

Enrico Cirelli

6 Bricks for Ravenna: Materials and the Construction of a Late Antique Imperial Residence

Abstract: The construction of the new imperial residence of Ravenna was quite completely made with reused materials, *spolia* and bricks such as many other Roman tradition cities and settlements since the second half of the 3rd century. This Late Roman architecture continued to follow the same ‘imperial’ construction techniques. Reuse of material was totally logical and practical, and was not due to an economic crisis, cultural change or loss of knowledge as I will try to demonstrate in this paper. Roofing tiles, *tegulae* and *imbrices* but also clay vaulting tubes, were produced without interruption also during the early Middle ages throughout Italy. I will also try to demonstrate that there is even evidence in Ravenna of production of new bricks at the beginnings of the 5th century and in the first quarter of the 6th century. This is already well known for the main churches built during the Ostrogothic reign in Ravenna, with San Vitale, Sant’Apollinare in Classe and San Michele *in Africisco*, later dedicated under the Byzantine rule and completely realized with new ‘manubriati’ bricks, following the Roman tradition.

Introduction

Since the second half of the 3rd century and more widespread in the 4th century, most of the public and religious building in Italy were built with reused materials, *spolia* and bricks: the arch of Constantine\Maxentius in Rome and the famously large Constantinian basilicas of St. John Lateran and St. Peter in the Vatican.¹ This late Roman architecture continued to follow the same ‘imperial’ construction techniques. Reuse of material was totally logical and practical, and was not due to an economic crisis, cultural change or loss of knowledge. Roofing tiles (*tegulae* and *imbrices*) were, for instance, produced without interruption even during the early Middle Ages throughout Italy.² In this paper, I will demonstrate that there is even evidence in Ravenna of production of new bricks at the beginnings of the 5th century and in the first quarter of the 6th century. Large use of reused bricks is also

¹ Deichmann 1976, 131–146. For a new perspective about Constantine’s architectural program, see: Guidobaldi 2016, 461–492. I wish to thank J. Riley Snyder, Debora Ferreri and Maria Cristina Carile for the suggestions and notice reading this paper. I also want to thank Riley for overhauling the English text.

² Deichmann 1975; Righini 1991, 193–221; Negro Ponzi 2000.

testified inside defensive city walls, built during the 3rd century at Rome,³ Rimini,⁴ Milan,⁵ Verona⁶ and Aquileia,⁷ or later in Como,⁸ Mantova,⁹ Parma,¹⁰ Bologna,¹¹ Classe¹² and finally Ravenna.¹³

During this period the northern Italian cities were already deep into crisis.¹⁴ Following Ambrose, bishop of Milan (AD 374–397), Italian cities seemed dead bodies, as they were mostly destroyed.¹⁵ In the light of what is actually known, the archaeology of the city of Ravenna describes the same evidence as the one described by Ambrose. Both for private and public construction, the archaeological evidence indicates numerous layers of burning and destruction of the ancient Roman buildings. These events date from the late 3rd and early 4th centuries. Evidence of this phenomenon has been identified at excavations inside the ancient city walls such as the *domus* at 'Orti Bacinetti' (destroyed during the 3rd c.), in 'Banca Popolare' *domus* (beginnings of the 4th c.) which was replaced at the beginnings of the 5th century by the Episcopal baths, in via Ercolana *domus*, under the foundations of the church of St. Andrew,¹⁶ and inside the two different via D'Azeglio *domus* (4th c.); at Largo Firenze' *domus* (end of the 3rd c.), inside the *domus* identified under the churches of San Vitale and the Santa Croce (end of the 3rd c.) and inside another Roman house identified during the excavations of one of the late antique city walls *posterula* (*Posterula Ovilionis?*). Most of these private houses were first recovered by temporary construction and after their destruction and abandonment during the 4th century and were replaced by monumental buildings at the beginnings of the 5th century (Table 1).

The same framework is offered by other cities in this region, where fires and devastation are often associated with Alemanni and Jutungi incursions, destroying

3 Coates Stephens/Parisi 1999; Meneghini/Santangeli Valenzani 2004, 55–57; Medri 2015.

4 Mansuelli 1941, 57–61; Negrelli 2008.

5 Sannazaro 2014, 82.

6 Cavaliere Manasse 1987, 46.

7 Bertacchi 1986, 111.

8 Lusuardi Siena 1984.

9 Tamassia 1993.

10 Dall'Aglio 1999.

11 Curina 1997.

12 Lepore/Montevecchi 2009.

13 Righini 1991 and later Gelichi 2005, observed that for the construction of the city walls of Ravenna must have been reuse a huge quantity of bricks. See also Christie/Gibson 1988, with a preliminary study where they proposed the use of new bricks, even if different in dimensions and fabrics.

14 Augenti 2001; Augenti 2006a; 2014.

15 Ambr., *Epist.*, 39, 3: "*semirutarum urbium cadavera*". See: Cracco Ruggini, Cracco 1977, 448–475; Delogu 1990, 146.

16 See: Cirelli 2008, for previous bibliography.

Table 1: Private buildings: Roman *domus* in late antique Ravenna.

