

# Knowledge, conservation and technologies: a research project on the streets of Ancient Pompeii

Alberta Martellone, Massimo Osanna & Gianluca Vitagliano

Parco Archeologico di Pompei, Italy

[alberta.martellone@beniculturali.it](mailto:alberta.martellone@beniculturali.it); [massimo.osanna@beniculturali.it](mailto:massimo.osanna@beniculturali.it);  
[gianluca.vitagliano@beniculturali.it](mailto:gianluca.vitagliano@beniculturali.it)

**Abstract.** The recent conclusion of a challenging project on surveying and monitoring the conservation status of the archaeological site of Pompeii was an opportunity to build a database of information about the city buried by the Vesuvius eruption in 79 A.D. The use of the most modern detection technologies (laser scanners, drones, etc.) has allowed to reach such degrees of accuracy as to open new perspectives of research on urban history.

The survey, in fact, has returned in detail for the first time the compositional geometries and the weaving of the blocks of the ancient roadmap of the site. In this perspective it seems interesting to systematise the new data and those from the archaeological excavations, also recent, on one of the most fascinating themes of the history of Pompeii: the forma urbis of the city, the chronology of the roads and the great work of monumentalisation consisting in their realization in stone blocks.

Therefore, on the basis of the study on the streets of Pompeii from a usage continuity perspective in the two phases of their life (the ancient, pre-eruption, and the modern, post-excavation), the research project that is illustrated aims to increase the levels of knowledge of the site, through the analysis of the techniques and the constituent materials, the definition of the relative chronology about the realization of the various stretches, the assessment of the conservation status. This also in order to identify appropriate management tools and appropriate strategies for the protection of such assets.

The project, for its implementation, will use: study of the construction typologies, surveys aimed to acquire knowledge of the constituent materials, observation of the stratigraphic relations between the different road sections, pre-eruption and post-excavation historical analysis.

The data that emerge will be integrated with excavation surveys, aimed at verifying chronologies and stratigraphic layers; they will be complemented by the results of the excavation of the alley between the *Insulae* 2 and 3 of the *Regio* V of Pompeii, to be executed, to return an undisturbed sample for study, both from the point of view of the geometries and of the techniques and the constituent materials.

## 1. Foreword

When, in 1748, the first ruins of Ancient Pompeii began to emerge, the interest of the excavators was primarily directed towards furniture, furnishings, works of art, frescoes and mosaics which were to be displayed in the rooms of the Royal Bourbon Museum: the excavations, whose locations depended on the will of their funders, were therefore geared towards maximising the recovery of finds, and thus keeping expenses under control. The situation changed under French domination, at the dawn of the



nineteenth century, when excavations occurred in a more regular manner, proceeding towards unearthing the *domus* by advancing from the streets and the entrance halls. In those years the unearthing of the perimeter walls also began, thus clearly exposing the extent of the ancient city. The Pompeii which gradually emerged from the excavations held a particular charm for travellers of the Grand Tour, as borne witness to by the many views of ancient streets in the iconography of the era, as well as views of public buildings and private residences, even if for many years few people would be authorised by the Bourbons - even after the Restoration - to make drawings and conduct surveys *in situ* at Pompeii [1].

In 1861 Giuseppe Fiorelli became Inspector of the Excavations, and then Superintendent between 1863 and 1875, and his lucid and rational approach reigned supreme over the excavations of Pompeii: the liberalisation of access to the site, at the cost of 2 francs per person, and the techno-operative precautions taken for its systematic excavation are but a few of the initiatives which the indications of his proposal of “Legge organica del Real Museo e degli Scavi di antichità” would inherit. In it, articles 163 and 164 - which dictate the investigation methodology - set out that any new excavations must be carried out respecting the continuity of previous ones, in order to obtain uniformity over the areas yet to be unearthed [2]. The proposed law would remain as such, however the direction of the excavations of Pompeii would be based on the principles it specified beginning in 1863. Nevertheless, attention is still focused upon the building: the street, from which the excavation above all proceeds, represents solely the physical limit - the boundary - of the *insula* and, naturally, the preferred route of the tourist itinerary, “ormai vero fine dell’impresa di scavo”[3]. The excavation carried out by Fiorelli by then had a wholesale - and no longer leopard spot - restitution of the site as its objective and, to this end, the areas between the old excavation sites were excavated, so that by the end of his Pompeian mandate, approximately the western half of the ancient city had been excavated.

The excavation and restoration operations carried out between the end of the nineteenth and the beginning of the twentieth century continued in the wake of the innovations introduced by Fiorelli, at least until 1911, when Vittorio Spinazzola, Director of Pompeii until 1923, gave the go-ahead to a large scale excavation of the eastern section of Via dell’Abbondanza, going on to achieve the objective of reconnecting the Civil Forum district to the Amphitheatre. On closer inspection, this was an *ante litteram* attempt at an immersive experience: making it possible to follow “una strada pompeiana, e possiamo dire di una cittadina campana o romana del Mezzogiorno d’Italia del I secolo dell’Impero, un aspetto che risulta in molta parte nuovo ed inatteso. Nuovo per la ricostruzione della sua vita, e nei rapporti dell’architettura e della decorazione architettonica: in ciò, anzi, che l’una e l’altra hanno di meno noto nei tempi grecoromani, la facciata, con il suo corteo di luci, aggetti, logge, coperture, ornamenti, colore”[4].

