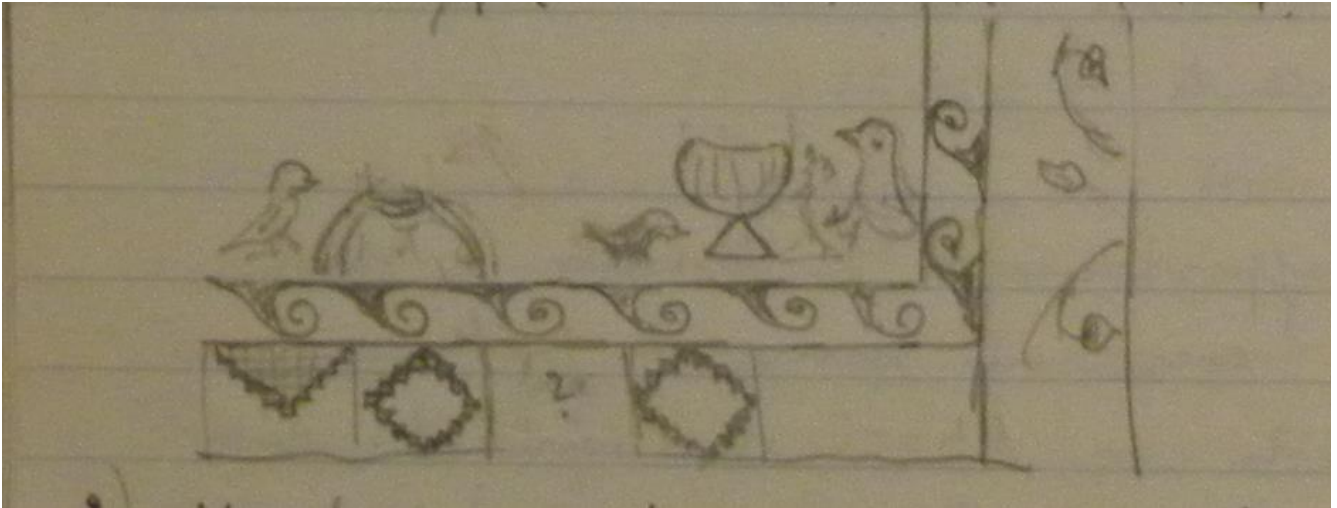


Fig. 7. Sketch of the mosaic floor in Brusin's site diary
(Courtesy of Museo Archeologico Nazionale di Aquileia archives, ms. 2006.23, date 29.12.1953).

been created in “a time of decadence and poverty”. Another sign that they were constructed on a tight budget lies in the fact that the double row of pier bases lining the square is also in part made up of reused masonry. There are 20 by 20 centimetres slots on the upper surface, providing a square lodging on each block to house the wooden pillars of a perishable roof.

Brusin reports a building constructed in the southeast corner of the square, over the pier bases, with two rooms with decorated floors¹⁶ (see fig. 2). The room to the north was better preserved than the fragmentary one to the south. The stratigraphy dates the building to a late phase. For Brusin the “mosaicist's technique and style” places it precisely in the fifth century CE. In the published report the floor decoration is briefly described. Brusin describes the first with “two elegant peacocks...and a large female head” framed by winding vines and foliage. The second has “a large rosette...with somewhat stylised billowing ribbons”. In the site diary he goes into greater detail, describing what materials were used for the *tesserae*, limestone and glass paste for the first, limestone and terracotta for the second¹⁷. A sketch in Ms. 2066 from December 29th 1953 is particularly interesting (fig. 7). It is the only record we have of the actual layout of the rooms the two mosaics belonged to. After his description of the central market building Brusin goes on to describe the other two, on either side¹⁸. He goes into little detail in his description of the one to the west: 1. much of it remained unexcavated thanks to the vineyard, mentioned above; 2. it was laid over the remains of some walls from an earlier period; and 3. along its eastern flank “about thirty amphorae all in line, one behind the other, still containing grain” came to light. These would have been used to store what was being sold in the market “like the sacks that we see today on display in shops”. The amphorae, too, have gone missing, along with all the other finds. There is, however, an interesting photograph of them that might raise some doubts over Brusin's interpretation¹⁹ (fig. 8). The depth at which they have been placed and the fact that the line continues under the pillars of the open portico running along the square suggest that they could instead be a French drain, put in place prior to paving. Unless, of course, they belong to an earlier, underlying phase.

¹⁶ *Ibid.*: 9-10.

¹⁷ Ms. 2066, date 29.12.1953. It should be noted the photographs of said finds are missing from the archives. For a description and more precise date for the two mosaics, one to the fifth the other mid fifth century CE, see GHEDINI *et al.* 2017: 463-466, nn. 711-712, 139.

¹⁸ BRUSIN 1957: 7-9.

¹⁹ Neg. 3105.



Fig. 8. The western market building seen from the north during Brusin's excavation. On the left the string of amphorae mentioned in the published report can be made out (Courtesy of Museo Archeologico Nazionale di Aquileia archives, negative 3105).

The diary contains another description that does not appear in the published report. It goes into detail about the pillar bases running along the north, west and south edges of the paved square. There are two main points: 1. one of the rows of pillars down the east side may well originally have been part of an earlier phase. The square pillar bases are brick built and measure 1.2 metres across; and 2. a second alignment, down the same side, sits on a 0.6 metres wide wall. The latter runs parallel to a second wall further to the east (fig. 9). The square is relatively small in size, 4.38 metres wide to the south and 4.54 to the north, with a 0.21 metres wide kerb down the east side and a 0.11 metres wide one to the west. It seems likely that it was surrounded by porticoes and stone and brick built shops, as opposed to the temporary lightweight stalls of the central market. The site diary goes on to describe two different layers of paving, separated by a 0.3 metres thick sandy layer. This suggests that there was more than one phase of activity for the market complex²⁰.

