

# New Technologies for the ‘Great Baths’ of Aquileia: Results and Prospects

Marina Rubinich

University of Udine, History and Conservation of Cultural Heritage Department,  
Vicolo Florio 2/b, I - 33100 Udine, Italy

[marina.rubinich@uniud.it](mailto:marina.rubinich@uniud.it)

**Abstract.** The Great Baths were a large and sumptuous public building of late Roman Aquileia, with refined mosaics and inlay-work floors. Today they are completely concealed below cultivated fields, because vaults, walls and their architectural decorations were despoiled already in the Middle Age. Therefore, the university of Udine Archaeological Mission needs to employ both traditional and new technologies to reconstruct their original luxury, their complete layout and the subsequent landscape transformations suffered by the area: a meticulous stratigraphical excavation; the analysis of aerial photographs and historical maps; photogrammetric, laser-scanner and geophysical surveys. Other research projects are involved in the 3D-modelling of the buildings and photorealistic reconstructions of mosaic floors, to prepare multimedia aids for the foreseen opening to the public. All of these works are in progress: the main results and future prospects are presented here.

**Keywords:** Aquileia, Roman Archaeology, Stratigraphical excavation, Photogrammetry, Laser-scanning, 3D-modelling, Cultural Heritage enhancement.

## 1 Introduction

The ‘Great Baths’ were one of the most important public buildings of late-Roman Aquileia and lay in the SW part of the ancient city, between the Amphitheater and the Circus. The ‘*Thermae Felices Constantinianae*’, as the Baths are called in an epigraph found in the 1980s, were built, on the initiative of the emperor Constantine, in the first half of the 4th c. A.D., when Aquileia was at the top of its prosperity.

The existence of a large thermal structure was ascertained already during the 20<sup>th</sup> century after a number of short-term excavations - on behalf of the local Superintendency - led by G.B.Brusin (1922-23), L.Bertacchi (1961) and P.Lopreato (1981-1987). In 2002, the university of Udine resumed the excavations thanks to a joint research project with the Superintendency for Archaeological Heritage of the Friuli-Venezia Giulia Region<sup>1</sup>. This project has relevant implications not only for research - to elucidate the entire layout of the Baths and clarify the development of the area from the 4<sup>th</sup> century up to the present time - but also for educational purposes, specifically for work-oriented training. Campaigns take place for two months or more each summer; between 40 and 60 students of the

university of Udine (UniUd) take part in the excavations in two-week shifts, thus obtaining credits for their degrees in Sciences of the Cultural Heritage. Their training involves the application of up-to-date methods of field archaeology; practice in stratigraphic documentation and drawing techniques; lab activities, ranging from the selection and filing of finds to photography and basic restoration [1]. In parallel, the aim of the Archaeological Mission at the Great Baths is to enhance the ancient site, by illustrating its successive phases through computer-aided techniques and preparing multimedia aids for the visitors, after opening it to the public.

## 2 The ‘Great Baths’: the building and its life

New stratigraphic studies and reinterpretations of the previous excavations [2-4] have revealed that the Great Baths had the typical plan of the Roman imperial public *Thermae* and sumptuous decorations; they were sized approximately 2 hectares - that is, almost as large as the central building in the Caracalla’s *Thermae* in Rome - and at least 10 m high. In the middle of the main axis of the building lay the *Frigidarium*, a vast hall with *opus sectile*-floor, crowned on three sides by six square pools for cold baths. A short stairway flanked by green *breccia* columns led from the *Frigidarium* to the *Natatio*, a spacious open-air cold-water swimming pool with stone-slab floor. Located on the W side, the *Tepidarium* and *Calidarium* were heated from below with floors suspended on small brick pillars. In the Great Baths, instead of the usual *palaestrae* (gymnasiums) at the ends of the *Frigidarium*, there were two large symmetric halls - the N- and the S- Hall - with refined polychrome mosaic floors, at times figured.