Site	Destruction\ burn	Downgrading\ transformation	Abandon	Reconstruction
via D'Azeglio's <i>Domus</i>	3rd c.	3rd–5th c.	no	Aristocratic <i>Domus</i> created merging two smaller Roman <i>domus</i> (5th–7th c.)
Orti Baccinetti <i>Domus</i>	3rd c.	3rd c.	3rd c.	
via Ercolana <i>Domus</i>		4th–5th c.		<i>domus</i> replaced by a basilica (5th c.)
Banca Popolare <i>Domus</i>	4th c.			<i>domus</i> replaced by Bishops Palace' Bath (5th c.)
<i>Domus</i> under S. Vitalis	3rd c.		3rd c.	<i>Sacellum</i> (5th c.); basilica (6th c.)
Santa Croce <i>Domus</i>	3rd c.		3rd c.	Church of Santa Croce (5th c.)
Roman House	2nd c.	3rd–5th c. (cemeterial zone)	2nd c.	City walls (5th c.)
Largo Firenze <i>Domus</i>	3rd c.		3rd c.	New late antique house (5th c.)
via Guaccimanni <i>Domus</i>		4th–5th rooms decay and wear		New public building (6th c.)
Via Diaz <i>Domus</i>				<i>Moneta Aurea</i> (6th c.)
Via di Roma's house				Imperial Palace

wide sectors of the Emilia Romagna towns.¹⁷ Destructive events are recorded in cities like Rimini (e.g. Piazza Ferrari and Palazzo Diotallevi *domus*¹⁸) as well as at Sarsina inside via Roma and via Finamore *domus*.¹⁹

The destroyed buildings are often abandoned or re-occupied by very small structures. Vast areas of the settlements, once flourishing, begin in this way to appear as piles of rubble and construction debris. Uninhabited areas start to be occupied by green spaces. In sectors where there are no traces of destruction, one can

¹⁷ Ortalli 1992, 584–585; 2003, 98–99.

¹⁸ Riccioni 1969, 313; Gentili 1979, 49; Maioli 1984, 461; Ortalli 1992, 584; 2000a, 518; 2000b, 176.

¹⁹ Gentili et al. 1967, 28, 56; Ortalli 1992, 573; 1997, 138, 153.

also observe a strong degree of deterioration and downgrading. Spaces previously paved with mosaic began to be covered with dirt floors, and frequent small fires are lit within formerly-luxurious convivial environments and representative rooms.²⁰ This is the case for instance for via Testoni *domus* in Bologna.²¹ Within the same *domus* a mosaic paved room is gradually replaced with a smaller room covered with wooden planks and used as a granary.

Inside the Roman city of Sarsina, moreover, the residential area of an ancient *domus* was transformed during the 4th century into a metal workshop with a small kiln for melting bronze.²² There is probably a new conception of domestic spaces, as is the case of sectors of the house or rooms transformed into working areas and as it was noticed in the new plan metric joints obtained through the use of new wood or clay partitions, or with walls built with mixed materials.²³ In “Boxers” *domus*, one of the two different houses discovered during Via D’Azeglio excavation, the monumental entrance of the late antique building was transformed into a sort of garage for one chariot, that left two parallels grooves inside the ancient (1st c.) mosaic pavement that apparently changed use.²⁴ Other large *domus* sectors are also buried and filled with earth and later converted into cultivated areas, in home gardens for instance. This is seen in the case of ‘Palazzo Massani’ in Rimini, where in the 4th century a *domus* with peristyle atrium was largely shaved and covered with agricultural land to achieve a vegetable garden for the use of new dwelling that re-occupied some rooms of the ancient building, spared by the transformation.²⁵

From the 4th century, a process began of degradation of the residential buildings and processing and downgrading of entire urban sectors. The reduction of the areas occupied by domestic plants, largely dependent on general demographic crisis, caused a considerable depletion of the structure of the urban blocks, and in some cases the abandonment of entire districts in every cities of the region. During the 5th and 6th centuries this phenomenon is most prevalent in the western regions of north Italy, and especially Emilia: Piacenza,²⁶ *Veleia*,²⁷ Fidenza,²⁸ Parma,²⁹ Reggio

²⁰ For a review of late antique houses, see: Baldini Lippolis 2001.

²¹ Ortalli 2003, 99.

²² Ortalli 1997, 141, 150.

²³ Augenti 2004.

²⁴ Montevicchi/Leoni 2004, 43.

²⁵ Ortalli 2001, 28.

²⁶ Marini Calvani 1990, 782.

²⁷ Marini Calvani 1975.

²⁸ Catarsi Dall’Aglio/Dall’Aglio 1991–1992, 12, 16, 22.

²⁹ Catarsi Dall’Aglio 1998, 607–609.

Emilia,³⁰ Modena,³¹ Bologna,³² Claterna,³³ *Forum Cornelii*³⁴ and Sarsina³⁵ display within them little evidence of buildings positively dated to these two crucial centuries to verify the transformations of urban settlements in Late Antiquity. Even in Ravenna this begins between the late 3rd and early 4th centuries: the phenomenon of town ruralization characterized all Mediterranean and northern European cities, especially the most decentralized settlements and far from the primary imperial centers of the Late Antiquity.³⁶ The reasons for this transformation are often seen in the context of the political and institutional crisis due to frequent raids of Germanic tribes (e. g. Alamanni and Jutungi) from the middle of the 3rd century.³⁷ The destruction and burning of some *domus* in Ravenna have been directly attributed to these kinds of raids,³⁸ although these catastrophic hypotheses are not convincing. War, especially so sporadic, are rarely cause for abandonment of inhabited areas in economically active society. The phenomenon is related rather to the inability of urban societies to renew them and regain possession of the devastated areas by these traumatic events.