The eastern market building gets no more than a passing mention in the published report. The site diary talks of the paved surface emerging just below the topsoil, with various masonry pillar bases found in numerous spots along the trial trench.

²⁰ For confirmation over the various phases of floor surfaces in our excavation, see BASSO, DOBROVA (eds.) *forthcoming*.



Fig. 9. The western market building and the alignments of piers uncovered by Brusin, attributable to different phases of construction (photograph Patrizia Basso).

Giovanni Brusin's published report describes in detail the inner one of the two curtain walls to the south²¹. He dates it to the third century, when Aquileia was besieged by Maximinus Thrax. He underlines its width, a full 2.4 to 2.6 metres, and the uniform construction technique, which includes frequent reused building material. Of the latter he mentions five fragments of a sculpted cornice which would have been part of "a conspicuous public building"²² along with two honorary inscriptions. Made from Aurisina limestone, one was whole, the other fragmentary. They were dedicated to a famous politician from the Trajanic period, *Titus Quintius Caesernius Staius Macedo Quinctianus*²³ (fig. 10).

The published report also describes the outer curtain wall. It emphasises the fact that it is narrower than the other, 1.4 metres wide, but constructed "with much more care", sitting on a double row of poplar piles and "lined on both sides by a series of the same type of piles down both sides"²⁴. This system of land consolidation is explained in great detail in the site diary²⁵, along with two sketches and a photograph²⁶ (figs. 11-12). "The walls rest on horizontal alder beams", as deep as 3.2 metres below ground level, and every 0.7 metres along the northern side rectangular-shaped oak piles (between 0.14 x 0.1 and 0.2 x 0.15 metres) whose function is to "underpin the very friable sandy subsoil".

The published article ends with some interesting thoughts as to what the outer wall was for. Brusin tells us that at the start he thought it may be an artificial "riverbank or embankment". This was thanks to "three regu-

²¹ BRUSIN 1957: 10-11.

²² *Idem*.

²³ All of these are still visible in the eastern part of the wall, apart from the fragments of an inscription, of which though there is a photograph (neg. 3130). On the person mentioned in the inscriptions and his role in Aquileia, see BRUSIN 1956.

²⁴ BRUSIN 1957: 14-17.

²⁵ Ms. 2068, date 21.1.1955.

²⁶ Ms. 2068, date 20.1.1955 and neg. 3313. In the photograph on the northern side of the wall some amphorae are also visible along with the wooden piling.



Fig. 10. The inner wall built using recovered materials (bases of statues with inscriptions and parts of moulded cornices) (photograph Patrizia Basso).

lar openings, at a distance of 25.5 and 24.5 metres, one from the other”²⁷. These could have provided access for the prow of a riverboat, “making it easy to offload” merchandise from the river. But he later noticed that one of the openings “at some point had been blocked with poor quality building material”, so as to make it possible to shut it off “when necessary, to impede possible enemy insurgence”. As access to the market would in any case have been impeded by the solid inner wall he came to the conclusion that it was a secondary defensive town wall.

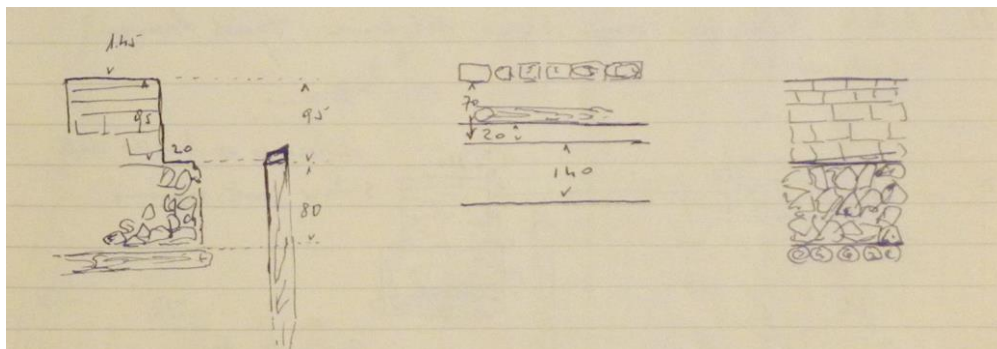


Fig. 11. Sketch in the Brusin’s excavation site diary, illustrating the system of land consolidation and underpinning for the outer curtain wall (Courtesy of Museo Archeologico Nazionale di Aquileia archives, ms. 2068.18, date 21.1.1955).

Two further comments about the wall in Brusin’s site diary are very interesting, especially in the light of results from our excavation. More detail is given in the part two of this paper about a sloping stone ramp associated with one of the openings Brusin comments on, as well as two aligned pier-like stone blocks on either side of said ramp.

Closing with the abandonment of the market area Brusin talks in his published report of burnt “piles of grain”, without going into details²⁸. In the site diary these piles were found as early as the first day of the exca-

²⁷ Ms. 2068, date 12.3.1955: more precisely the stretch of wall brought to light measures 122 metres and the widths of the three openings is given (from east to west 2.60, 3.20 and 2.75 metres).

²⁸ BRUSIN 1957: 8.

ation, just 0.6 metres below the surface. A burnt layer, some 0.15 metres thick, is described in the western square, as well as the northern part of the central square and on one of the mosaics, blackened by the fire. Here, large quantities of carbonised barley were recovered. The same situation was also found during our excavation²⁹.