Today, nothing survives of the walls and colonnades of the Great Baths. Apart from the mosaic floors, only scant traces point to their original luxury and stateliness: collapsed blocks of the vaults, which were lightened by pumice stone; remains of columns of granite or coloured *breccia*; fragments of architectural marble decorations and painted plasters; fragments of precious marbles cut for wall inlay-works with geometrical and figurative patterns; glass mosaic tiles, at times with gold leaf and shells for *incrustationes* on the walls, all discovered in the infills dating after the building was pillaged. The infills of the pools yielded fragments of refined sculptures which probably decorated the rooms in the complex, and were spared from being baked and transformed into lime for new buildings in the late Middle Ages. Nowadays, the late Roman building is completely concealed below cultivated fields. Only an in-depth attention to the sequence of occupational phases, as envisaged by present-day stratigraphical excavation methods, allowed us to identify the long history of the Great Baths. They were in use as late as the 5th century A.D., witnessing the recovery of Aquileia after the plunder of Attila the Hun (452 A.D.), but around the 6th century they lost their thermal functions and some rooms were occupied by small families, who built poor wooden huts and buried their dead outside the ancient walls. The earliest collapses of the vaults pushed out the Medieval inhabitants, and the Great Baths became a quarry for building materials, similarly to the Amphitheater nearby. Between the 13rd and the 14th centuries the ruins were systematically spoiled, and the area - today called ‘Braidà Murada’, i.e. ‘enclosed field’ - became an expanse of cultivated land with a few houses and cottages, as may be

observed on some drawings of Aquileia made during the 17<sup>th</sup> and 18<sup>th</sup> centuries. Similar transformations were carried out until recent times, ending in 1960, when the long wall around the Braida was taken down.

### **3 Rediscovering and ‘narrating’ the Great Baths and the Braida Murada: aids by traditional and new technologies**

Reconstructing and giving an effective description of the Great Baths over time is by no means an easy task. The late-Roman building took up a large surface and bringing it completely to light requires years of work, when considering the slow pace of a methodologically correct stratigraphical excavation. Moreover, the archaeological site suffered from profound transformations, which brought to the complete removal of the monumental Roman and Medieval structures. Thus, apart from a careful stratigraphical excavation to record all the buried traces, the need is felt for a series of advanced techniques to collect and correlate the available geo-referenced data - maps, aerial photographs, historical archives - into a unique GIS system accessible to scholars. A few steps have already been taken, but much remains to be done. Several projects have been launched but none can still be considered fully in place yet, because they proceed in a step-by-step fashion following the findings from the excavations.

The difficult search for funding for the annual excavations forces us to waste human resources that could be better employed. Only during the last few years, the local Superintendency has taken on the task of coordinating the multi-disciplinary activities and researches carried out in Aquileia [5] by various cultural Institutions. Quite often, the latter do not communicate with each other, thereby wasting further intellectual and economic resources. The present Workshop has the merit of comparing the results of parallel research actions, so that the various existing databases will be hopefully integrated and shared.

#### **3.1 Traditional and new techniques of rediscovering and surveying: results and prospects**

Analysis of aerial photos and 2D-3D mapping. The analysis of aerial photos and digital images allows to read clearly enough the layout of the Great Baths. We can distinguish the characteristic curve of the Caldarium located at the centre of the W side also observing the change in colour of the ground after the ploughing of the arable fields (soil-marks). This profile was drawn on a map by the architects G. Auditore and D. Miniutti (Studio 3DEG-Treviso), who also geo-referenced all topographic drawings made by the Archaeological Mission of the university of Udine, adding them to those performed by the local Superintendency – never precisely positioned – and referring them to the Gauss-Boaga coordinate system (Fig. 1). They could thus correct the mistakes of the previous maps, in which the building was too long, not respecting the symmetry of the typical Roman-imperial baths. Moreover, the new map has allowed us to locate precisely the N edge and the SW corner of the Baths, directing new archaeological

investigations.<sup>1</sup> We have yet to set correctly the Great Baths into the digital archaeological map of Aquileia, where the previous, too long picture is still in use [4].



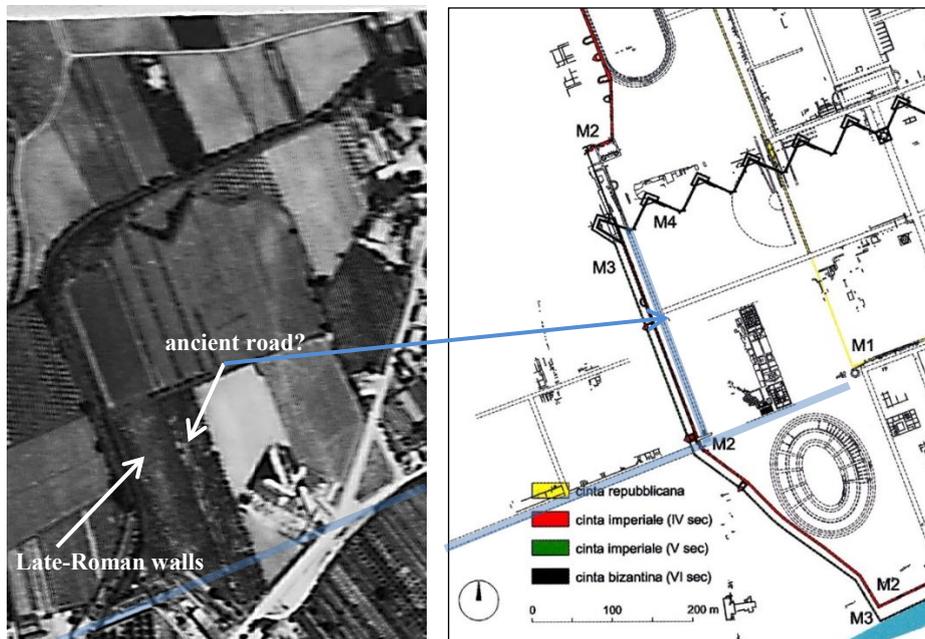
**Fig.1.** Soil-marks outline the *Calidarium*, geo-referenced in the 3DEG-Studio's map.