At the conclusion of the works in 1923, it was possible to traverse the entirety of Via dell’Abbondanza, from the crossroads with Via Stabiana to the *insula* of Octavius Quartio: the urban *facies* was now defined by the façades of buildings with upper floors and balconies [5], by the walling, by the colours of the frescoes and *tituli picti* preserved *in situ*; and then again by the pavements, by the public fountains and by the basalt paved streets. In short, everything refers to the street as a public social place, such as in the first life of Pompeii fixed to AD 79. Thus the experience of Spinazzola can be considered fundamental in the history of archaeology, which at Pompeii in the twentieth century, was immediately geared towards the understanding of social life in public spaces, well exemplified by the ‘vision’ which the Director pursued in his work [6].

Spinazzola documented the work carried out in a three volume work, *Pompei alla luce degli scavi nuovi di via dell’Abbondanza (anni 1910-1923)*, not published until 1953; in which he gives an account of the excavation methodology and finds - primarily the façades of the buildings along Via dell’Abbondanza - which allow us to re-examine the relationship between the private buildings and public spaces of the Roman city. Even if few words are given over to the role of the street as a significant element in its material substance [7], Spinazzola can be credited for having considered the excavation of the street as truly being *of the street*, in which the then followed approach appears to have been overturned: indeed for the first time, the objective of the excavation was the street itself,

whose limit was fixed by the façade of the *insulae*, and not the other way round. Rarely did Spinazzola go further [8].

The street, therefore, came to exercise a particular charm, since it is configured as a system of elements, unique in the site, with the same function in Ancient Pompeii as today. Only the actors have changed: until AD 79, the street was the site of social interactions in which Pompeians played out their daily lives; in the modern age, travellers and tourists walk along it, living it as a place in which to sense life of the first century after Christ. In other words, even today the street system, with its pavements and fountains, continues to be a site of social interaction: tourists who stop near the fountains or entrances to the *domus* establish relationships among them neither more nor less than the inhabitants of two thousand years ago. Bearing this in mind, the streets are an element which strongly characterise the current site of Pompeii, and indeed in terms of its landscape, whose material integrity is to be protected.

However, every conservational action must imply an adequate ‘knowledge operation’.

The ‘Plan of Knowledge’ of Pompeian streets arises from such premises, with the objective of shedding light on certain problematic areas related to aspects of material culture: it is not therefore a study of the urban development of Ancient Pompeii, but rather an investigation into the paving of the streets, which examines themes such as the construction techniques and production methods which, by necessity, had to have followed a diachronic logic before the eruption of AD 79. Awareness of the characteristics of the streets and verifying the state of conservation will allow us to specify protective operations, with a further view towards preserving material integrity in the face of a growing anthropic pressure due to the consistent flow of visitors [9].

## 2. The Project

The street, in this research project, refers to a system of elements in relation to each other which are only partially dedicated to the transit of vehicle, animals and people [10]. It has come to be characterised as a palimpsest upon which differing levels of understanding of the dynamics of urban development of Pompeii are arranged. Hence, as well as the street base, or more correctly the carriageway, whose role was - and remains - ensuring the outflow of water in the absence of a dedicated drainage system, components which contribute towards defining the Pompeian street are:

- the pavements, generally present to the sides of the carriageway, delimited by curbs and widely paved in Antiquity;
- the pedestrian crossings, raised above the level of the carriageway, which allowed the pedestrian to cross the street from one side to another in a straightforward way, keeping the walkway at the same level as the pavement;
- the guard stone blocks, found only on certain streets - mostly between Via di Nola, Via della Fortuna and Via di Vesuvio - and around a great number of public fountains;
- the public fountains, which were distributed along the paved arteries of the city, and were able to guarantee a water supply to the population;
- the other systems related to the water supply, including piezometric towers related to the aqueduct, which served the most important structures.

This project seeks to investigate this system of elements in its material components, with particular regard - at least in this first phase - to the carriageway. To begin with we proceeded to analyses of the data from the Plan of Knowledge [11], which in 2015 yielded the survey of the entire city at a scale of 1:50, utilising advanced technologies.

For the first time it is possible to understand the composite geometries and structure of blocks of the entirety of the ancient road network on the site. Previously, the most up-to-date maps of Pompeii, at a 1:500 scale, did not allow us to appreciate the details of the streets, such as the morphology and structure of the paving stones [12]. The results of the Plan of Knowledge are interwoven with the data which emerged during the recent archaeological excavations which formed part of the sites relevant to the Plan of Works of the Great Pompeii Project - the stabilisation of the *Regiones*, the new itineraries

for improving accessibility and the restoration of certain structures - which provide additional data on the street network of the city.