Patrizia Basso

1.2 Paola Lopreato's work during the 1980s

The area located at the western edge of the former Pasqualis property, once used as a home and stable, is currently hosting the headquarters of the Fondazione Aquileia from one side and a Carabinieri Station from the other side. Over the years the plot has been archaeologically excavated due to rearrangement of the buildings.

The first mention in the archives of these excavations dates back to 1980. To convert the ground floor of the farmstead into a museum archaeological excavation was necessary. The site records report the find of a mosaic, with terracotta *tesserae* (figs. 2, 13). Further renovations of the building located along the via Giulia Augusta went ahead in 1983. The works, between April 18 and December 23, were supervised by Paola Lopreato. The archives are home to the site diary and a series of drawings, both plans and elevations, concerning the building renovation.

Paola Lopreato returned to supervise further excavations in 1989 in the southern part of the central courtyard. Unfortunately, there is no site report in the archives or any trace of the finds. The only information we have about the excavation is the discovery of at least seventy coins. These go still further to support the theory that this was a commercial zone. The dates of the coins indicate that the area went through an intense period of activity in Late Antiquity, between the fourth and fifth century CE³⁰.

1.3 The GeoTest s.n.c. 1990s excavations

The then archaeological superintendent, Franca Maselli Scotti, set in motion a new wave of research in the 1990s with a series of excavations in the hands of GeoTest s.n.c. archaeological unit.

In 1990 the ex Pasqualis house in via Giulia Augusta was renovated to house a museum on the ground floor. Archaeological excavation inside the building uncovered a stretch of mediaeval road, overlying the Roman *decumanus*. The latter was laid with uniform trachyte slabs and limestone blocks (figs. 2, 14). The excavation ran from January 22 to February 8. All site records are housed in the museum archives. These include the site diary, context sheets, two plans documenting the state of the site at the end of the excavation and illustrations



Fig. 12. Land consolidation with amphorae and timber piling uncovered by Brusin just north of the outer curtain wall (Courtesy of Museo Archeologico Nazionale di Aquileia archives, negative 3313).

²⁹ See further details in BASSO, DOBREVA (eds.) *forthcoming*.

³⁰ Some information about the site was found in a university thesis which had drawn from the site diary. This too is yet to be found in the archives of the *Museo Archeologico Nazionale di Aquileia*: SELLAN 1997-98: 41-43 and 128-160. Thanks go to Andrea Stella for the information.

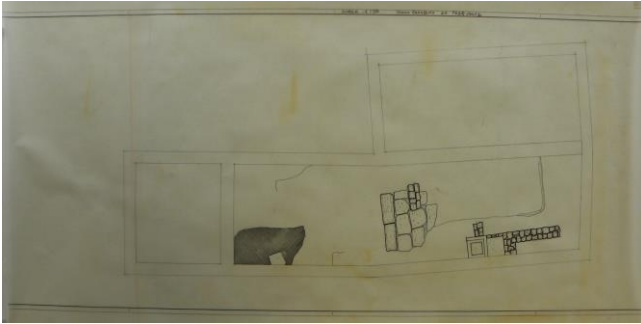


Fig. 13. 1980 site plan (Courtesy of Museo Archeologico Nazionale di Aquileia archives, n. 1518).

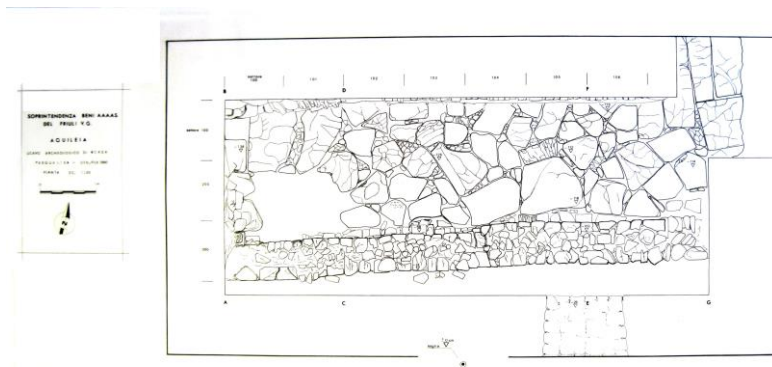


Fig. 14. 1990 site plan (Courtesy of Museo Archeologico Nazionale di Aquileia archives, n. 521).

of some of the more significant finds (figs. 2, 15). The finds have been located in the museum store-rooms³¹. There are three crates containing a total of 649 pottery, glass and metal finds, along with organic material and architectural elements³². Most of them are potsherds. The principal pottery classes indicate that there was activity in the area between the Early Imperial Period and Late Antiquity. The latter period is particularly documented by the presence of fourth and fifth century African Red Slip ware (fig. 16) and glazed pottery. Functionally, most of the pottery is transport containers, the majority *amphorae*, followed by kitchenware. The latter included

both locally or regionally manufactured coarse ware as well as imported Internal Red-slip pottery. The tableware included thin walled vessels and *terra sigillata* manufactured in northern Italy and Africa. The examples of tableware are enriched with numerous glass and locally produced fineware plates. There are also objects used for illumination, for the most part lamps, either disc lamps or *Firmalampen*. The building material recovered on site was probably part of the numerous renovations the area underwent. According to the site documentation these are, for the most part, mosaic *tesserae* and small terracotta cubes.

