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Studies

ARCHAEOLOGICAL TOPOGRAPHY

THE ROLE OF TOPOGRAPHY AND PHOTOGRAMMETRY IN CONNECTING ARCHAEOLOGICAL VESTIGES. DOCUMENTING THE THERMAE OF LEGIO XIII GEMINA FROM APULUM

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Abstract: The archaeological research, especially the preventive type, is usually determined by interventions and investments in a specific archaeological area, having also a powerful destructive character. The role of the topography in this research, together with the legal compulsory character, is very important; the modern measuring techniques have a special contribution in the contextualisation of the archaeological discoveries, especially for those from a documented archaeological area, due to the fact that it can be a revealing factor by bringing vestiges together and achieving a "composite" material, that can be useful to draw important conclusions related to the "monolithic" ensemble of structures and buildings belonging to the same period. At the same time, the modern techniques for the collection, storage and analysis of the topographic-archaeological data may be significantly important for the sustainable development of a region, by preserving and highlighting the cultural heritage.

Keywords: *topography, archaeology, photogrammetry, interdisciplinarity, sustainable development, modern techniques, Roman legionary fortress, Apulum*

1. INTRODUCTION

The layout of the topographic plans for the revealing of the archaeological vestiges is already a tradition; their presentation in the specific reports is a legal obligation for the archaeological research.

The measurements and the plans have a long tradition in archaeology, especially for the sits represented by archaeological excavations, a common practice that contributes to the interpretation and classification of a site, using the investigation of the spatial relations between the archaeological features and the landscape.[1]

The possibility to reuse the archaeological studies has an important impact on the development of the capacity to manage and archive the digital data. The measurements are necessary for fulfilling specific requirements. Therefore, the topographic plans are at specific scales. Once placed in a digital environment, the potential of data reusage increases due to a facilitated

[1] BOWDEN 1999.

access. Still, in this type of abstract environment, the initial issue examination, such as the scale or the purpose, may be easily lost. Thus, if a plan is reused in an environment with the capacity to generate new data, as GIS[2], the deformation level and the imprecision can increase.

The evolution of digital data storage capabilities allows the accessibility of the data sets and their free reuse[3], this potentiality being highlighted especially for data sets with spatial referentiality and in the development of the archaeological research in the field, based on GIS[4], for the data acquisition, storage and analysis. This environment allows the inclusion of results from previous research in the current database, obtaining more understandable conclusions, using a standardized frame.

The topographic measurements represent a special form of data reuse. In fact, they are, normally, data with special referentiality, which makes them ideal to be included in the data sets of archaeological importance.[5] The results of surface archaeological research are mainly interpretative drawings. They are representations to certain scales of the details in the field and are obtained by combining the knowledge of the archaeologists with the experience of the topographer. As they cannot be considered to be objective, the measurements offer another type of data, compared with the distribution of the discoveries. The use of measurements is also determined by their aim, imposing the scale of the representation, and the detailing level and accuracy, when reused. In time, this information obtained to an initial scale can be lost, especially when their registration is a secondary presentation. Therefore, the problem of the storage of previous data was considered in the literature and remains a fundamental theme in the digital storage.[6]

2. MATERIALS AND METHODS

The present study was initiated starting from the topographic surveys occasioned by the preventive archaeological research carried out in 2019, in the area of The Third Gate of the Vauban Citadel from Alba Iulia, inside the fortress of Legio XIII Gemina at Apulum.[7] They were determined by the implementation of a private investment positioned in the South-East of the Roman fortress, in *praetentura dextra*.

Fig. 1. Localisation of the researched area in 2019.

[2] SAVAGE 1990.
[3] RICHARDS 1997.
[4] GILLINGS/WISE 2002.
[5] PARKER/SYDES 1995.
[6] WISE/MILLER 1997.
[7] GORONEA 2007.

Fig. 2. The topographical survey.

2.1. The geographical context

The construction area for the Roman fortress and most of the *canabae* civil settlement (the south, west and north sectors) is situated on the third terrace of Mureş River, also called *The Romans' Plateau*. The eastern sector is situated on the first terrace of the same river.[8] Next to Mureş River, in the vicinity of the Roman settlement, there are the affluent rivers, Sebeş River and Ampoi River. The terraces where the fortress and the first civil settlement from Apulum were formed are situated on the corridor Alba Iulia - Turda (110 km in length, between 5 and 10-20 km wide), in the Transylvania Basin. The legionary fortress was placed in the central area of the province, strategically at the confluence of Mureş River and Ampoi River.

Built on the third terrace of Mureş River, the fortress of Legio XIII Gemina was placed at the intersection of the communication paths connecting the capital Ulpia Traiana Sarmizegetusa with Napoca and Porolissum – representing the most important defence point for the northern border of Roman Dacia. At the same time, this construction facilitated an easier exploitation of the gold found in the Apuseni Mountains. This was the control point of the commerce with the surface and subsurface resources (gold, silver, salt and copper) in the new province.

2.2. The archaeological context

The researched area is historically and archaeologically situated in Apulum, inside the fortress of Legio XIII Gemina. The Roman fortress (2nd - 4th c. AD) is considered a site A type and a priority archaeological site, according to the LMI Code (AB-I-m-A-00001.01).

Apulum represents the biggest Roman conurbation in the province of Dacia. After the second Dacian War, it will become the residence of Legio XIII Gemina until the Aurelian withdrawal. The medieval fortress reused the walls of the Roman fortress, overlaid later, in the 18th century, by the Vauban fortification.

[8] MOGA 1998.