The transformation of Ravenna in imperial residence reversed this trend, which had an echo more widespread in the other cities of Romagna and inside the organization of the territories under its administration.³⁹ As for public buildings the investment of the urban and imperial aristocracy in this period of structural crisis is even more modest. Only in Ravenna (within the territory of the modern Emilia Romagna) stands a public commitment in these later centuries, thanks to the elevation of the city to the rank of imperial seat in the 5th century.⁴⁰

Unlike Ravenna, the private residences of the rich cities of western Emilia are never transformed into aristocratic buildings or public structures. The crisis affecting the other cities of the region is more incisive. In these settlements, even including the 5th and 6th centuries, private investment lacked and the deconstruction process did not stop following the conquest of Justinian and the exarchate birth in the eastern part of the region. These investments would be absent until at least half of the 7th century in the West when occupied by the Lombards. Only with rare urban renewal in the mid-seventh century some urban settlements began to rise

³⁰ Gelichi 1998, 11–16; Scagliarini Corlàita/Venturi 1999, 19, 33, 39.

³¹ Gelichi/Malnati 1986, 552; Giordani 2000, 432.

³² Zuffa 1944; Bergonzoni/Bonora 1976; Ortalli 1996.

³³ Bollini 1985.

³⁴ Mancini/Mansuelli/Susini 1957, 185.

³⁵ Mansuelli 1954; Gentili et al. 1967, 27, 56; Ortalli 1997.

³⁶ Cosentino 2016; Zanini 2016.

³⁷ Ortalli 1992, 557–563.

³⁸ Manzelli 2000, 236.

³⁹ Ortalli 2003, 115; Cirelli 2015, 14.

⁴⁰ Gelichi 2000; Lippolis 2000, 114.

again, as evidenced by the case of Modena⁴¹ and other northern Italian cities, thanks to new élite investments.⁴²

From this moment and with particular importance from the late 5th to the mid-6th centuries during the Ostrogothic administration, Ravenna becomes one of the only European cities of the 'barbarian kingdoms', along with Toledo and *Ticinum*, trying to imitate a capital-model hardly imitable: Constantinople.⁴³

Materials for the Construction of an Imperial Residence

Apart from the extraordinary use of marble and stone, the skeleton of the massive construction site of Ravenna was made of bricks. That is easily visible throughout most of the late antique monuments still preserved inside and outside the city walls. This is a totally different point of view standing against the original perspective when every façade was covered by plaster followings Roman construction rules.⁴⁴ It definitely means that no one really cared about dimensions and height of these materials except for what was linked to static but not aesthetic reasons. Most of the reused bricks were fragments of the original rectangular 'sesquipedale cisalpino' (45x30x6 cm)⁴⁵; different from other Roman regions where the square shape (44–45 x 5–8 cm) is more common.⁴⁶ From the main 'cisalpino' type, there were normally various subdivisions, such as the 'mezzo sesquipedale' (45x16x6 cm) and the 'bessale' 22x22x5 cm, used inside bath for *suspensurae*, but also frequently reused inside structures.

The chronology of production of this type of bricks is normally helped by stamps, which occurred mainly until the age of Severus Alexander (AD 222–235).⁴⁷ The most famous stamped bricks found in Ravenna's excavations come from *Pansiana* kilns, whose production has been identified all along the Adriatic coasts, from *Picenum* to Dalmatia since the end of the 1st century BC to Vespasian age (AD 69–79).⁴⁸ The major number of finds is instead produced during the reign of Emperors Hadrian (AD 117–138) and Antoninus Pius (AD 136–161) and these bricks were later largely reused inside the late antique warehouse at Classe and in structures of the medieval monastery of San Severo (Fig. 1).⁴⁹

⁴¹ Gelichi 1989; 2001, 231.

⁴² Delogu 1980, 68–75; Cirelli 2013a, 132.

⁴³ Brühl 1967, 215; Brogiolo 2000, 135.

⁴⁴ Carile/Cirelli 2015, 104.

⁴⁵ Novara 2000, 118.

⁴⁶ Vernia 2005, 1110.

⁴⁷ Righini 2008, 15.

⁴⁸ Matijašić 1983, 961–995.

⁴⁹ Augenti 2010; Augenti/Cirelli 2016.