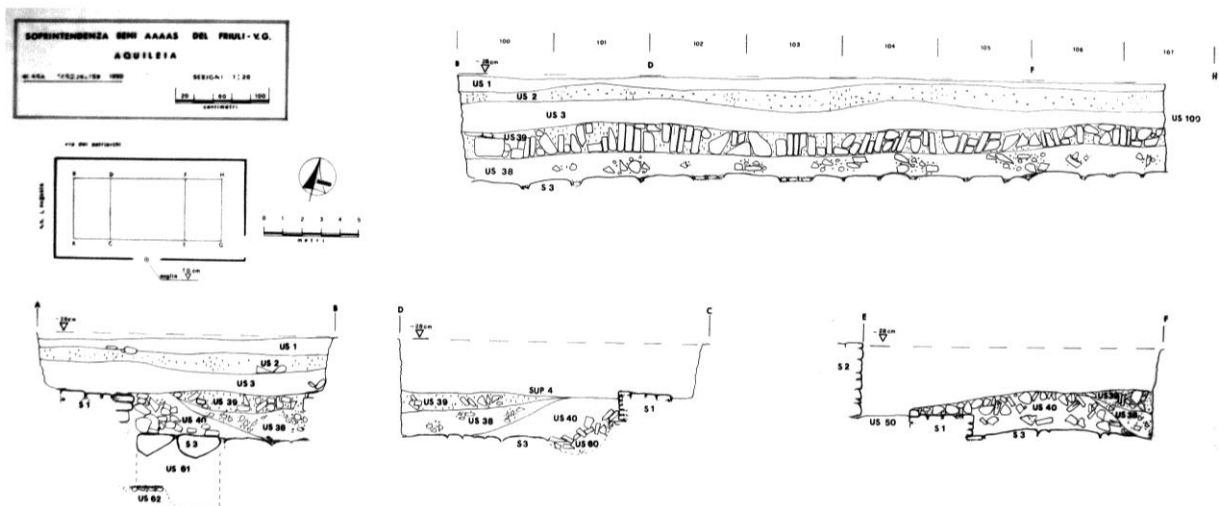


Fig. 15. 1990 site section (Courtesy of Museo Archeologico Nazionale di Aquileia archives, n. 521a).

³¹ The finds were tracked down thanks to the generous help of Elena Braidotti of the Museo Archeologico Nazionale di Aquileia.

³² Catalogued finds 372401 – 372600 e 375780 – 375925. Thanks to Vittoria Canciani and Sabrina Zago for their help in viewing the finds in question.

There are also roof tiles, one of which has part of a stamp, [C.TITI]HERMER[OTIS]. There are also a few iron nails, limestone slabs and fragments of marble architectural elements. The rare examples of painted plaster include a fragment of a moulded cornice. The rest of the finds are either bone or shellfish.

Between November 22nd and 30th 1993 a new excavation took place on a patch of land known as “Braidia Pasqualis”. It lies on the southern edge of town, limited by the inner town curtain wall and the River Natissa. The site documents housed in the museum report various stretches of wall. These were thought to be the continuation to the West of the two curtain walls excavated by Brusin. To better understand these structures the area was reopened and cleaned in 2019³³.

The importance of this area for understanding both the course of the town walls and its relationship with the excavated area of the market buildings and the Roman *decumanus* was the main focus of the further excavation held between April 18th and May 3rd 1994. This was because a septic tank had to be sunk on the eastern side of the building, almost up against the boundary wall between it and *Via dei Patriarchi*. The structures that came to light were very badly preserved. In spite of this, the medieval road was identified “laid with limestone slabs and horizontal bricks, its surface much worn”³⁴. The above mentioned Roman *decumanus* was too badly preserved to be identified, thanks also to a modern ditch that had carried off a lot of the stratigraphy.

In April 1995, the 1993 and 1994 excavation on the “Braidia Pasqualis” was reopened. The idea was to open up a stretch to the East, in an attempt to better understand the relationship between the previously uncovered structures. One major result concerned the best-preserved, seventeen metres long, stretch of wall. It was no longer seen as a continuation of Brusin’s inner curtain wall, but instead as an embankment on the River Natissa. The site also provided precious information about the earliest activity in the building complex, as finds dated this to the first century CE. Finds also dated when said complex fell into disuse, apparently between the fifth and early sixth century³⁵.

The site was reopened one last time between June 17th and August 25th 1996. The excavation revealed the importance of what had been interpreted as a jetty that runs along the Natissa River from east to west, and a probable mooring spot already excavated previously. The 1996 excavation identified four different phases in its construction³⁶ (fig. 17). The jetty appears to have been built between 25 and 125 CE. Somewhere between the first and third century a mooring spot was created with the addition of four sandstone steps. Between the fifth and sixth century the jetty fell into disuse and was blocked off. Immediately north of it new buildings, possibly warehouses, went up. In the same period drainage ditches were cut and various dump layers deposited along with their occupation levels, covering the earlier structures. The fourth and last phase of activity is difficult to date. A vast landfill project shifted the course of the River Natissa to its current position. The latest activity recorded on site was a series of robber trenches in the twelfth or thirteenth century. There are also some traces from the First World War.

Diana Dobreva



Fig. 16. African Red slip ware finds from the 1990 excavation (photograph Sabrina Zago).

³³ See results in BASSO, DOBREVA (eds.) *forthcoming*.

³⁴ *Relazione 1994*: 7.

³⁵ In reference to finds from contexts 8, 8A, 9 e 9A, see *Relazione 1995*: 14.

³⁶ *Relazione 1996*: 4-9.