The analysis of aerial photos taken in 1954, 1961 and 1984 - kindly made available to me by prof. Alma Bianchetti (UniUd, Dept. of Human Sciences) - highlights several marks related with buried structures to the W of the Baths: the late-Roman and Medieval walls; a NS alignment, perhaps a road inside the town wall, and other traces yet to be interpreted (Fig. 2). It also allows us to observe the recent changes which occurred in the Great Baths area (from the 1950's to the present) such as the cultivations following one another, or the knocking down of the Braidia's enclosure wall. It would be important to add these data to the images collected into the Antaeus software system, an open GIS platform designed by a joint research project between the Civici Musei and the Informatics Department of the university of Udine [6]. This project has so far mainly in-depth analyzed the suburbium of Aquileia and the N sector of the ancient town; widening its view also onto the SW area of Aquileia (in which the Great Baths are located) will be the next step.

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<sup>1</sup> The last excavations of UniUd have brought to light the southern edge of the Great Baths, that overlooked, probably with a portico, the *decumanus* between the *Thermae* and the Amphitheater.

**Laser-scanning and photogrammetric surveying.** In 2005, prof. Domenico Visintini (Georesources & Territory Department, UniUd) has surveyed the S sector of the Great Baths with a laser scanner system integrated with a Nikon D100 photogrammetric digital camera [7]. With this surveying we produced a DTM of the sample area, but the long processing time of a cloud of 6,7 million points, and logistical problems - at that time the laser scanner was borrowed by the University of Venice, Laboratory of Photogrammetry - led the Mission to contact the Studio 3DEG-Treviso Architects, who made an accurate photogrammetric survey of mosaics and structures brought to light in the S-Hall and the SW-rooms of the Baths. Nowadays, the UniUd has its own laser-scanner, and we hope to resume the scanning of other areas of the Baths.



**Fig. 2.** Marks of ancient structures on a 1961 aerial photo, compared with a recent Aquileia's map (Source: *Moenibus* 2009, p. 84).

**Geophysical surveys.** The results of the 2011 excavations have yielded important data on the late-Medieval organization of this area, especially of its SW sector. A floor made of despoiled ceramic fragments seems to follow the track of the ancient *decumanus*. Moreover, we identified the corner of one of the cottages represented on the 17<sup>th</sup>-18<sup>th</sup> century maps of Aquileia, where we also see the ruins of the S.Siro Church, surely known since 1283 and located near a tower of the late-Roman walls. Geophysical surveys – also based on the interpretation of aerial photographs – are scheduled for November 2011 and will be aimed at identifying the church, the perimeter of the Great Baths and their inclusion within the town walls built in the 4<sup>th</sup> century<sup>2</sup>. Apart from the results of the geophysical surveys, it would be important for the Archaeological Mission to have the

opportunity to resume the integration project of airborne LIDaR (Light Intensity Detection and Ranging) and hyperspectral data developed by the National Institute of Oceanography and Experimental Geophysics (Trieste) and the Department of Georesources & Territory (Udine) [8-9]. The integration between points acquired with an Optech laser scanner and MIVIS (Multispectral Infrared & Visible Imaging Spectrometer) and AISA hyperspectral data allows to identify specific humidity, vegetation and thermal conditions, as well as detect buried archaeological remains within a target area perfectly 3D geo-referenced. During the operational phase of this project, Aquileia was chosen as a case study, but the research team focused its attention on the N part of the ancient city. Now the need arises to examine the SW part also, where the Great Baths stood.