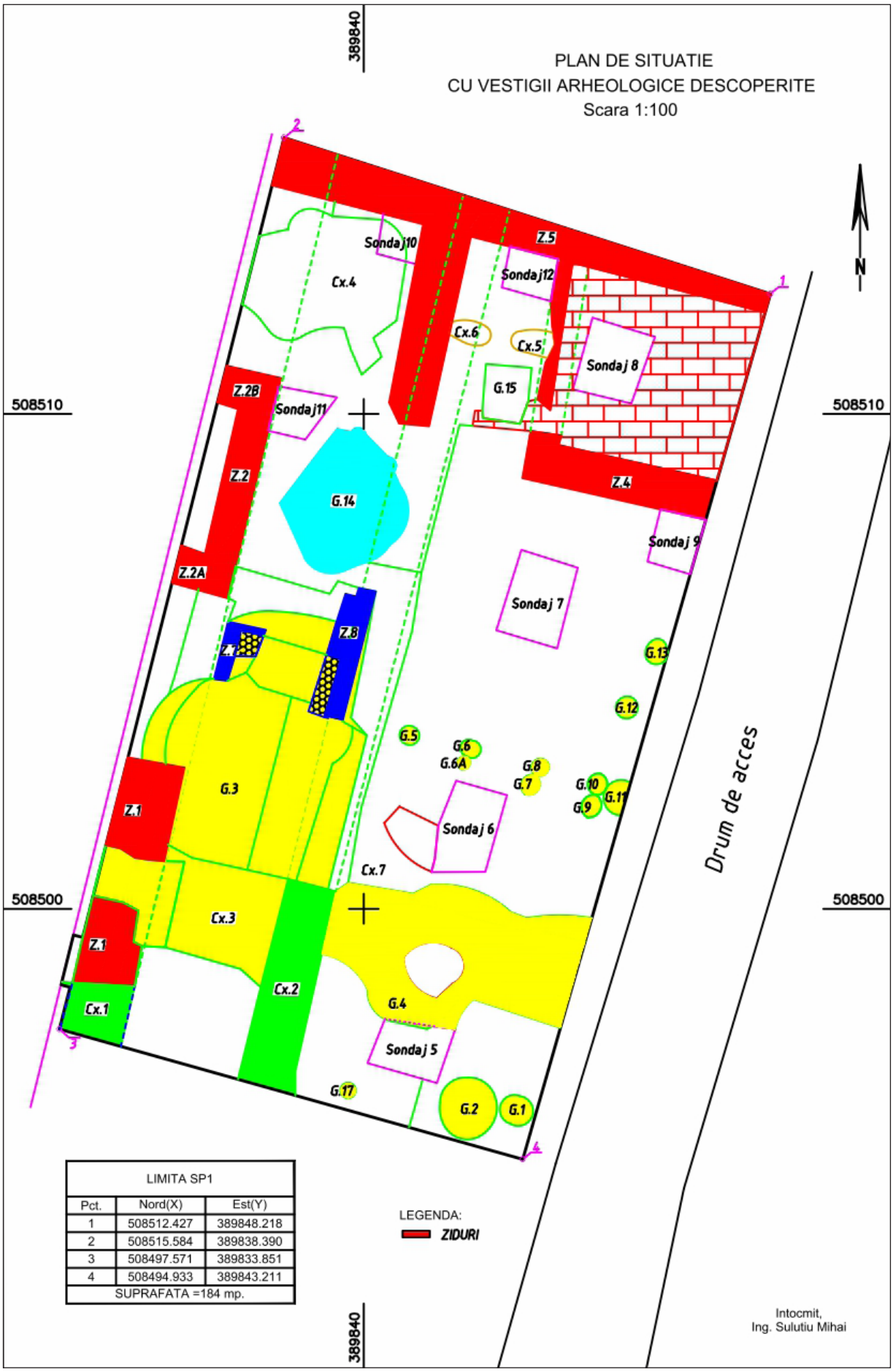

Fig. 3. General site plan.

Apulum had a unique urban evolution through developing two centres. The first city, Municipium Aurelium Apulense, was established during Marcus Aurelius; it received the statute of *colonia* (*Colonia Aurelia Apulensis*) during the reign of Commodus (180-192 AD) – conventionally called *Apulum I* (under the present Partoș District). The second city (*Apulum II*) became *municipium* under Septimius Severus – *Municipium Septimium Apulense* - and coexisted with the first urban centre. In 1989, the archaeological research of Al. Diaconescu and I. Piso brought out new information on the localisation and the features of the two Roman cities.[9]

If *Municipium Aurelium Apulense* was outside of a *leuga* (2.2 km, delimiting the territory administered by the Army), initially a *pagus* of *Colonia Ulpia Traiana Augusta Dacica Sarmizegetusa*, during Septimius Severus, this rule changed and the statute of *municipium* was granted to a part of *canabae* settlement, as recognition for the military contribution and support. Therefore, along with *Municipium Septimium Potaissa*, located in the vicinity of the fortress of Legio V Macedonica, the *Municipium Septimium Apulense* developed from the civil settlement (*canabae)* of Legio XIII Gemina at Apulum.

The Roman fortress at Apulum was built immediately after the conquest of Dacian Kingdom of Decebalus by the Emperor Trajan (98-117 AD), starting with 106 AD. It is assumed that, in its first construction phase, the fortification consisted of an earth mound, one or two defensive trenches and a wooden palisade. The second stage of construction is represented by the fort with limestone walls, brought from the quarries of Șard and Bărăbanț and dates from the time of Hadrian (117-138 AD). Their construction technique is *opus quadratum* (parallelepipedal and shaped stone blocks, arranged in several rows, fastened with iron and lead clamps). The *castrum* has a rectangular shape, with sides of 470/480 m x 440 m and an area of 21 ha. It was strategically located on the third terrace of the Mureș River (*Maris*).