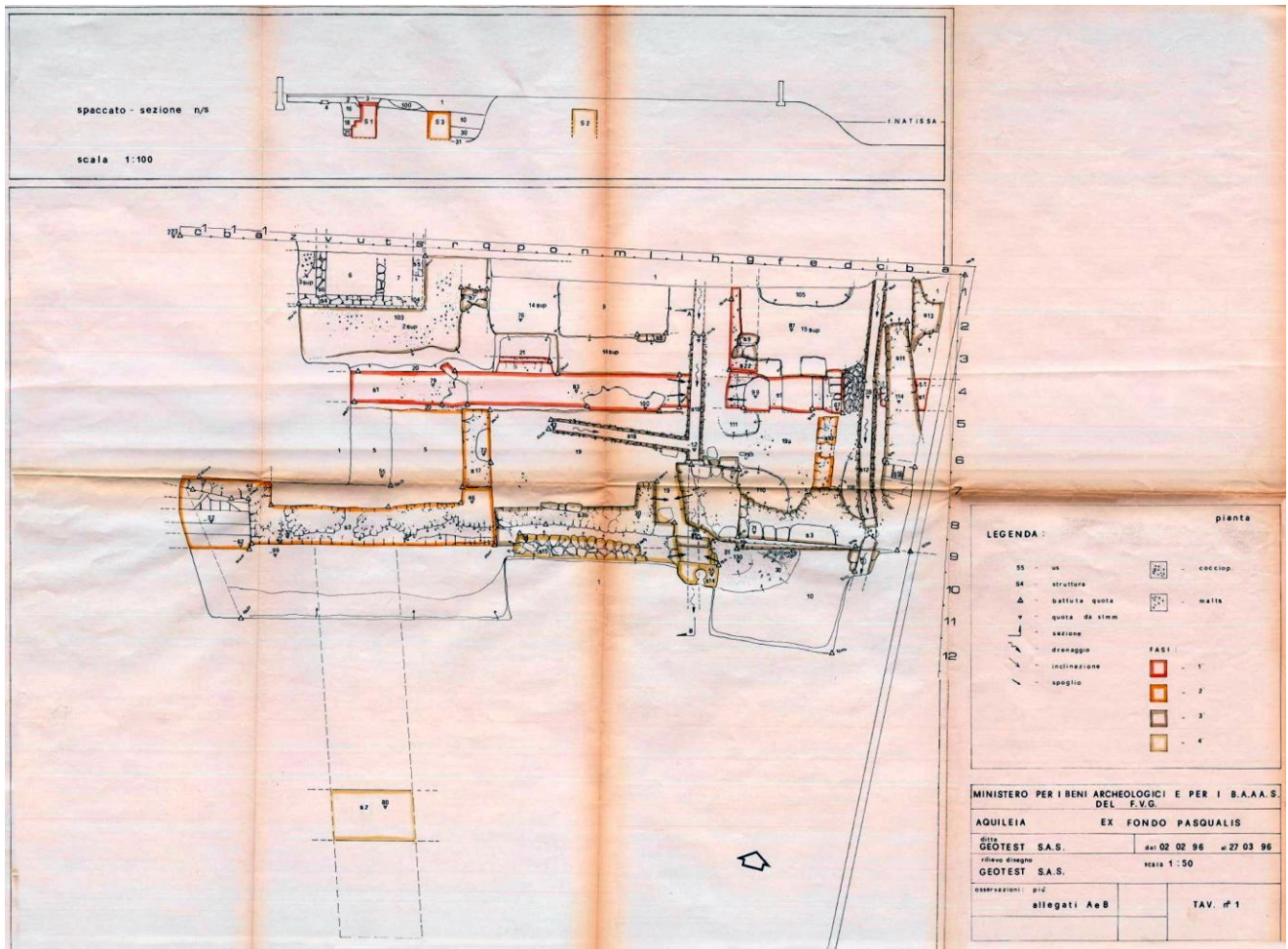


Fig. 17. 1996 site plan and section (Courtesy of Museo Archeologico Nazionale di Aquileia archives, Table 1).

2. Geophysical survey

As mentioned above, prior to excavation two geophysical surveys were completed over the whole site. The results are presented here in the order in which they were carried out.

2.1 The geophysical survey carried out by Esplora srl

The geophysical survey was carried out in April 2018. It was performed integrating 3D GPR and multi-spectral aero-photogrammetric methods to get the maximum amount of high-resolution data down to some meters below the surface.

2.1.1 3D GPR results

We used a full 3D Malà MiniMIRA system equipped with an array of 9 shielded antennas with a central frequency equal to 400MHz. The survey allowed us to collect a data volume with trace and profile spacing equal to 8cm on an irregular area of about 1.5 hectares. Our dataset was georeferenced with an RTK GPS and, after a dedicated processing phase, the interpretation of the electromagnetic features permitted the reconstruction of the shape, dimension, and thickness of several buried structures. Imaging techniques were applied to

focus diffractions so increasing lateral resolution, while specific GPR attributes were calculated to make more affordable data interpretation and target classification³⁷.

The soil conditions allowed us to reach a depth of about 2.5 m from the topographic surface, with a vertical and lateral resolution of a few centimetres. The electromagnetic features identified and extracted from the processed GPR data volume, are basically of two types: 1- high-amplitude localised horizons and 2- planar well-reflecting surfaces. The first structures can generally be interpreted as portions of walls, more or less continuous, and/or columns; the second are probably paved areas, roads or ramps.

In the 3D view of the depth slices, all these elements are characterised by some regularities in their shape, making it fairly easy to detect their dimensions and extension.