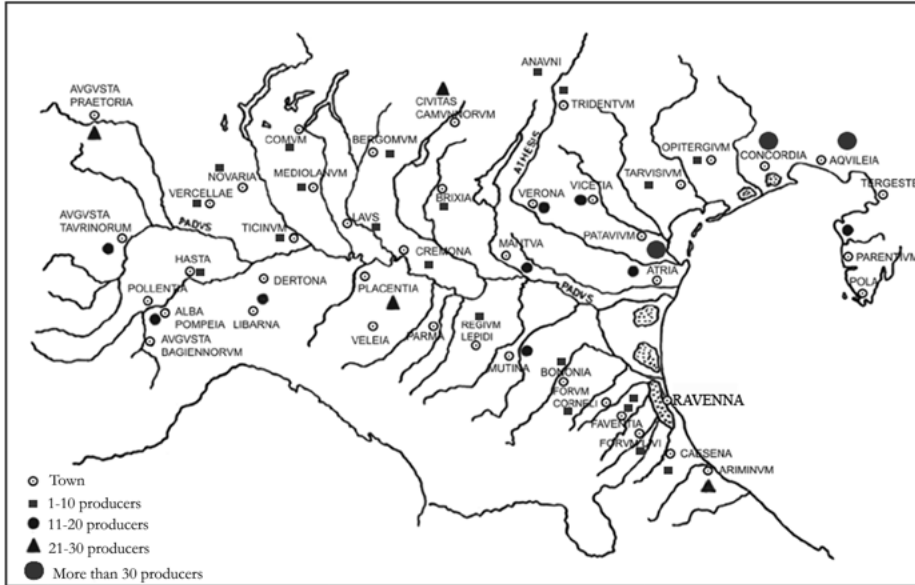


Fig. 1: Distribution map of Roman and late antique kilns in northern Italy (after Righini 2010).

Table 2: Bricks with imperial stamped names identified in Ravenna's territory.

Emperor's stamp	Bricks	Tegulae
Hadrian (AD 123–138)	45	4
Antoninus Pius (AD 138–161)	85	1
Commodus (AD 161–192)	39	3
Septimius Severus, Caracalla and Geta (AD 193–211)	25	
Severus Alexander (AD 222–235)	4	
Martialis 3rd c.	1	

Table 3: Private stamped bricks and roofing tiles from Ravenna's territory.

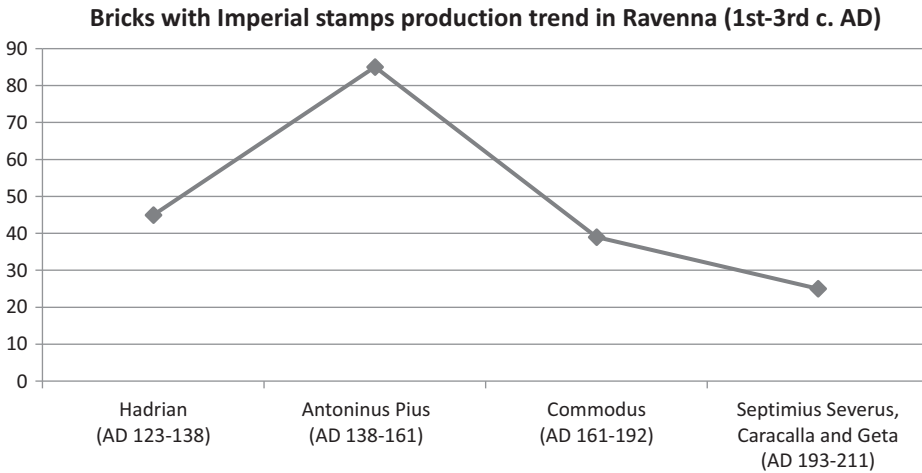
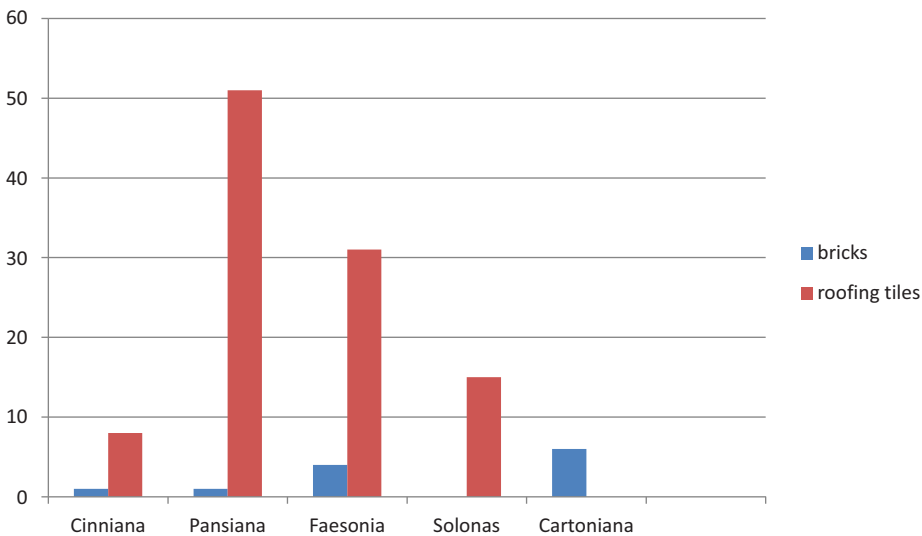
Stamp	Brick	Tegula	Site
CARTORIANA	1?		Ravenna
	1?		Classe
CARTORIAN	2		Ravenna
	2		Classe
CINNIANA	1	1	Classe
		1	Bagnacavallo Lugo

Table 3 (continued)

Stamp	Brick	Tegula	Site
CINNIANA.C.I.P.		1 1?	Ravenna? Ravenna
CINNIANA.IVL.PRI		2 1 1	Ravenna Classe Lugo
FAESONIA		3 1	Ravenna Classe
A.FAESONI.A.F.	2 2	16 3 1 6	Ravenna Classe Faenza Lugo
C.TVLLI.ATISIANI.F/FAESONIA		1	Classe
PANSIANA		23 3	Ravenna Classe
TI.PANSIANA		8 1	Ravenna Classe
T PASIANA		1	Faenza
C.PANSIANA		1	Bagnacavallo
C.PASI.A.NA		1	Ravenna
C.CAESAR[–]		1	Ravenna
TI.CLAVDI[PANSI]		1	Ravenna
NER.CAES.PANS		1	Classe
NERONIS.CLA.PAN		2 1	Ravenna Classe
NER.CLAVDI-PANSIANA		1	Ravenna
NER.CLAVDI-PANSI		3 1	Ravenna Classe
NER.CLAVD PANSIAN		1 1	Ravenna Classe
IMP • (small circle) CL S (inverted) P Λ	1		Ravenna
SOLONAS		4 5	Ravenna Classe
SOLONAS CIPRO		2	Ravenna