The archaeological research undertaken within the perimeter of the fortress of the legion XIII Gemina and its civilian settlement, managed to provide an overview of the dimensions, organization and planimetry of the Roman fortification. The most important recent investigations were carried out in 2011 - rehabilitation of the historical center of the Alba Carolina Citadel[10], 2016 - archaeological research occasioned by the restoration of a historical monument building in order to set up a religious art museum (*Museikon*), which brought to light important data with looking at the vestiges in the north-western area of the fortress[11], 2016 - archaeological research in the *praetentura dextra* occasioned by the restoration of the War Commissariat building, which led to the discovery of the sides of some Roman barracks[12], 2019 - the discovery of large halls and heated rooms that could belong to the military baths (Fig. 1).

[9] DIACONESCU/PISO 1993.
[10] GUDEA *et alii* 2015.
[11] OTA/FLORESCU 2016.
[12] OTA/FLORESCU 2017.

2.3. The development of the topographic and photogrammetric observations; data processing and storage

The topographic measurements within the archaeological research were first initiated in order to determine, with the help of the GPS technology, the coordinates of the support points (Stereo `70), as points for the detailed measurement of the archaeological vestiges (Fig. 2). We used the real time services - RTK pf the national system for determining the position - **ROMPOS**, as system based on the GNSS technology.

The angular and linear observations of the points of archaeological interest were performed with the help of the total station, using the standard prism and also the mini prism, necessary to obtain precise archaeological details, in order to contextualise them on the researched area.

The data transfer and processing were performed using a specific software of the station and also a specialised software for processing the data coming from the archaeological topographic surveys. The site plans of archaeological interest were completed with the help of the AutoCAD software (Fig. 3-5).

During the second stage, a general plan was completed, including the complete representation of the archaeological vestiges discovered within the rescue excavations (Fig. 3). Later, at the request and with the collaboration of the archaeologists, we completed the thematic plans necessary

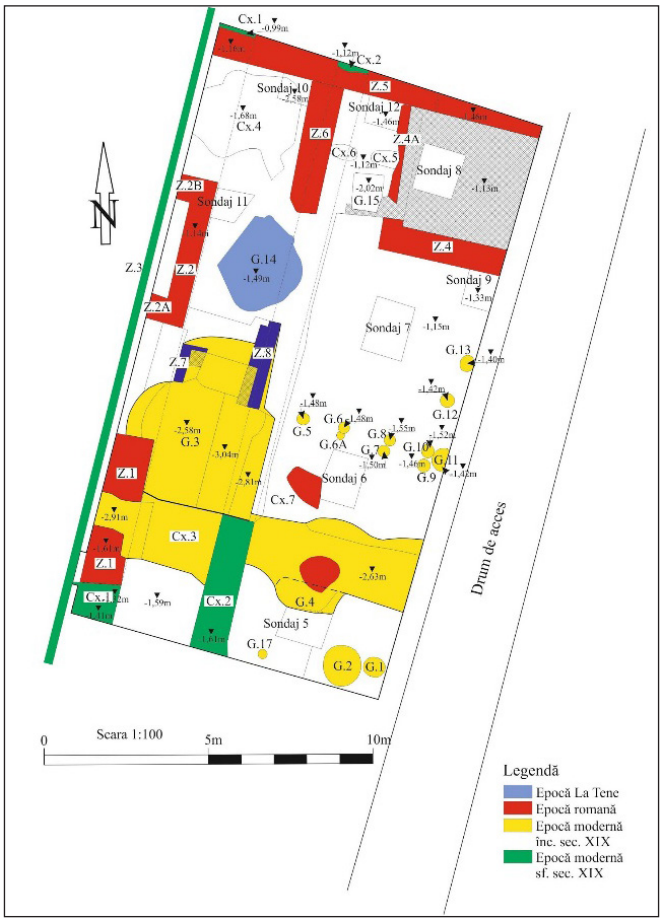

Fig. 4. The plan of archaeological features by historical periods.