Fig. 18a shows the location of the interpreted features within the whole survey area: different colours refer to their depth, while each numbered code to their thickness. In the south, west and east portions of the surveyed area a great number of well-defined rectangular shaped features follow the prosecution of the outcropped city walls (depicted by pink arrows). To the north, a clear linear anomaly is evident, continuing to the eastern part of the site (purple arrows). This is thought to be a road. A first interesting complex of raised structures (fig. 18b): a set of square anomalies at the depth of 1.3m, regularly spaced along a rectangular edge, with a thickness of about 0.5m, and, at their bottom, a planar surface. Such elements can be interpreted as a paved surface with the remains of an arcade, very similar to the adjacent excavated features associated with the market building. A second group of interesting features are shown in detail in fig. 18c: there is a circular structure with a diameter of about four metres, one metre below the surface, near a paved area which also has circular shape (orange arrows).

2.1.2 Multispectral Aerophotogrammetric results

Remote sensing multispectral surveys can help in the detailed location and mapping of structures lying in the shallowest parts of the subsurface. The estimation of the health of plants and vegetation can provide ancillary information on the presence of buried structures, because these can hinder water seepage, thus limiting plant growth. Such information can be highlighted by the Red and Near infrared bands³⁸. The aerophotogrammetric multispectral investigation was performed using a MicaSense RedEdge sensor that records pictures within the bands of Blue, Green, Red, RedEdge and Near Infrared (NIR), mounted on a Nautec NT6 APR. We summarized the multispectral results with a CI Index (Chlorophyll Index) which gives an estimate of Na content in plants and their photosynthetic activity, which in turn refers to the health conditions of the vegetation.

We found an interesting correlation with some GPR features (fig. 18d, black arrows), especially in correspondence to the paved area detected in the western part and of some walls in the central area. The anomalies are characterized by low values on the CI index (light blue to white colours), but in the present case are quite weak, making it difficult to directly link them to deep buried structures.

2.1.3 Conclusions

The 3D GPR method demonstrated its high potential in an accurate reconstruction of the shape and dimensions of archaeological targets down to a depth of about two to three metres. 400MHz antennas are a good trade off between resolution and penetration for this kind of study. The aerophotogrammetric multispectral data can be a valid support, but limited, in the present case, to very shallow features. The final results can be easily managed on a GIS platform, making archaeologists able to plan future excavations and to better integrate the results of previous surveys.

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³⁷ ZHAO *et al.* 2018.

³⁸ MUSSON *et al.* 2005; LASAPONARA, MASINI 2007.

a- 3D GPR depth slice at 1.7m of depth from the surface with the map of the anomalies over the aerophotogrammetric picture

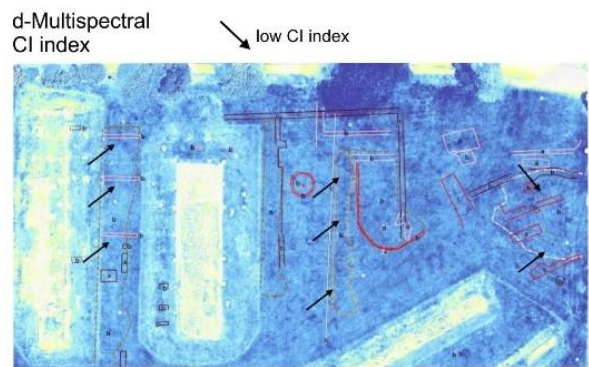
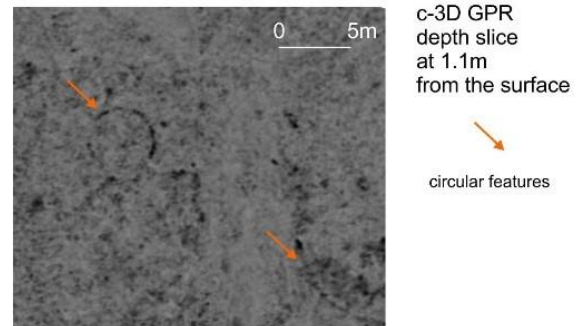
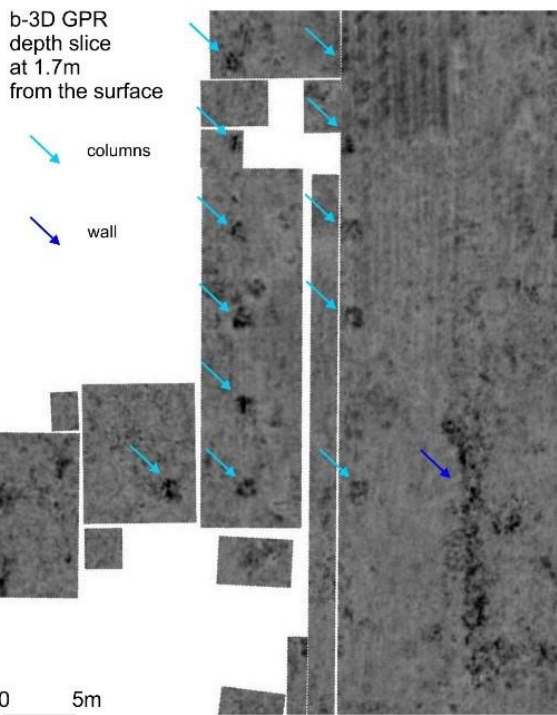
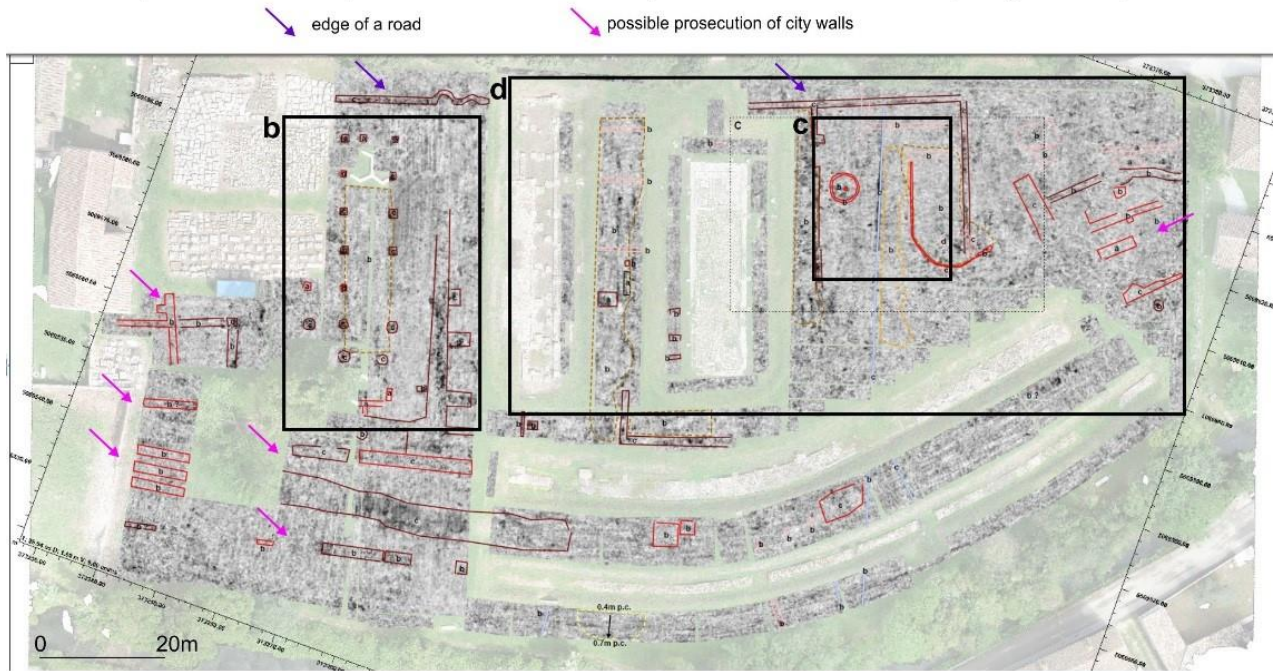