Table 3 (continued)

Stamp	Brick	Tegula	Site
[SOLO] NAT		1	Classe
L FRENI CF SOL		2	Ravenna
M FVLC CLEMENTIS / SOLONAS DE PLAVTI		1	Classe

**Graph 1:** Bricks with Imperial stamps production trend in Ravenna.**Graph 2:** Histogram of the main *figlinae* brickstamps identified in Ravenna and Classe.

From this list, we have in Ravenna and its territory mostly *tegulae* from *Cinniana* (8 stamps), *Faesonia* (31 stamps), *Pansiana* (51) and *Solonas* (15) *figlinae* (Table 3 – graph. 2). Stamped bricks are much rarer and come from great estates at *Cartoriana* (6), *Faesonia* (4), *Pansiana* (1), and *Cinniana* (1).⁵⁰ They are typically thought to be produced in the area around the Po Delta, and in the territory north of Ravenna, but information about kilns have yet to be completely published.⁵¹ Most of these ‘private’ *figlinae* were specialized in the production of *tegulae*, while in the 2nd century we find ‘imperial stamps’ particularly over bricks (Table 3 – graph.1). The quantities show a top standard of production during Antoninus Pius’ administration and diminishing during the first half of the 3rd century. Other smaller private kilns have (Table 4) been identified in Ravenna’s territory, standing to their diffusion and brick production linked to the numerous *villae* identified all throughout the surrounding landscape.⁵²

Table 4: ‘Minor’ private kilns.

Stamp	Brick	Tegula	Site
CN AVIL	1?		Ravenna
C CEIONI MAXI		1 1	Ravenna S. Zaccaria
T COELI	1		Ravenna
C CRITONI CN	2		Classe
L EGNATII SOR		1	Ravenna
CN FAVSTI	1?		Ravenna
L FREN	1		Lugo
C IVL THIASI EROTI	1 2? 2		Ravenna Villa di Russi Cotignola
C IVL THIASI GALLICAN	1		Ravenna
Q LEI[–] / AMA[–]	1?		Ravenna
C M S		2	Faenza
MACEDO	1		Ravenna

⁵⁰ Pellicioni 2010, 19.

⁵¹ Righini/Biordi/Pellicioni 1993, 33–34.

⁵² See previous bibliography in Cirelli 2014, 343–344.

Table 4 (continued)

Stamp	Brick	Tegula	Site
IL MONTANI		1 1?	S. Pietro in Campiano S. Zaccaria
Q P C	1		Classe
PASAE		1 1	Faenza Riolo Terme
LVC I QVAN	1		Lugo
Q RVSTICELI / AMERYMNI	1?		Ravenna
[–] SABINI		1	Classe
C SAF AGRIC	1?		Ravenna
MVSZ	1		Ravenna
SEVIAE	1?		Ravenna
SPVRENNI		6	Lugo
Q T P	3		Ravenna
[–] ARVITA		1 1?	Ravenna Faenza
[–] AVC [–]		1	Faenza
C MAV	1?		Cotignola
[–] IRS [–]		1	S. Pietro in Campiano
[–] NONI	1?		Ravenna
[–] OL PROSI [–]		1	S. Zaccaria
PAET [–]		1	Faenza

In Ravenna's territory, the existence of a late Roman bricks production has been uncovered with inscribed stamps using the name of SANTERNI ARMENTARIA (bricks, Fig. 2.1) and QVIRICVS (typically stamped on *tegulae*, Fig. 3.3–4), preceded by a small cross.⁵³ The chronology of this later production was occurred in a first

⁵³ Vernia 2005, 1112.