For perhaps the first time, areal information will permit a comprehensive reading of the *forma urbis* of the city in AD 79, with a level of information that can be progressively implemented along with the results of other ongoing interventions.

In order to achieve the objectives outlined above, the project has been divided into phases.

The first phase, an account of the preliminary results of which are reported here, envisages mapping of the street paving and geometric characteristics.

The second phase consists of a vast study aimed at understanding the characteristics of specific elements of the infrastructure and any links with the context. In this phase, the potential use of a series of geognostic surveys carried out on all of the infrastructure will allow us to understand the thickness of the paving and alert us to the presence of any anomalies in the subsoil of the carriageway, to the additional end of putting into action any conservation work considered appropriate.

The complexity of the approach that a systematic study on the infrastructure network presents cannot disregard the preliminary definition of the situation regarding our understanding of the streets of Pompeii, integrated with information supplied by the Plan of Knowledge and *in situ* verifications.

### 3. Notes on recent excavations of the streets of Pompeii

As already hinted at, this project seeks to increase the level of understanding of the streets in their material consistency, with particular attention to the paving. It can not, however, ignore the study of urban development in Pompeii, a highly complex subject that is currently undergoing a renewed interest, both on the basis of information which is emerging from the conservational interventions being carried out on the site, and following stratigraphic excavations in various areas of the site and *extra moenia* which were launched in 2017, that will add data to our knowledge of the city's origins [13].

It is opportune to here recall the models of urban development which over time have animated the debate on the birth of the city. Among them, one well known model holds that the urban centre developed from the 7th century BC, starting from the *Altstadt*, corresponding to the Civil Forum and Triangular Forum [14], and continues in successive moments, until the colonial era, towards the eastern sector [15].

The alignments would already have been present at the beginning of the development of the city, and would have been accompanied by a 'tracing' operation, in which it is possible to recognise an urban planning project [16]: it is dated by certain recent studies to "at least the 6th century BC" and complied with at a later date [17]; others in the 4th or 3rd century BC [18]. The street paving must necessarily then be dated to moment after the earliest urban planning operation; in AD 79 it was not yet complete, and many streets were still *stratae terrena*.

This research, which must necessarily take into account models of urban development which were developed in earlier studies, was born during the 'Pompeii for All' [19] intervention and amid the results of the preliminary investigations into the creation of new paving that primarily concerned the pavements, starting from the Amphitheatre, arriving at the Forum and spreading out towards the terrace of the Temple of Venus to the west and towards Via di Mercurio to the north. The archaeological investigations have made it possible to understand in detail the characteristics of the pavements and underground utilities, which are also known partially due to previous interventions [20], including: the private channels which occupy the base of pavement; the water system which distributes water in a capillary way via the lead *fistulae*, and the paving mixture created over an extended time sequence.

The 'Pompeii for All' operation was therefore a unique occasion to investigate these aspects, along the major arterial roads of Pompeii. It has allowed us to gather unexpected data on the history of the evolution of the ancient city, suggesting the notion that the street is a flexible system, able to metabolise the changes of urban construction over time: indeed, three experiments conducted in areas of the city somewhat distant from each other - along the northern side of the terrace of the Temple of

Venus [21], in Via di Mercurio [22] and in Via dell'Abbondanza, *Regio III* 7 side [23]- have clarified that the streets underwent modifications even after paving; these modifications consisted of a narrowing of the carriageway, in two cases in favour of widening the pavements.

The numerous experiments carried out along the arterial roads of Pompeii during the course of the most recent investigations suggest the absence of ballast or preparatory layers on which to lay the paving stones, which would be placed *ad solidum*; so the road foundation at Pompeii seems to consist of a compact layer of protohistoric volcanic eruptions [24].

Upon close inspection, the central zone, between *Regiones VII* and *VIII* - i.e the area corresponding to the *Altstadt* - is wholly paved with basalt flagstones. Certain sections of *Regio I* are *glareae stratae*; the rest of the streets are *terrenae*: including almost all of those of *Regio II* - including the area of the Amphitheatre and certain alleys between *Regiones III, V, VI* and *IX*; the work of paving the streets never reached there, and therefore another way had to be found to make the road surface compact, to additionally solve the problem of water flow.

Among the most interesting points of reflection that the project will face is the lack of paving in the sector corresponding to *Regio II*, which also includes the Amphitheatre. The latter lies in an area primarily crossed by pedestrian traffic: carts could only traverse *Vicolo dell'Anfiteatro*; the other alleys were inaccessible from *Via dell'Abbondanza*, where the pavement found no continuity [25].

#### 4. The articulation of the project and the preliminary results

The framework of knowledge on Pompeian streets as it has been defined leaves certain problematic areas unexplored. These are areas of research whose examination is not possible without obtaining a vast and detailed understanding of the site.

The quantitative data has initially been specified: they allow us to understand the complexity of the street system of Ancient Pompeii within the city walls.

The city covers 66 hectares, of which 44 have been excavated. The street network runs for approximately 16.1km, of which 4.7 (equal to 29% of the total) are only theorised, since they have not been excavated. The remaining above-ground network is composed of streets paved with lava stone basalt slabs over a length of about 8.7km (54% of the total) and compacted earth streets along 2.7km (17% of the total).