Fig.18. Esplora srl's 3D GPR result: a - 1.7m depth slice superimposed on the aerophotogrammetric image with the most relevant interpreted structures; b - detail of the 1.7m depth slice, the arrows depict anomalies referring to walls and columns; c - detail of the 1.0m depth slice, the arrows depict anomalies referring to circular structures; d - portion of the multispectral results (CI index), the arrows depict low values zones in correspondence to some GPR anomalies (reworked by Roberta Zambrini).



Fig. 19. Magnetic (L) and GPR survey (R) by the Ghent University team (photograph Frank Vermeulen).

2.2 The geophysical survey carried out by a team of the Department of Archaeology of Ghent University (Belgium)

The aim of the survey, conducted between July 6th and 8th 2018, was to test the suitability of the geomagnetic technique and to confirm the suitability of ground-penetrating radar (GPR) for the detection of archaeological remains in this part of ancient Aquileia. The location, layout and known burial depth of the excavated structures provided the reference for the geophysical prospection and helped to refine the archaeological interpretation. As had already been demonstrated by Esplora srl (see above §2.1), the soil conditions are good for a GPR survey. This allowed us to detect a whole series of anomalies down to an estimated depth of at least 1.8 metres. Several buried features, visible on the GPR data, may be related to the remains of the late Roman market building and adjoining shops, and two city walls partly excavated in the past (see above §1.1). The magnetic data obtained by our team was less convincing and did not add much new information. The results from both methods will be further evaluated and interpreted parallel to the new excavations.

2.2.1 Magnetometry survey

For the magnetometry survey in Aquileia we used a mobile cart array with four magnetic fluxgate gradiometer probes produced by SENSYS (fig. 19). For logistical reasons we used two types of probes for data acquisition: two shorter outer ones with a sensor separation of 0.4 m (FM400) and two longer inner ones (FM650, sensor separation 0.65m). This configuration could in theory affect the consistency of the data, but in practice the effect was minimal. Positioning was obtained with a GPS (Leica Viva) mounted on the cart and the resolution was 0.5m profile distance/0.05m point distance. A total of about one hectare was surveyed, around the previous excavation area (fig. 20). The magnetometer survey was affected by a series of modern disturbances on the site (iron fences, iron chains, buildings, scrap metal etc.) mostly from the former excavations and panels and safety equipment for visitors.

Throughout the survey area, but mostly in the eastern sections, a number of single positive magnetic anomalies were detected. These may be archaeologically relevant, but they could also be related to disturbance. More convincing are a few linear features with negative magnetic amplitudes in the eastern part of the survey area. These may be related to archaeological traces with diamagnetic properties, such as limestone walls or other structural features with a negative magnetic contrast. As a general observation it can be stated, however, that magnetic gradiometry was not particularly helpful in detecting traces of archaeological remains in this part of Aquileia. The Roman occupation levels are most likely buried too deep to be detected by the equipment used. In the exposed excavation areas, the depth of the remains was seen to be more than 1.5 metres



Fig. 20. Image from the geomagnetic survey (reworked by Wieke de Neef and Frank Vermeulen).

below the present day surface. The maximum detection range of the used equipment is typically 1-1.5 metres; weakly magnetized materials such as the predominant sandstone building material used here may not be detectable at this range, especially if they are covered by more magnetic material.