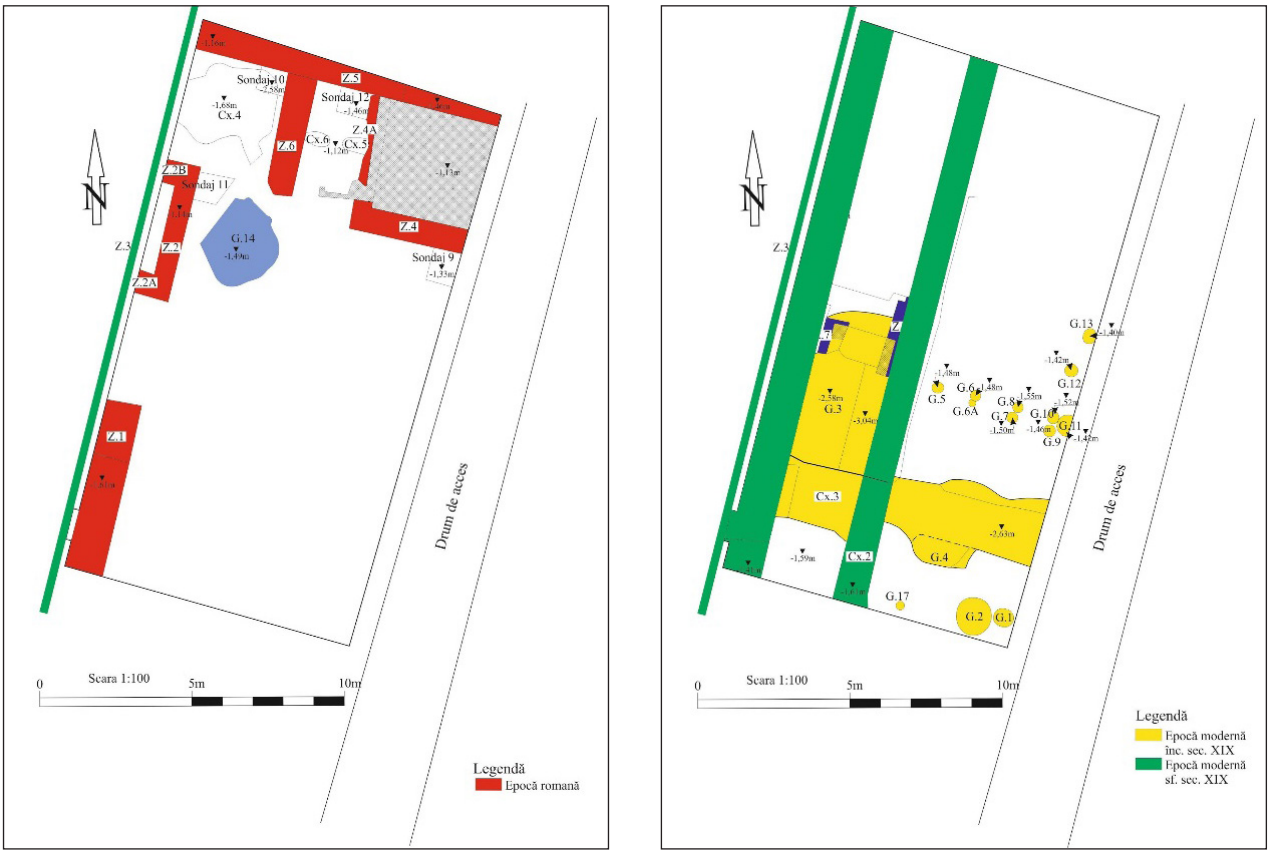

Fig. 5. The plans of archaeological features - Roman (left) and Modern (right).

Fig. 6. The photogrammetric documentation of the researched area.

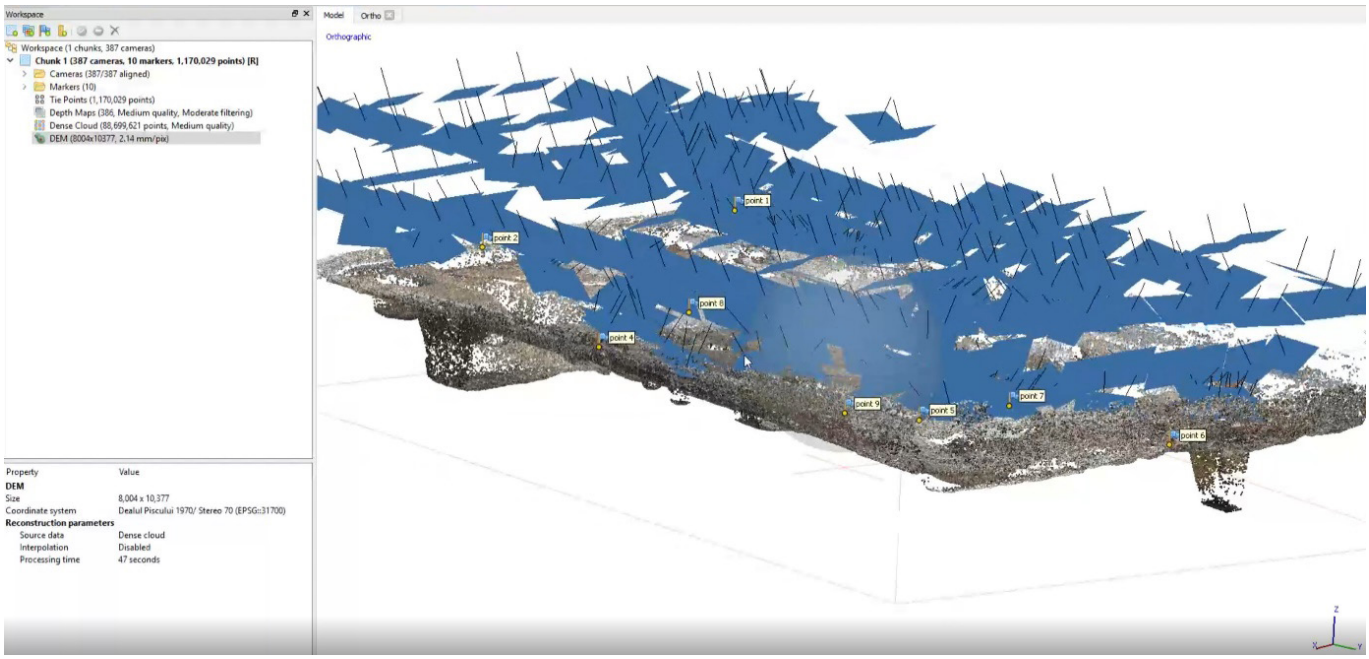

Fig. 7. Photogrammetric data processing.