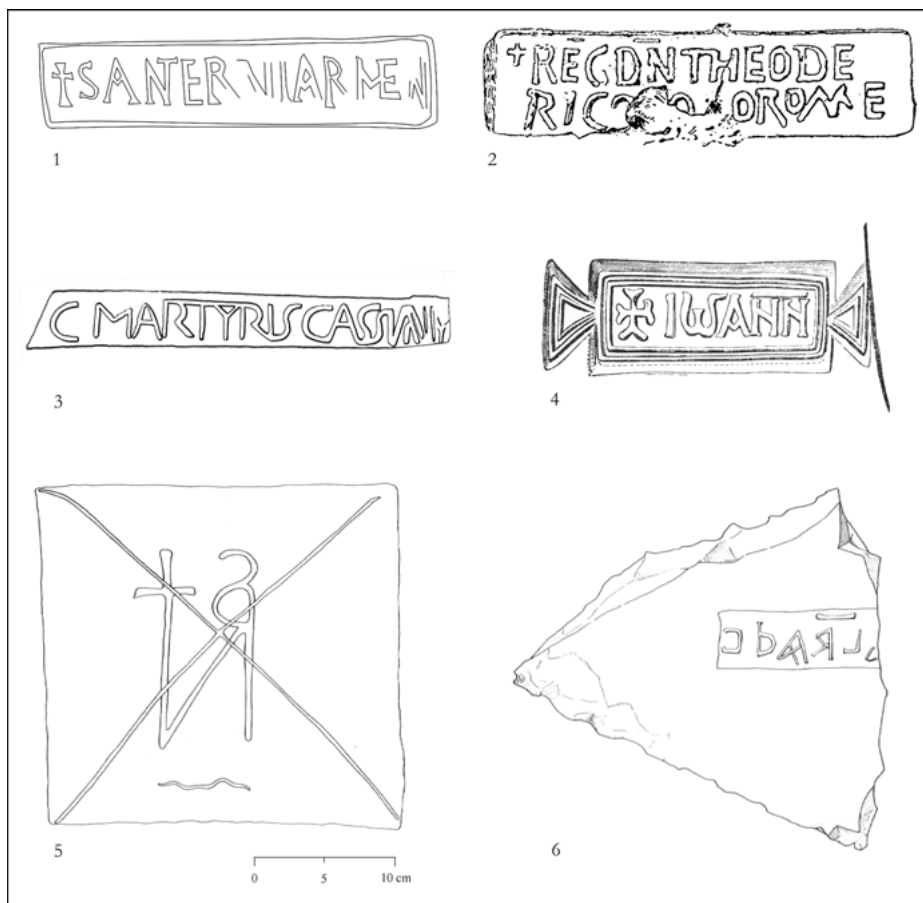


Fig. 2: Early medieval brickstamps from Italy: 1) 5th c. brickstamp found in Ravenna “SANTER NI ARMENTARIA†”, produced in its territory (Bagnacavallo); 2) King Theoderic brickstamp from Rome (“+REG(nante) D(omino) N(ostro) THEODE/RICO [b]O[n]O ROM(a)E”); 3) Brickstamp from 5th–6th c. context at Villa Clelia, Imola (Curina *et al.* 1990); 4) Brickstamp with the name “Iwann(hs)”, probably the Bishop of Rome John VII (AD 705–707), found in the Atrium of Vesta (Lanciani 1883); 5) Bishop Sabinus monogram on squared bricks from the 6th c. ecclesiastical complex at Canosa (Arthur/Whitehouse 1983); 6) Early medieval brickstamp (second half of the 6th–end of the 7th c.) found in the excavation of the monastery of Farfa, Viterbo (Arthur/Whitehouse 1983).

instance after the 3rd century⁵⁴ and then ten years postponed into the 4th century⁵⁵ because of the use of the ‘cross’. In this case, it might be the earlier example where a cross has been used as Christian official representation in Ravenna.⁵⁶ I propose

⁵⁴ Pellicioni 1983, 222.

⁵⁵ Righini/Biordi/Pellicioni 1993.

⁵⁶ Pasquini 2005, 1100.