### **3.2 The virtual reconstruction of the Great Baths: another work-in-progress**

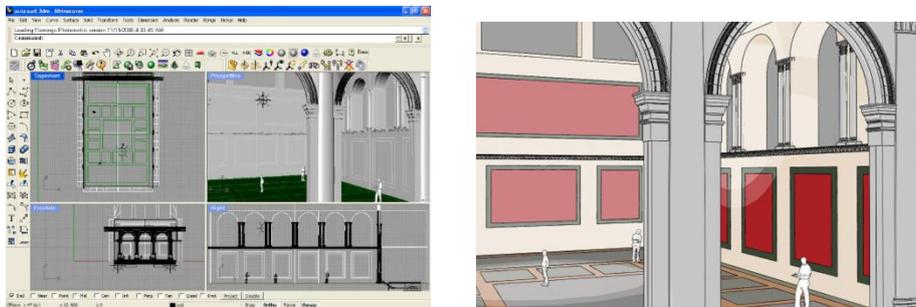
The Archaeological Mission of UniUd has employed new technologies especially for surveying and virtual reconstructions, which represents the best way to explain also to a non-specialized public the late-Roman thermal building and the complicated overlapping of subsequent life phases in this area [10].

Between 2006 and 200, thanks to a one-year funding from the Friuli-Venezia Giulia Region, we started up a virtual 3D modelling of the best known sectors of the Great Baths. The model was based on photogrammetric surveys already carried out and compared with data derived from written sources and remains of monumental public Thermae of the Roman-imperial age. Dr. Francesco Del Fabbro realized the photorealistic reconstruction of mosaic floors (Fig. 3) and the 3D modeling of the S sector of the Great Baths (South Hall) with conjectures about elevations (Fig. 4). This is a work-in-progress that proceeds in parallel with the excavations. Studies of architectural decorations; floor- and wall-coverings carried out by our students for their B.A., M.A. or Doctor's degree will allow us to 'dress' the 3D-model. Moreover, the 3D-model itself will be completed by the reconstructions of functional internal routes; heating systems; water catching and drainage plants, with the possibility to navigate into and outside the Thermae using different visual perspectives. The results of the virtual reconstructions will be used for didactic aids - videos, panels, ... - essential to address the visitors when the Great Baths will be opened to the public. The progress in the reconstruction work will be documented by updating a dedicated website - now available to the research group only - which is to be published soon.



**Fig. 3.** Photorealistic reconstruction of a mosaic panel: from an orthophoto (by Studio 3DEG architects) to virtual rendering (dr. F. Del Fabbro).

Another project aims to produce a cartoon movie in collaboration with the DAMS of UniUd. It will reconstruct the occupational phases and landscape transformations undergone by the Braidia Murada, since the Roman times up to the present day. For the reconstruction the results will be used of geo-pedological studies and of palaeobotanical and palynological investigations, which are already in part underway.<sup>2</sup>

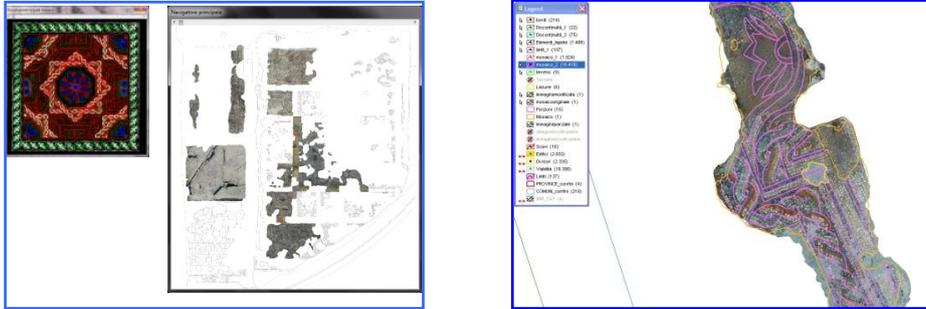


**Fig. 4.** Stages of the South Hall's 3D virtual rendering (dr. F. Del Fabbro).

**Navigating into mosaic floors software.** The architects on Studio 3DEG-Treviso, in collaboration with some members of the Mission, have produced a software that allows even to a non-expert to navigate effectively into the orthophotos of the mosaics; the operator can view all information and images collected in a correlated database, including excavation data, characteristics of mosaic tiles and of bedding layers, 'historical'

<sup>2</sup> A preliminary geological study was carried out in 2005 by dr. Umberto Stefanel.

pictures, comparisons of decorative patterns, measures - dimensions, coordinates and altitude – raster and vectorial reconstructions (Fig. 5a)<sup>3</sup>.