2.2.2 Georadar survey

Terrain conditions for GPR survey were optimal, as the relatively flat terrain was covered by short grass. A robotic total station Leica TS15 P 3" was used from three setup points from where the mobile GPR platform could be tracked everywhere in the prospection area. For geophysical data acquisition we used a Sensors & Software pulseEKKO PRO Spidar GPR with fifteen antennas with a frequency of 500 MHz and Network Interface Controllers connected to a laptop computer. The antennas were mounted on a wooden cart, towed by an ATV (quad bike), with a distance between them of 0.25 metres (fig. 19). Since the antennas were arranged in two rows, the distance between transects was only 0.125 metres. After data processing the geophysical results were converted to greyscale images which allowed the presentation of a series of depth slices of the surveyed terrain. A two-dimensional interpretation drawing is given (fig. 21), comprised of the interpretation of all depth slices.

The clearest anomalies visible in the GPR survey results belong to a building complex situated to the west of the excavated market structures. They consist of a paved area with a minimum area of six metres by thirty, surrounded by columns. It can be interpreted as part of another market building. To the east of the excavated market building, other features in the GPR data set may point to a fourth market or warehouse (?). In particular, a round structure with a diameter of about 4.5 metres may be similar to the channels that delineate a square area in the eastern excavation. However, the interpretability of these anomalies is lower since they are obscured by features probably of a more recent origin (a drain; marks of recent cultivation?). Also, the two ex-

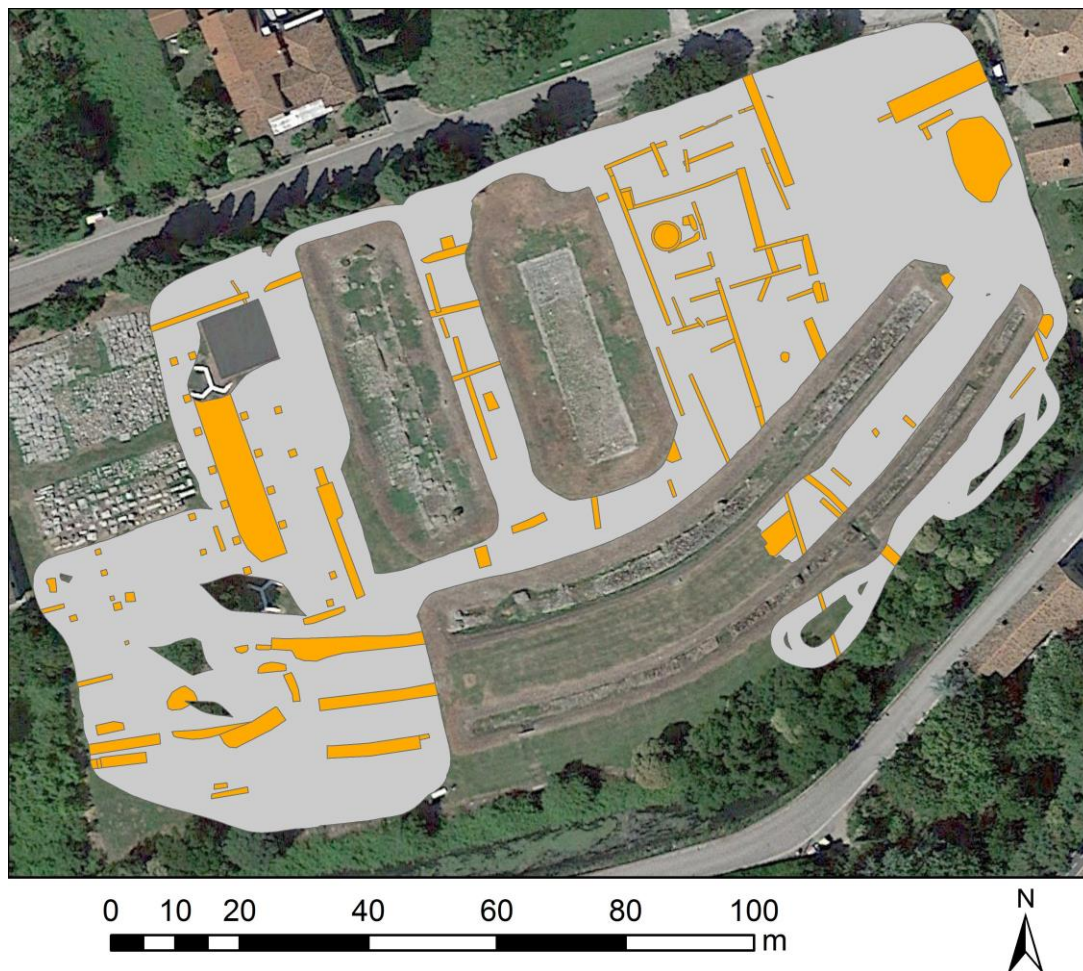


Fig. 21. Interpretative plan of the GPR-data (reworked by Lieven Verdonck and Frank Vermeulen).

cavated city walls can be reconstructed further, to the west. The clearest anomaly is caused by the inner city wall, appearing in the horizontal slices at depths from about 0.5 metres down to over 1.50 metres, for a length of about 25 metres. The outer wall is less clear on the GPR results. In between these two wall anomalies, a third one of less certain interpretation (road, reinforcement of the other walls?) is clearly visible down to a considerable depth. For several other anomalies there is no straightforward interpretation.

2.2.3 Conclusions

The geophysical surveys in Aquileia obtained good results that can enhance the understanding of this late Roman intra-mural market complex on the southern edge of the ancient city. In particular the GPR results can be of great value for positioning future excavation trenches and for a more complete topographical reconstruction of the site. The GPR approach could also be successfully applied to other sectors of the cityscape of Aquileia.

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