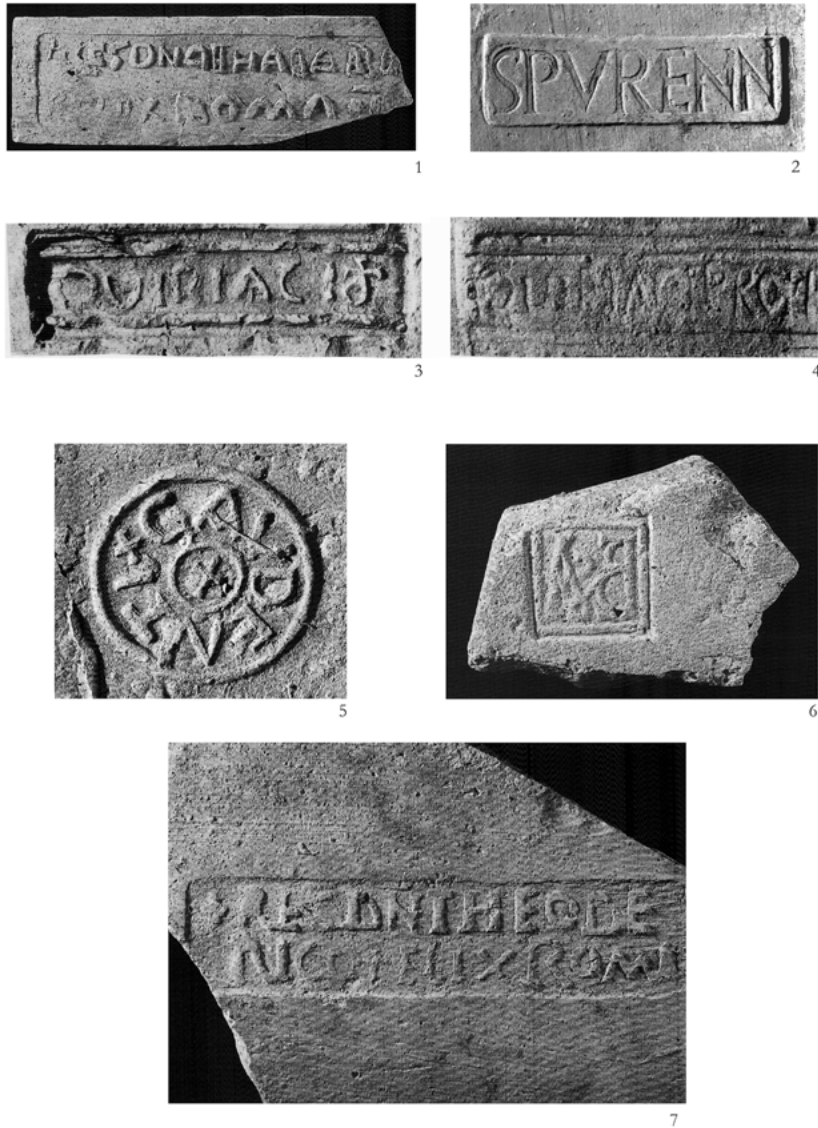


Fig. 3: Late antique brickstamps from Ravenna and Rome: 1) Athalaricus roof tile stamp (†REG D N ATHALARIC[O] FELIX ROMA ID V) from Kircherian Museum at Rome (Camilli 2001); 2) Mid-roman brickstamp from a private landowner in Ravenna's territory (*Spuren* from Lugo); 3) 6th c. brickstamp from St. Apollinaris in Classe 5th c.: QVIRIACI OT (Pellicioni 1983); 4) 6th c. brickstamp from St. Apollinaris in Classe: QVIRIACI PROTI OT (Pellicioni 1983); 5) roof tile with stamp († GAVDENTI) from Rome (Vatta 2001); 6) Early medieval (5th–7th c.) stamped brick from Rome attributed to bishop Bonifacius or to Beronicianus, an unknown private landowner (Steinby 1986); 7) King Theoderic stamp over roof tile (†REG DN THEODE[RICO] FELIX ROMA) found in Rome (Camilli 2001).

that the production period of this *figlina* must be fixed at the beginning of the 5th century. The enormous building site that was moved in this old city to be transformed into an imperial residence surely needed new materials together with the vast quantity of reused bricks (city walls, churches, the imperial Palace, the bishop's Palace with all its buildings etc.).⁵⁷ Furthermore, in this territory, the Christian community was not yet very strong. Its diffusion, as it has well been demonstrated, occurred at the very end of the 4th century and mostly at the beginnings of the 5th century, when cities receive new basilicas with full Christianization and fuller elite patronage appear as regular builders too.⁵⁸ No church or other Christian building was attested inside Ravenna before the construction of the great basilica Ursiana, and only two small private 'shrines' are found outside the proper city's borders before the edification of the late antique city walls, linked to bishops' memories: Liberius II⁵⁹ and Severus.⁶⁰ Both were built probably at around the half of the 4th century close to their own private suburban house and overall with the purpose to receive their burials, as *mausolea*.⁶¹

Most late antique bricks have been identified at old excavations and during the last fifteen years none have been recovered at Classe. It is notable that only one *tegula* was in any case recovered at Classe, and all the yellow bricks produced by *Santerni Armentaria* kilns come from Ravenna or Bagnacavallo (Tab. 5).⁶² This is where we may identify their site of production in a *Fundus Armentarius*, whose localization was put very close to the church of St. Peter in *Silvis*.⁶³ Dimensions are also different from previous *sesquipediales*. They are 47.5 cm large x 31 cm and 4.5 cm deep and also characterized by a Crescent-moon's shape 'hand grip', what in Italian is defined 'manubriato'.⁶⁴ I do not believe that this production site was the only one that contributed to the construction of the Imperial seat. Several other suburban *figlinae* must have contributed to it and this new rise in activity added a second chance to all this territory, as demonstrated by surveys⁶⁵ and excavations.⁶⁶

Another important *figlina* operated during the second quarter of the 5th century, producing the characteristic red bricks necessities for the construction of the small mausoleum (or *martyrium*), the so-called Galla Placidia's Mausoleum, connected a bit later to the Santa Croce Basilica, wanted by Galla Placidia (AD

⁵⁷ Carile 2012; Cosentino 2015, 55; Snyder forthcoming.

⁵⁸ Christie 2006, 97.

⁵⁹ Cirelli 2008.

⁶⁰ Augenti 2006b; 2012; Augenti/Cirelli 2016.

⁶¹ Ferreri 2011.

⁶² Rossini 1938, 148, n. 138; Veggi 1964, 120, n. 4; Pellicioni 1983, 212, 222; Righini 1986, 394.

⁶³ Veggi 1964, 120; Pellicioni 1983, 222.

⁶⁴ Pellicioni 1983, n. 22.59, 237.

⁶⁵ Augenti et al. 2005.

⁶⁶ Ferreri 2014.

Table 5: Late antique private stamps from Ravenna's territory (4th–5th c.).

Stamp	Brick	Tegula	Site
QVIRIACI O†		1	Classe
QVIRIACI PROTI O†		1	Ravenna
SANTERNI ARMENTA	1		Ravenna
SANTERNI ARMENTARIA†	4		Ravenna
SANTERNI ARMENTARIA†	1		Bagnacavallo