Regarding the basalt paved streets, the length of the network with an average section greater or equal to 4ml is equal to 2.7 km, or 31% of the excavated basalt paved roads: Via dell'Abbondanza, Via di Nola, Via della Fortuna, Via delle Terme, Via del Foro, Via Stabiana, Via di Vesuvio and Via di Mercurio. The total surface area occupied by paved carriageways is equal to 1.8 hectares.

The study of the streets dovetails with that of other infrastructure, including the pavements and public fountains. The pavements constitute a kind of system within the system, defined by the carriageway, whether paved or not, and by the kerb which defines its limit towards the street. In the carriageway run the *fistulae* for the capillary distribution of water - whose system in relation to the presence of piezometric towers needs to be better understood - and the small channels for private use, which carried water from buildings to the street. Furthermore, the stone blocks which mark the property limits are still documented on it.

The fountains are located along the paved streets, with a greater frequency along those which have a wider cross section (of the 42 fountains accounted for on the site, 21 are located along the principal streets of the city), most of them partially constructed on the street and partially on the pavement.

In this first phase, in addition to the survey of quantitative data, a sampling of road sectors was carried out on Via di Nola and Via di Vesuvio, two of the main arteries of the site, for which graphic illustrations were made available, being produced as part of the Plan of Knowledge. Road modules of 5 metre length have hence been identified; the measurement of these modules has been defined on the basis of assessing their feasibility in the space of a working week, including the moving and handling of the blocks and the surface treatment [26].

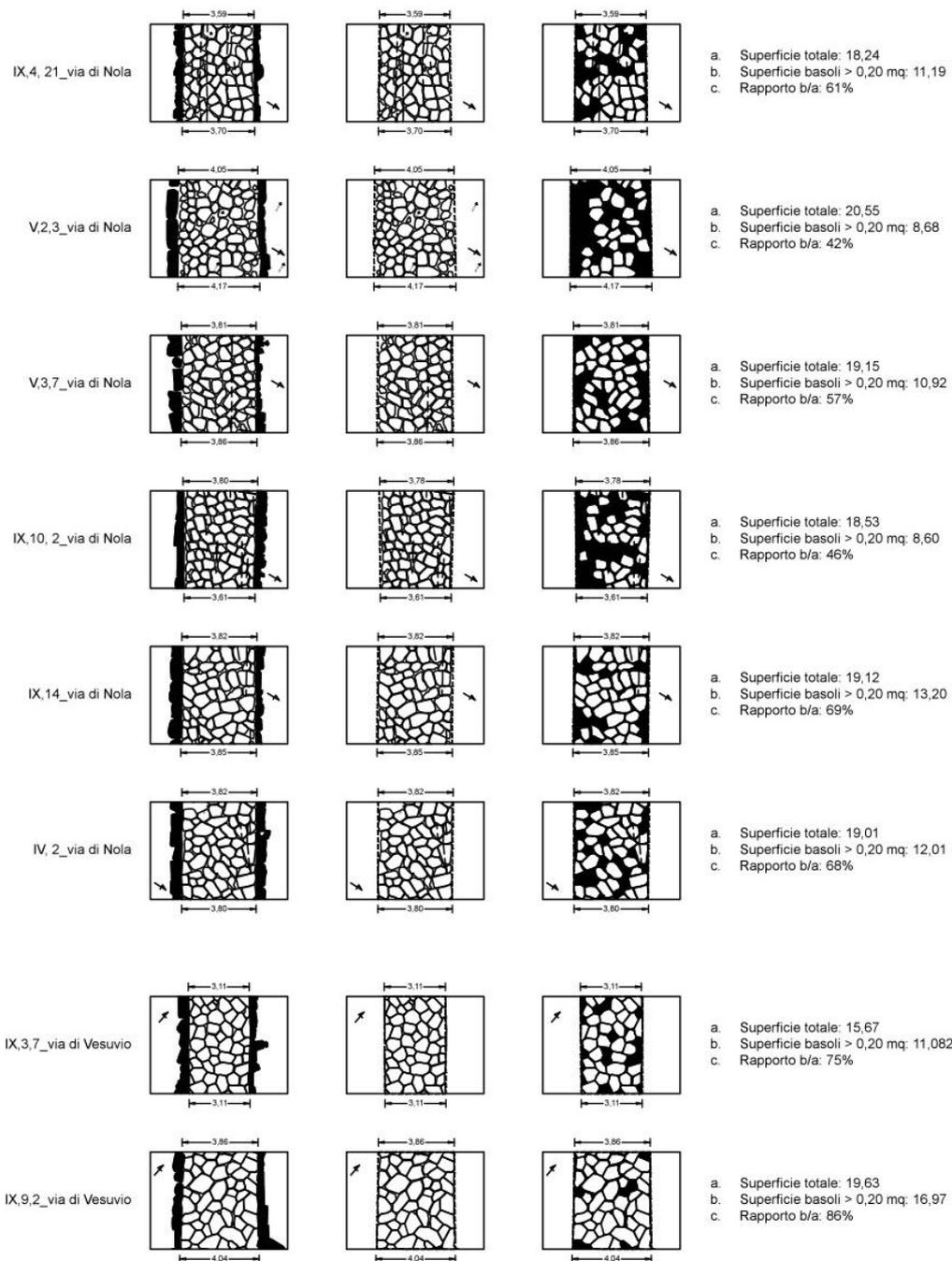
The sampling did not include those stretches of road which were tampered with in the post-excavation phase [27], or which suffered damage during the 1943 bombing. In the latter case, the survey allowed us to document traces of bomb damage, even where mapping carried out immediately following the bombing provided no information [28]. On the basalt slabs, indeed, one often finds traces of bomb explosions: one example is on Via di Vesuvio, between *Regiones* VI 14 and V 1, where one notes the absence of basalt slabs, corresponding to the burst crater filled with soil; around this block one see the splintering of blocks caused by the explosion of the bomb.