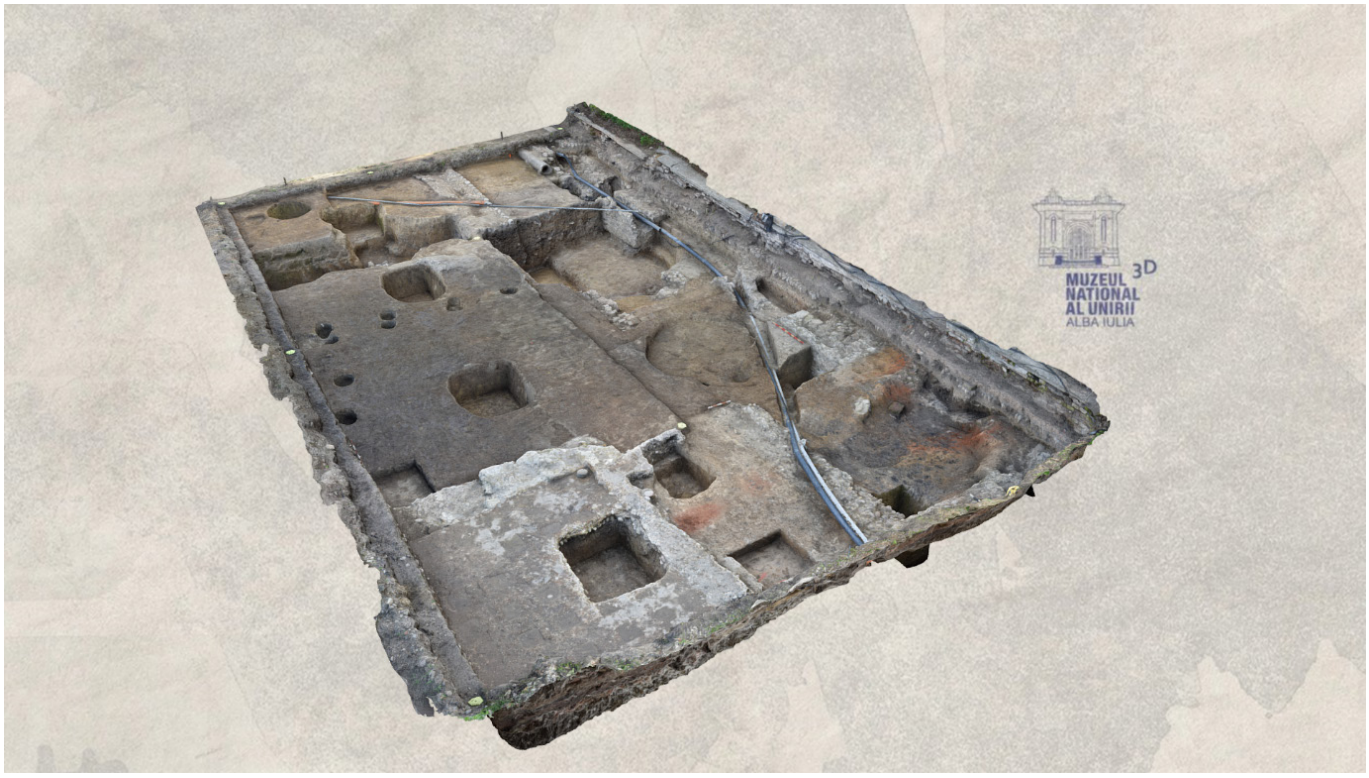

Fig. 8. The 3D model of the researched area.

for the search of the archaeological elements and materials (type of material, period etc.).

The archaeological features were also photogrammetrically documented by aligning the cameras (375 high resolution photos) and the generation of the rare point cloud, dense point cloud (88 million point, medium), and the digital elevation model (DEM). The georeferenced and the orthorectification were completed with the help of 10 targets. The measurements were performed with a GPS RTK Leica GG04 unit (Fig. 6-7).

As observed, we completed a three-dimensional and extremely accurate reconstruction of the archaeological elements within the archaeological excavations (Fig. 8). The archaeological excavation correlated with the topographic and photogrammetric studies highlighted a series of structural elements probably belonging to the military baths (*thermae*) of Legio XIII Gemina at Apulum (Fig. 13).

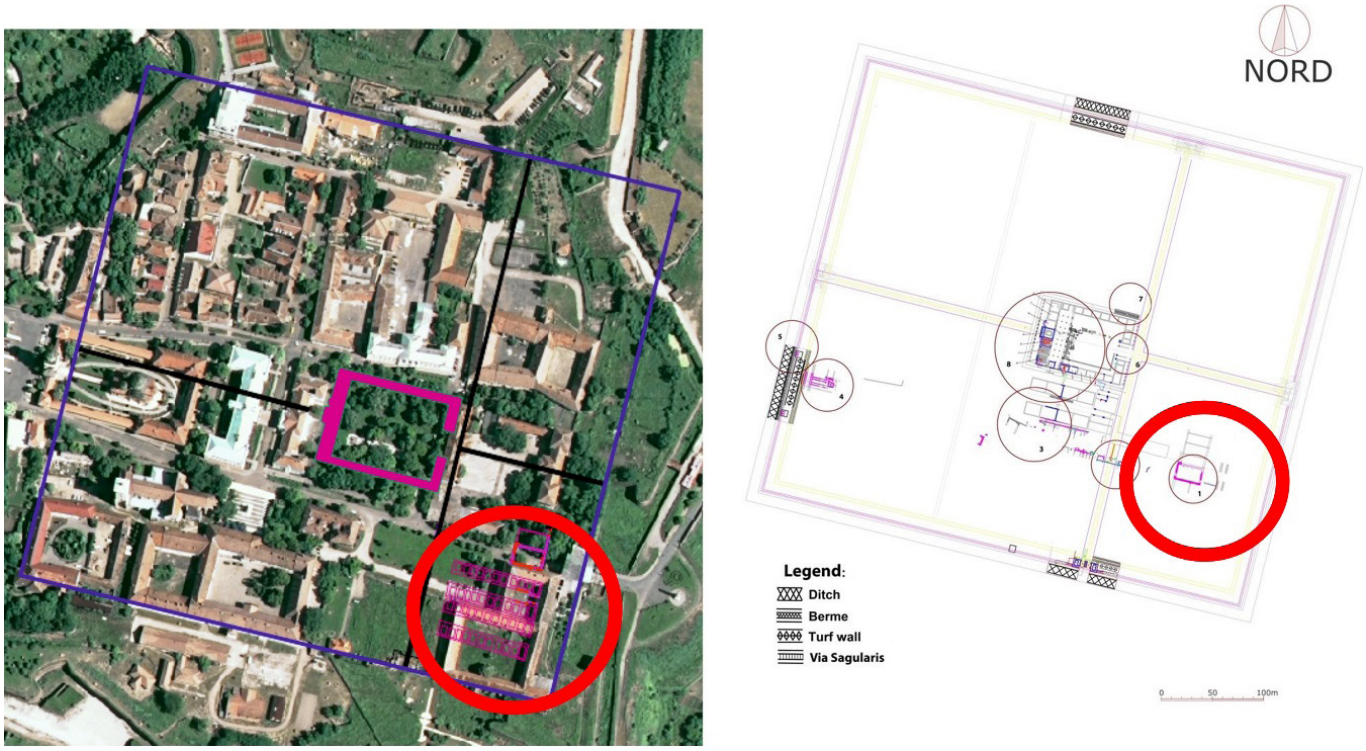

Fig. 9. Plan of the fortress with the room (*Hall I*) discovered during the archaeological research in 2011 (after GUDEA *et alii* 2015) – right; the Roman barracks investigated in 2016 (proposed planimetry), the area researched in 2019 – left.