**Fig. 5.** Navigating into mosaic floors software (by *Studio 3DEG Architects*) and semi-automatic reconstruction of *lacunae* suggested by the *MIRAGE* project (*Virtualgeo, Sacile, Italy*).

**Tools to transform the Great Baths into an open-air museum.** In parallel to the virtual reconstructions, the Archaeological Mission is also engaged – at the present only with its strengths – in restoring mosaic floors and structures of the Great Baths, and in creating new tools that will make their comprehension easier when the area will be opened to the public. Therefore, in 2006 the Mission, together with Virtualgeo S.r.l. - a firm at the forefront in Geomatics and Computer Graphics - and the ‘Scuola Mosaicisti del Friuli’ of Spilimbergo, presented a project called *MIRAGE* at the Start Cup Udine 2006 business plan competition, which was awarded a prize as semi-finalist. *MIRAGE* (Mosaic Information Retrieval Applied to a Georeferential Environment) is aimed at providing the Archaeologists with an innovative, effective and rigorous tool for the study and enhancement of ancient mosaics, based on laser-scanning or other geo-referenced documentation; 3D-geometric databases of mosaic floors found in the archaeological excavations. The basic idea was to develop a kind of mosaics GIS, in order to facilitate the study of the floors; mapping of ancient restorations; archiving and managing data; programming and monitoring conservation and restorations. This information also allows for reliable semi-automatic reconstructions of gaps (Fig. 5b), to be used for virtual models and full - or in scale - mosaic reproductions with special printers for scientific and educational purposes. The project has been tested on the fine but gap-ridden floors of the Great Baths, with the opportunity of extending the method to all the mosaics of Aquileia and other archaeological sites. The *MIRAGE* project has not been abandoned, but fits into a broader restoration program of the precious mosaics of the Great Baths, which is currently under development.

## References

1. Fales, F.M., Maselli-Scotti, F., Rubinich, M., Clementi, T., Magnani, S., Rebaudo, L., Saccocci, A., Sperti, L.: Università di Udine. Aquileia: scavi dell'edificio pubblico detto "delle Grandi Terme". Campagne 2002-2003. *Aquileia Nostra* 74, 181--286 (2003)
2. Rubinich, M.: Le 'Grandi Terme' di località Braida Murada. In: Ghedini, F., Bueno, M., Novello, M. (eds.) *Moenibus et portu celeberrima. Storia di una Città*, pp. 108-110. Poligrafico dello Stato, Roma (2009)
3. Rubinich, M.: Aquileia (UD): Le Indagini dell'Università di Udine alle 'Grandi Terme' in località Braida Murada. *Notiziario della Soprintendenza per i Beni Archeologici del Friuli Venezia Giulia*, 2, 133--140 (2007)
4. Rubinich, M.: Aquileia (UD): Le Indagini dell'Università di Udine alle 'Grandi Terme' in località Braida Murada. *Notiziario della Soprintendenza per i Beni Archeologici del Friuli Venezia Giulia*, 3, 161--166 (2008)
5. Fozzati, L., Benedetti, A. (eds): *Per Aquileia. Realtà e programmazione di una grande area archeologica*. Marsilio, Venezia (2011)
6. Buora, M., Roberto, V.: New work on the plan of Aquileia based on aerial photographs and a GIS platform. *Journal of Roman Archaeology* 23, 32--334 (2010)
7. Visintini, D.: The Roman Thermae and the Patriarchal Basilica of Aquileia analyzed by modern techniques of surveying and representation. *Friulian Journal of Science* 10, 9--32 (2008)
8. Coren, F., Visintini, D., Prearo, G., Sterzai, P.: Integrating LIDaR intensity measures and hyperspectral data for extracting of cultural heritage. In *Proceedings of the Italy-Canada 2005 Workshop on 3D Digital Imaging & Modeling: Application of Heritage, Industry, Medicine & Land*, Padua (2005)
9. Coren, F., Visintini, D., Fales, F.M., Sterzai, P., Prearo, G., Rubinich, M.: Integrazioni di dati laserscanning ed iperspettrali per applicazioni archeologiche. In *9ª Conferenza Nazionale ASITA*, I, pp. 793--798, Artestampa, Catania (2005)
10. Rubinich, M.: Aquileia (UD): Le Indagini dell'Università di Udine alle 'Grandi Terme' in località Braida Murada (scavi 2005-2006). *Notiziario della Soprintendenza per i Beni Archeologici del Friuli Venezia Giulia*, 1, 151--158 (2006).