Traces of splintering can also be found on certain blocks on Via del Tempio di Iside, between *Regiones* VIII 4 and VIII 7, but their location must have been subject to some repositioning after the war, since the splintering lines do not seem to correspond.

Following the identification of the sections to be sampled, strategies were outlined which aimed to understand the distribution of the blocks according to their dimension, on the basis of the

documentation produced as part of the Plan of Knowledge. Specifically, blocks of a surface area greater than 0.20m<sup>2</sup> were selected, considering that stone elements of smaller dimensions can be moved by a single worker [29]. Such a distinction was thus considered ideal for verifying any differences between street sections which were attributable to different workers or time periods. The studies are still ongoing and will be completed at the end of the project, when the entire street network of Pompeii will be mapped out. However, an initial analysis already makes it possible to verify that the sampled street sections of Via di Nola exhibited a percentage of large blocks which averaged 57% compared to the total of the carriageway module [30], far from the 81% observed along Via di Vesuvio [31].



In this initial phase a study has been carried out on the pedestrian crossings. They can consist of a single block or a pair of juxtaposed blocks - corresponding with the alleys - or of an alignment of two, or three blocks in the case of wider streets. They take on a particular importance since they are linked to solutions of continuity in the structure of the basalt slabs, determined by a different modality or phase of laying the blocks compared to the creation of the rest of the paving.

Within the site, 163 crossing blocks have been identified, all on roads paved with lava stone blocks [32]. Some of them have been modified or removed due to particular conditions: for example, we know that two of the three crossing blocks at the crossroads of Via delle Terme and Via del Foro were removed before 1849, on occasion of the visit of Pope Pius IX [33].

Of further interest are the analyses of the distribution of these crossings in the site, according to demographic pressure: 103 crossings are located in *Regiones* VII and VIII and along Via delle Terme, della Fortuna and di Stabia which delimit the *Regiones* over an area of around 16.5 hectares. 65% of the crossings, therefore, are located on a little more than 37% of the excavated city.

Not only that: certain arterial roads, although paved, are devoid of crossings, such as in the case of Via dell'Abbondanza in the section in contact with *Regio* II, for a length of about 250 metres; or for the section of Via di Nola, in the direction of the port of the same name, which has no crossings for around 190 metres. This data confirms a distribution of the resident population with a lower incidence in the east of the city and a greater mobility of pedestrian flow in the western sector, around the Civil Forum and craft and commercial businesses.

## 5. First conclusions and perspectives

At the end of the surveys which were launched in the first research phase, a model will be created to survey the entire street network of Pompeii. The data gathered will yield information relative to solutions of continuity in the street sections, the types of cross section, the morphology and structure of the basalt slabs of the carriageway but also the types of surface working of the blocks and to a macroscopic reading of the lithotypes.

This survey will be aimed at understanding the specific aspects of Pompeian streets, such as the ability to identify temporal indicators for an absolute or relative dating of homogenous characteristics. Furthermore, the characterisation of traces of surface working of the blocks and the information regarding their 'wear' as a function of the period of construction and excavation, and of the lithotypes and current anthropic pressure, will allow us to put conservational measures into action. This last aspect, which does not only concern the lava stone blocks, also extends to analyses of the joints, and their possible construction typology, as well as evaluating the state of conservation and appropriate maintenance operations.

Finally, a series of non-destructive investigations utilising geognostic surveys across the entire street network will provide information on the thickness of the paving blocks and on any anomalies present in the subsoil.

In conclusion, the outlined project will yield an up-to-date reading of the role of streets in Ancient Pompeii, allowing a step forward in research in the field of archaeology, thanks to the use of innovative surveying and investigational technologies, as well as the results of the Plan of Knowledge drawn up under the Great Pompeii Project.

The vast amount of data which will be gathered, and the reflections which will result will allow us to define the most appropriate conservation strategies for the site, which itself represents a *unicuum* in the field of archaeology.

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[1] On the role of Pompeii in European culture over the last two and half centuries, cf. Osanna M, Caracciolo T and Gallo L 2015 *Pompei e l'Europa 1748-1943 Catalogo della mostra* (Naples).