3. RESULTS

Considering the existent documented information regarding the area of the Roman fortress and inside the Vauban fortification, together with the topographical and archaeological realities from the previous research (2011), we completed a contextualization of the topographical data by "extrapolation" from the archaeological information recovery status and "interpolation" with the documented material from various historical periods, finally obtaining a primary correlation of all the data related to the South-Eastern area of the Roman fortress (*praetentura dextra*).

3.1. The integration of data in a larger context

The archaeological complexes discovered during the preventive research in 2019 are in close connection with the results of the preventive research previously made in 2011.

With the intention of connecting the discovered structural elements of the Roman fortress at Apulum, following various archaeological research, we completed a planimetric reconstruction of the Roman buildings and highlighted the area that is the subject of this research.

For an accurate documentation of the researched area, in the context of its positioning inside the Vauban fortification, we overlaid the archaeological elements discovered in the *praetentura dextra* on the orthophoto map (Fig. 9). During 2016, the preventive archaeological research determined by the restoration of the War Commissariat Office (built during the Habsburg domination), brought to light structural elements inside the Roman fortress – the walls of the military barracks. Using the analogy with the areas discovered with similar structures, we carried out a planimetric reconstruction, revealing the inner sides of two barracks situated one in front of each other, which unveiled a part of the surface from the apartments inhabited by centurions.[13]

3.2. The analysis of the researched area

The detailed analysis focuses on the topographic-archaeological documentation of the discoveries from the South-East area of the Roman fortress, due to the fact that, together with the latest situations presented above, we also studied a series of data from various periods and contexts that were already researched at that time.

We are in the *praetentura dextra* of the fortress of Legio XIII Gemina at Apulum, in the space between the main road (*via principalis*) and the eastern wall of the fortress, where in 2011, during the urban rehabilitation works inside the Citadel, a large building was discovered (conventionally named *Hall I*). This large room had river stone foundations bound with mortar, extending 26.6 m in length and 14.1m in width. The width of the walls was impressive, varying between 1.2 m and 1.9 m (Fig. 10). It was believed to be part of the Roman barracks[14], but the results of the archaeological research in 2019 changed this theory.

A first set of elements resulted from the processing, with the help of topographical-archaeological methods, of the archaeological preventive research from 2011, occasioned by rehabilitation works inside the historical centre, in the

[13] OTA/FLORESCU 2017, 72, Pl. 2/1., Pl. 3/1.
[14] GUDEA et alii 2015.

Fig. 10. *Thermae – Hall I*, discovered in 2011(left), marked at pavement level (right).

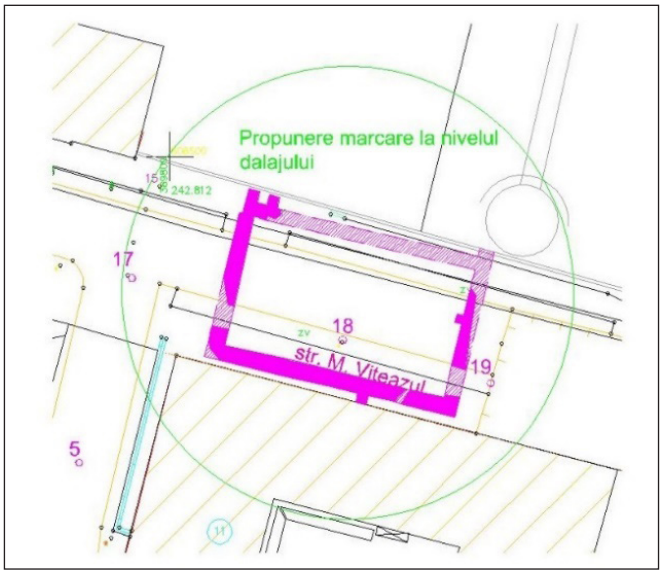

Fig. 11. *Thermae – Hall I*, the plan and marking proposal.

area of The Third Gate of the Vauban fortification, where structural elements belonging to a large Roman building were discovered. The trajectory of the walls discovered in 2011 in this area of the fortress were marked at the current pavement level with white marble (Fig. 10-11).

The preventive archaeological research carried out in this area of the fortress of XIIIth Gemina legion at Apulum, resulted in the discovery of several large halls and heated rooms that could belong to the baths (*thermae*) of the fortress of the XII[th] Gemina legion (Fig. 12). The dimensions of the rooms (*Hall I - apodyterium*? and *Hall II*), the planimetry, but also the location of the building in the *praetentura dextra*, lead us to assume, by analogy with the situation in other legionary fortresses (e.g. the fortress of Legio V Macedonica at Potaissa, where the baths were fully researched and published[15]), that the military baths of the Roman fortress at Apulum were discovered during the archaeological investigations in 20111 and 2019 (Fig. 15).

During the 2019 preventive archaeological research, the foundations of other large rooms and heated spaces in connection with *Hall I* were investigated. The traces of two furnaces (*praefurnia*) that provided the hot air through the Roman underfloor heating system were discovered and, also, the lower part of the hypocaustum installation, where a

Fig. 12. The Roman underfloor heating system (*hypocaustum*) – *praefurnium* (left), *opus signinum* layer with square brick prints (right).

[15] BĂRBULESCU 2019.