[2] "163. I nuovi scavi dovranno essere fatti in prosieguo degli antichi, né questi saranno intralasciati se prima non verrà tutto scoperto quello che erasi già cominciato a scavare....."

164. Al primo vestigio di edificio si farà opera di scoprire le strade da cui può essere cinto; onde le città antiche dovranno essere dissotterrate per isole...”, cf. Osanna M 2015 “*Tutto è stato riformato, moralizzato nella città morta*”. *Giuseppe Fiorelli a Pompei* in Osanna M, Caracciolo T and Gallo L (eds) *Pompei e l'Europa 1748-1943 Catalogo della mostra* (Naples) p 230, In the articles of the proposal “Legge organica del Real Museo e degli Scavi di antichità” one reads (in a nutshell) of the successive reform of the nomenclature of Pompeii, with the identification of *Regiones* and *insulae*.
- [3] De Caro S 1999 *Giuseppe Fiorelli e gli scavi di Pompei* in De Caro S and Guzzo P G (eds.) *A Giuseppe Fiorelli nel centenario della morte Atti del convegno Napoli 19-20 marzo 1997* (Naples) p 18.
- [4] Spinazzola V 1953 *Pompei alla luce degli scavi nuovi di via dell'Abbondanza (anni 1910-1923) posthumous edition with foreword by S. Aurigemma* (Rome) p 11. Aurigemma credits Spinazzola for the innovative scope of his project, underlining that in 1923, at the end of the works, there were no longer “più strade pompeiane monotone, chiuse, deserte; ma finestre, balconi, tettoie e terrazze, che si seguono l'una all'altra, quasi che tutta la vita non avesse per iscopo se non la strada”, cf. p XIII.
- [5] It should be noted that the excavating from above and, therefore, the ability to reconstruct the upper floors, was already a widespread method under the direction of Fiorelli, who employed the wisdom gained from his experiences during the Bourbon era. The volumetric reconstruction of the House of the Hanging Balcony, for example, is due to Fiorelli (VII,12,28).
- [6] F. Mangone, speaking of the works conducted at Pompeii since the last decades of the nineteenth century, observes that they tend to regulate the excavation areas according to the road network, “assecondando inconsapevolmente il nuovo interesse estetico per i vuoti urbani maturato nella Mitteleuropa di fine Ottocento”, in Mangone F 2015 *Pompei, ginnasio dell'architettura europea, 1815-1914* in Osanna M, Caracciolo T and Gallo L (eds) *Pompei e l'Europa 1748-1943 Catalogo della mostra* (Naples) p 130. However, it is not by chance that the debate centred upon Pompeian city planning saw light in 1913, shortly after the beginning of new excavations on Via dell'Abbondanza by Spinazzola, with the contribution of Haverfield F 1913 *Ancient town-planning* (Oxford).
- [7] On the other hand, interest in the materiality of the objects of use (which a street can be considered as) would come later than the historical period in which Spinazzola operated.
- [8] Only in particular cases did Spinazzola go on to excavate rooms which faced onto the street (such as for example, the Fullonica of Stephanus or the House of the Moralist); in the majority of cases work proceeded by highlighting the façade and creating retaining walls for holding back earth behind the ancient walls. Such containment walls were also used alongside the alleys perpendicular to Via dell'Abbondanza, conveniently antiquated so as not to hinder their overall perception.
- [9] In 1950 the site welcomed 300,000 visitors; in 2017 visitor numbers exceeded 3,400,000. For data regarding the last fifteen years, see <http://www.pompeisites.org/Sezione.jsp?titolo=Dati+Visitatori&idSezione=9> (last access 12.01.2018). Data on visitors to the site throughout the twentieth century can be found in Longobardi G 2002 *Pompei sostenibile* (Rome).
- [10] “In campo urbanistico il termine definisce uno spazio di percorrenza con una misura prevalentemente allungata, delineato con intenzionalità costruttiva da parte dell'uomo”, source *Via (Strada)* from Wikitecnica.com, F. Angelucci (ed.), <http://www.wikitecnica.com/via-strada/> (last access: 14.01.2018). Regarding the widespread presence of vehicle grooves along the street network of Pompeii and traffic routes, see the recent Poehler E 2017 *The Traffic Systems of Pompeii* (Oxford).