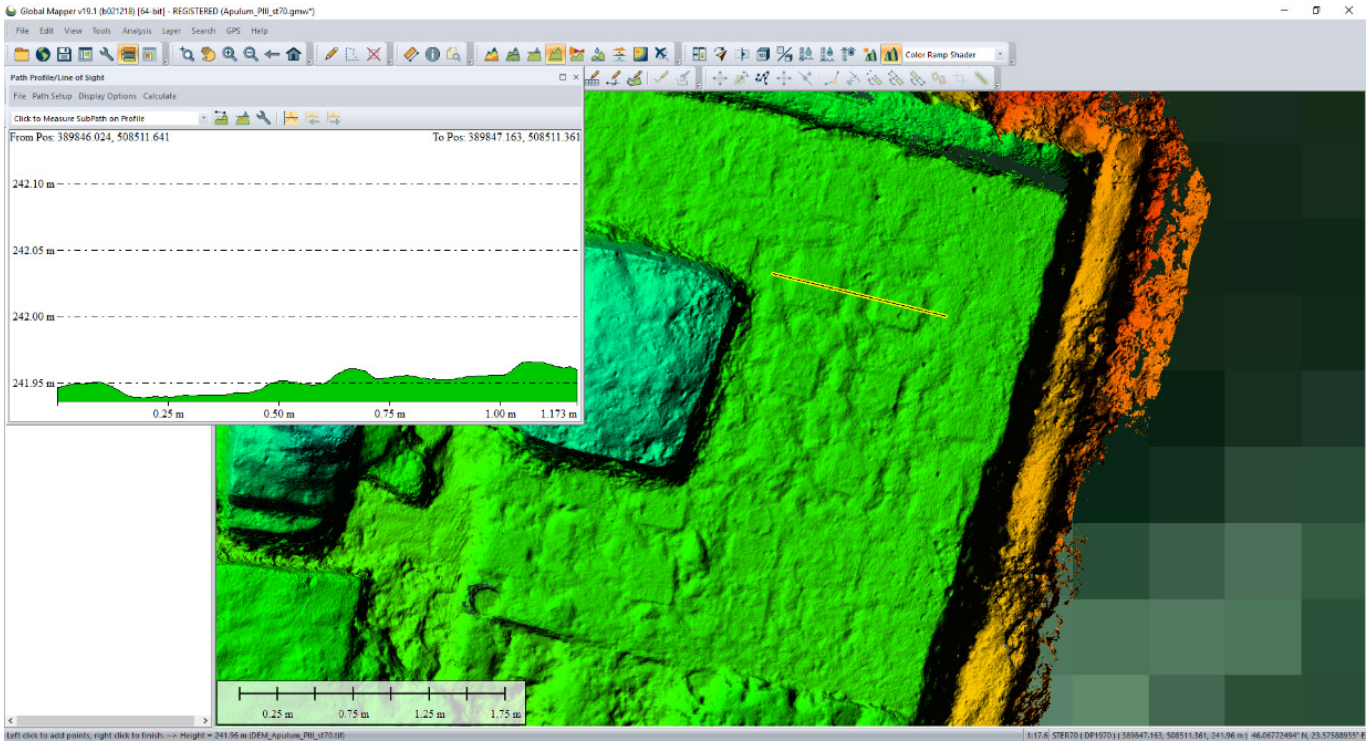

Fig. 13. *Hypocaustum* profile based on a digital elevation model obtained by photogrammetry.

resistant *cocciopesto* layer was placed, made of a special mixture of mortar, crushed bricks and fine gravel (*opus signinum*).

Starting from the previous archaeological research, after topographic measurements of the archaeological details with the help of modern measuring techniques in a unitary system (Stereo `70), using the results of the photogrammetric study, and connecting the details on the topographic plans (general and detailed), a strong connection between the elements discovered in several archaeological research in various periods was highlighted (Fig. 14-15).[16]

By connecting the existing structural elements on the topographic plans, and by analogies with buildings having similar functionality, the planimetry of the discovered rooms can be observed.

4. RESULTS AND DISCUSSION

The preventive archaeological research within the *praetentura dextra* of the fortress of Legio XIII Gemina at Apulum was initially carried out in 2011 and then in 2019, being transposed and processed through topographical and photogrammetric methods. A necessary connection was made between all these results and archaeological data. This process allowed the contextualization of the information obtained on an extensive area inside the Roman fortress, as well as the identification of the eastern side of the legionary baths (*thermae*).

The documentation of the 2019 research offered us new planimetric and archaeological elements that led us to assume that it was about an important building – the legionary baths. Due to the fact that in the investigated area the Roman

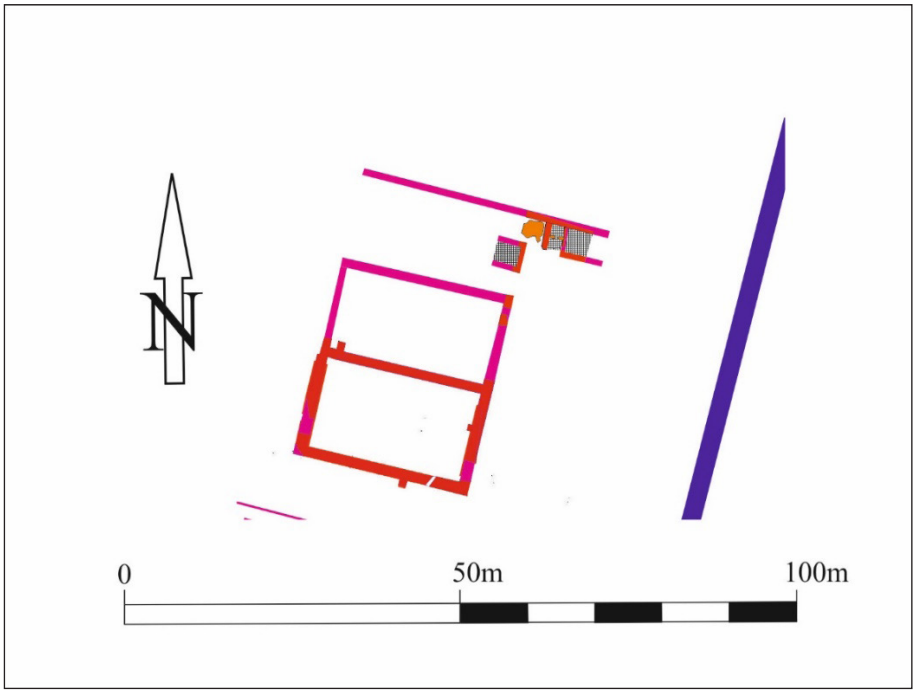

Fig. 14. The planimetric layout of the building (legionary *thermae*) discovered in 2011and 2019.

[16] The results of the preventive archaeological research carried out in 2011 and 2019 will be published in detail in a future study.

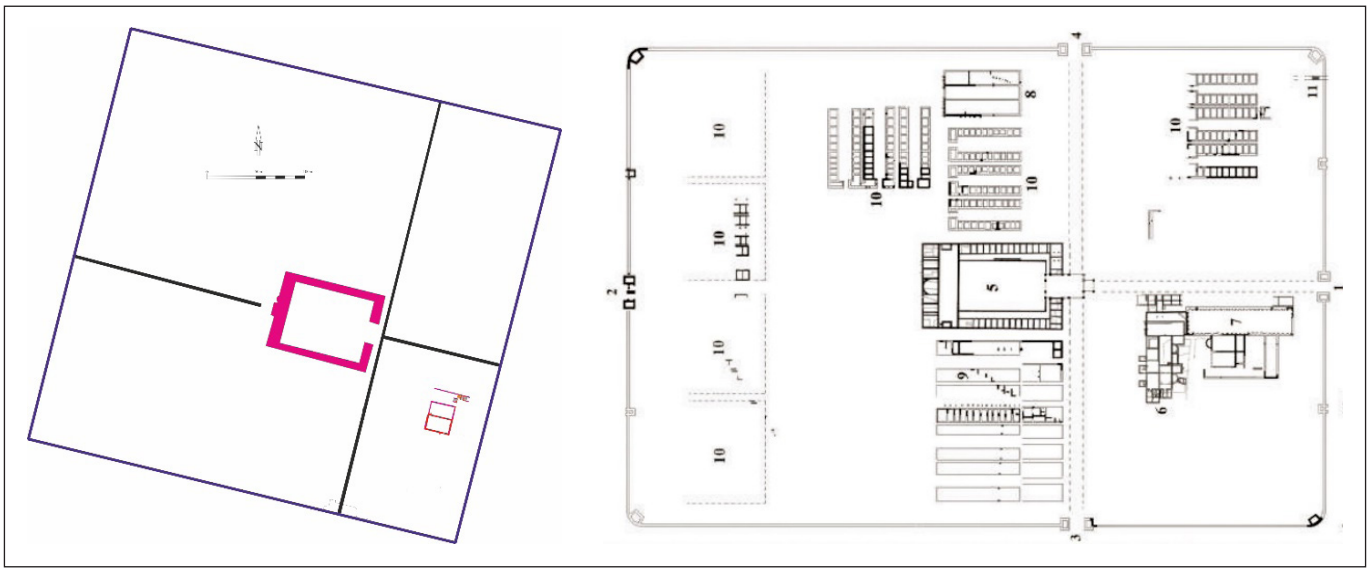

Fig. 15. Analogy with the fortress of Legio V Macedonica at Potaissa - location and planimetry of the legionary *thermae* in *praetentura dextra* (BĂRBULESCU 2020, Fig. 2).

building was affected by modern interventions (18th-20th c.), we assume that the baths functioned in parallel with the activity of the legion, in correlation with the period of maximum activity of the legion within the fortress starting with the reign of Hadrian (117 - 138 AD) and Antoninus Pius (138 – 161 AD).

A degree of relativity in the stated conclusions is obvious, due to the preventive nature of the excavations on a limited surface delimited by the proposed investment, but also due to the "obstacles" in the area (functional buildings, roads, green area etc.). The degree of accuracy in linking several "fragments" belonging to the same building can be adjusted in the future by potential systematic archaeological research, thus resulting in either confirmation or modification of the conclusions of the present study.

Next, the results and conclusions of the study regarding the archaeological discoveries in the *praetentura dextra*, can be integrated into a larger and more complex study regarding the fortress from Apulum and its surroundings, including all the archaeological research in the area, together with possible new elements, using advanced methods of documentation, processing and highlighting the results obtained (archaeological topography, photogrammetry, GIS design and development, geophysical surveys etc.).

5. CONCLUSIONS

Considering the multidisciplinary nature of the research, the importance of topography and its continued contribution to the documentation and study of archaeological discoveries it's indispensable. Its role is easily understood and accepted, as well as the importance and influence of topographical surveys for archaeological research. Using modern geospatial methods, advanced techniques and technologies such as photogrammetry, processing and storage of digital data, we are able to appreciate also the importance of topographical studies for archaeological research. Therefore, the topographic documentation in archaeology, especially the correct editing and representation of details from topographical plans in a unitary reference system, as well as the digital recording and archiving of archaeological data, are extremely useful tools in the recovery and harmonization process of the archaeological features belonging to the same historical area.

The preventive archaeological research carried out in 2011 and 2019 identified the eastern side of the legionary baths, the rest of the monument extending north and west into the courtyard of the nearby military establishment. At this stage of the research, we are faced with several questions regarding the water supply inside the fortess, the planimetry of the entire complex, the functionality of the discovered rooms and the internal organization of space. We hope to obtain more relevant information following an extensive systematic archaeological research in this area of the Roman fortress, on the Sf. Ioan de Capistrano Bastion of the Vauban fortification.

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