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- [11] As part of the Great Pompeii Project, between 2015 and 2016, the “Plan of Knowledge. Diagnostic and monitoring services of the state of conservation at Pompeii” was carried out, which was an organised program of surveying and monitoring of the state of conservation at the archaeological site. With laser scanning technology, it surveyed the entire city and organised this data into an open multimedia ‘container’, the ‘Information System’. This is a new GIS which forms the basis for both present and future studies and research which allows us, through periodic monitoring of the conservational state of ancient structures, to plan in an effective and timely manner, consolidation and restoration works which are necessary for the security and protection of the archaeological site of Pompeii. It is also becoming the digital archive for information resulting from archaeological and geognostic investigations conducted at the site.
- [12] The “Nuova Cartografia Pompeiana Georiferita”, edited by R. Morichi and R. Paone, after a long work project which began at the end of the 1980’s and lasted about 25 years until 2012, for the first time granted Pompeii a digital map on a topographical basis at the conventional scale of 1:500, cf. Morichi R, Paone R, Rispoli P, Sampaolo F and Sodo A 2011 *Sulla nuova Cartografia Digitale di Pompei* in Rivista di Studi Pompeiani (XXII) pp 133-143.
- [13] In 2017, the Archaeological Park of Pompeii began the “Scavi e ricerche a Pompei e siti della Soprintendenza” intervention which will be completed by 2018. However, the stabilisation interventions of entire *Regiones* and enhancement works which form part of the Great Pompeii Project have often provided for excavations which have increased the level of understanding of the site, particularly regarding the street network. Of particular interest is the intervention regarding *Lavori di messa in sicurezza dei fronti di scavo interni alla città antica, messa in sicurezza del fronte sud della Regio VIII e mitigazione del rischio idrogeologico delle Regiones I-III- IV-V- IX*, which was recently launched, and which envisages the excavation and opening up of the alley between *insulae* 2 and 3 of *Regio* V.
- [14] Cf. Haverfield F J 1913 *Ancient town-planning* (Oxford). During the twentieth century A. von Gerkan and H. Eschebach entered the debate regarding the development of the city, perfecting the model proposed by Haverfield, cf. von Gerkan A 1940 *Der Stadtplan von Pompeji* (Berlin); Eschebach H 1970 *Die staedtebauliche Entwicklung des antiken Pompeji mit einem Plan 1:1000 und einem Exkurs: die Baugeschichte der Stabianer Thermen* (Heidelberg).
- [15] However, it is not possible, under the current state of awareness, to substantiate this record with certain archaeological data, which is based on the observation of the shape of blocks; the attempt to reinforce it with stratigraphic data from archaeological investigations in a building remains weak, cf. Guzzo P G 2006 *Pompei. Storia e paesaggi della città antica* (Verona) p 48.
- [16] Guzzo identifies the phase of ‘tracing’ of the original orientation in the western sector, and also underlines that it is “ben arduo immaginare che i tracciati siano stati formati altro che da battuti, sia che da essi abbiano, già entro il VI secolo, tratto forma e orientamento tutti gli isolati, per non parlare della rispettiva edificazione”, in Guzzo P G 2006 *Pompei. Storia e paesaggi della città antica* (Verona) pp 48-49.
- [17] For a summary of the wide debate, see the recent contribution of Giglio M 2016 *Considerazioni sull’impianto urbanistico di Pompei. Teorie sull’evoluzione urbanistica del settore orientale di Pompei in Vesuviana* (8) (Pisa-Rome) pp 11-48, with the relative bibliography.
- [18] De Caro S 1992 *Lo sviluppo urbanistico di Pompei* in *Atti e Memorie della Società Magna Grecia* (3-1) pp 67-90; F. Coarelli F 2008 *Il settore nord-occidentale di Pompei e lo sviluppo urbanistico della città dall’età arcaica al III secolo a.C.* in Guzzo P G and Guidobaldi M P (eds.) *Nuove ricerche archeologiche nell’area vesuviana (scavi 2003-2006)* Atti del convegno internazionale (Roma 1-3 febbraio 2007) (Rome) pp 173-176. In the discussion forum of the conference “Nuove ricerche archeologiche nell’area vesuviana (scavi 2003-

- 2006)", F. Coarelli states that "lo strato più antico [della strada] è di fine IV - inizi III a.C.", in Coarelli F 2008 *Discussione*, in Guzzo P G and Guidobaldi M P (eds.) *Nuove ricerche archeologiche nell'area vesuviana (scavi 2003-2006)* Atti del convegno internazionale (Roma 1-3 febbraio 2007) (Rome) p 514.
- [19] The 'Pompei per tutti. Percorsi per l'accessibilità ed il superamento delle barriere architettoniche' intervention is part of the Plan of Works of the Great Pompeii Project and was completed at the end of 2016. It involved the creation of easily accessible routes within the site over a length of 3 kilometres. The origins and results of the intervention in detailed in Sirano F 2016 *Pompei per tutti* (Naples).
- [20] Nappo S C 1994 *L'impianto idrico a Pompei nel 79 d.C. Nuovi dati* in De Haan H and Jansen G (eds.) *Cura Aquarum in Campania Proceedings of the Ninth International Congress on the History of Water Management and Hydraulic Engineering in the Mediterranean Region*, Pompeii (Leida) pp 37-45.
- [21] There was a reduction in the width of the functional carriageway upon the construction of the boundary wall on the northern side, which involved the removal of basalt slabs, which were never reintegrated. The investigations carried out as part of the "Pompeii for All" on the terrace of the Temple of Venus, north side, are currently being published (L. D'Esposito, publication underway).
- [22] In this case, the trace in negative of a pair of removed basalt slabs, flush with the residues of an old pavement, suggest that there was a narrowing of the carriageway in favour of a greater width in the pavement (D'Esposito L, Galeandro F, Iadanza M and Martellone A *Il contributo dell'archeologia alla conoscenza* in Osanna M and Picone R (eds.) *Restaurando Pompei*, proceedings of the conference 3rd-4th April 2017, publication underway).
- [23] From the pavement base of *Regio III 7*, a section of paving emerged whose basalt slabs have dimensions inferior to those of the central section; even the level of placement appears to be incompatible with the central paving of *Via dell'Abbondanza*: both of these elements suggest an interesting hypothesis, namely that the basalt slab identified predates the known one of AD 79, belonging therefore to a phase in which the carriageway was wider (this has also been encountered in *Via di Mercurio*, where it has however not been possible to verify the typology of the basalt slab and placement height of the blocks).
- [24] However, precisely in the absence of ballast, a potential cause of localised subsistence of the street foundation can be identified.
- [25] Guzzo P G 2006 *Pompei. Storia e paesaggi della città antica* (Verona) p 139.
- [26] This data is taken from the analysis of the *in situ* relocation of certain paving blocks along *Via dell'Abbondanza*, near the entrance to the *Praedia* of Julia Felix, which was carried out as part of the 'Pompei per tutti. Percorsi per l'accessibilità ed il superamento delle barriere architettoniche' in 2016. On that occasion, it became necessary to proceed with the relocation of certain basalt slabs which the explosion of wartime ordnance of 1943 had damaged; the explosion of the bomb had disintegrated some of them. During the archaeological excavation, the margins of the crater were identified as being at least fifty centimetres deep compared to the street level. It is likely that during the removal of the rubble, the blocks were placed along the pavements. In 2016 they were therefore detected and, on the basis of their geometry and the alignment of the cart grooves, they were repositioned in the carriageway, which however still had a substantial gap due to the lack of other blocks. The relocation operation was conducted without the assistance of machinery, by a team of three workers, and took place during normal working hours from the 26/05/2016 to the morning of the 30/05/16; the surface covered by the end of the operation was equal to 10m<sup>2</sup>; hence, for the laying of the lava stone blocks for a paved surface equal to 20m<sup>2</sup> (the 5 metre long module considered for an average width of 4 metres), one can reasonably consider a working week to be necessary. Due once again to the explosion of

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- munitions, a reconstruction intervention similar to that on Via dell'Abbondanza was conducted in Vicolo di Tesmo where, however, a substantial number of blocks was preserved, so that it was possible to restore the street paving in its entirety.
- [27] Those sections in which evident disconnections of the paving due to maintenance interventions or the crossing of modern subservices were rejected: consider for example the anomalous repositioning of blocks, in which the cart grooves are not aligned with the main directions - one can find a clear case of tampering along Via di Stabia, corresponding to the entrance to the Theatres; along with cases in which the lithotypes clearly trace back, due to their conservational condition, to recent interventions.
- [28] For the sections of street damaged by 1943 bombing, reference was made to the map *Pompeii - Bomb damage. 1943* attached to the *Final Regional Report Campania Dec 1945-May 1946*, in the Central State Archives, Allied Commission Control fund, Headquarters Allied Commission-Monuments & Fine Arts (and Archives).
- [29] The specific weight of the lava stone is around 2800 kg/m<sup>3</sup>. If one assumes an average block thickness of around 20cm, 1m<sup>2</sup> of lava stone block weighs around 560kg. However, blocks with a smaller surface area have smaller thicknesses: a block of 0.2m<sup>2</sup> paving surface can have an average thickness of 15cm, even weighing less than 70/80kg, and is therefore movable by a worker. The calculations reported show the distribution of blocks with a surface area less than 0.20m<sup>2</sup> (marked areas) compared to larger blocks.
- [30] In the 6 sampled sections of Via di Nola, the percentages of surfaces occupied by large blocks compared to the total area are, respectively: 61%; 42%; 57%; 46%; 69%; 68%. The selected samples are indicated according to a west-east direction.
- [31] In the 2 samples sections of Via di Vesuvio, the percentages of surfaces occupied by large blocks compared to the total area are: 75%; 86%. The selected samples are indicated according to a north south direction.
- [32] The sole exception consists of three crossings (two near the intersection of Via di Castricio with Vicolo dell'Efebo, and one in Vicolo di Paquius Proculus) in which there is scant evidence of lava stone block paving. At present, the crossing on Vicolo dell'Efebo has a higher surface compared to the same walking level of the street, which was recently repaved (2016).
- [33] To allow the visit of the Pontiff by carriage within the site, some other crossing blocks were likely removed along Via della Fortuna. The news, supplied by Vincenzo Sabini, technical assistant to the Archaeological Park of Pompeii, needs however documentary confirmation, which will be awaited during the course of research. For the visit of Pius IX on the 22nd October 1849, cf. Ascione G C and Conticello B 1987 *Pio IX a Pompei. Memorie e testimonianze di un viaggio* catalogo della mostra (Naples). It is conceivable that the absence of a series of three crossing blocks near the House of Marcus Lucretius on Via di Stabia can be attributed to the same explanation.