432–450).⁶⁷ The building is entirely constructed of bricks and well preserved in height. It is a Latin-cross shaped building (12.75x10.25 m) and the elevation is now standing without the original pink plaster that covered it completely.⁶⁸ Every façade is divided by lesenes covered by small blind arches. Even though some of the original bricks were used during restoration in the 19th century, serious stratigraphic analysis has shown that the original building was built with all the same type of bricks. Old interpretations explain this evidence with the idea that the building reused material from a single structure⁶⁹ or that the coherence was due to restorations.⁷⁰ The original bricks measured 29–30 cm in length and 9–10 cm in height (Tab. 6). Bricklayers used mortar thickness within the rows of 2–2.5 cm. This type of brick is really different from most of the first to third centuries *sesquipedales* reused in Ravenna's and in Classe's buildings (mostly cut by a prototype of 44–45 x 35 x 5–8 cm). Overall the homogeneity of these materials and their dimensions must be connected to a new and different site of production, active during the second quarter of the 5th century. They are also used in other buildings, even though not with the same quantities: the Neonian baptistery, St. John Evangelist (also dedicated by Galla Placidia)⁷¹ and Saint George at Argenta (sixth-century rural church).⁷²

The fabric is not the same as others produced in the 5th century but petrographic analyses of these intense-red bricks have still not been made. A fifth-century brick production site has been identified in northern Italy from the defensive walls of the

⁶⁷ Deichmann 1969, 152–170; 1974, 48–124; Cirelli 2013b.

⁶⁸ Vernia 2005, 1128, figg. 9–10.

⁶⁹ Righini 1991; Vernia 2005, 1130.

⁷⁰ David 2013, 17.

⁷¹ Vernia 2005, 1129.

⁷² Gelichi 1992, 226. B. Vernia indicates that also in the medieval church of Saint Mary in Forlimpopoli were used bricks of the same height, but the length is different (45 cm), the same as the *sesquipedalis* (see Vernia 2005, 1129, n. 81).

late antique site of *Laumellum*, close to *Ticinum*,⁷³ with traditional bricks (43–48 x 28–32 x 5–8 cm) and new complete bricks (60x30x6 cm).⁷⁴ Other fifth-century production sites of bricks have been identified in Rome, with Emperor Arcadius' stamps,⁷⁵ and also *tegulae* from a private landowner, Gaudentius, identified with Gaudentius *vicarius Africae* (AD 409), that had a *domus* close the Basilica Hilariana.⁷⁶ The name impressed on the *tegula* (†GAVDENTI), might be referring to someone else (e.g. the son of Flavius Aëtius), overall because the vicarius of Africa was famous for being pagan, contrasting with the cross used within the stamp (Fig. 3.5).⁷⁷ The same problem of identification is connected with another stamp: a monogram that has been attributed to a private landowner named Beronicianus,⁷⁸ but more likely associated with the episcopal production of one of the Bonifacius (5th–7th c.)⁷⁹ attested in the Roman episcopal list (Fig. 3.6).

They were also possibly produced in the same period for the early construction of the ecclesiastical building of Cimitile (Naples)⁸⁰ and surely on the island of Ischia, close to St. Restituta church, where kiln wasters have also been found.⁸¹ The same evidence of a small but established brick production area is also demonstrated on Sardinia at the site of Su Marmarzu, probably a village with a rural church, where a brickstamp with *chrismon* and the inscription 'EVSEBI VIVAS' has been identified.⁸² Another stamped brick also comes from a rural site close to Vico Equense in Naples southern territory, with the *legenda* '†SPES IN DEO'.⁸³

At the beginning of the 6th century, a new unique brick production site has also been identified, often defined 'giulianeae' because it has mostly been used in ecclesiastical buildings financed by Iulianus Argentarius,⁸⁴ the famous banker, who gave money for the construction of San Vitale, Sant'Apollinare *in Classe* and a smaller, possible private church, San Michele *in Africisco*.⁸⁵ All of these churches were finished between Ecclesius's and Victor's episcopate, during Goth's Kingdom and dedicated after the Gothic war with Justinian.⁸⁶ Bricks used for this new age of monumental building, at least for these three main churches, were produced in

⁷³ Sibilia/Della Torre 1987, 219.

⁷⁴ Blake/Maccabruni 1991.

⁷⁵ *CIL* XV, 1, 1660; Camilli/Vatta 2001, 223.

⁷⁶ Steinby 1986, 132–134.

⁷⁷ Vatta 2001, 224.

⁷⁸ Steinby 1986, 116, 134.

⁷⁹ *CIL* XV, 1, 1724; Camilli/Vatta 2001, 226.

⁸⁰ Arthur/Whitehouse 1983, 528. For Cimitile see: Ebanista 2008.

⁸¹ Monti 1980, 257.

⁸² *CIL* X, 8046, 15; Delussu 2008, 2668.

⁸³ *CIL* X, 8042, 139; Arthur/Whitehouse 1983, 528.

⁸⁴ Cosentino 2006.

⁸⁵ Augenti/Bertelli 2006.

⁸⁶ Cirelli 2007.

Ravenna's territory as demonstrated above. None of the bricks identified thus far have stamps, even though some of them have impressed lines (as mid-Roman 'bolli anepigrafi'), probably linked to the production process and trade of these materials (Fig. 4).⁸⁷ Dimensions of 'giuliane' bricks are normally 50x33x4 cm with a pale red fabric and crescent-moon's shape 'hand grip' (*manubriati*) as the older types. Not many other Italian cities in this period had evidence of brick production like Ravenna: Rome, with Theoderic's stamp found in the Temple of Vesta⁸⁸ and inside various restored sector of the Aurelian city walls (Fig. 2.2),⁸⁹ in Vibo Valentia (*Hipponion*), and in Calabria (†REG DN THEODE/RICO BONO ROME).⁹⁰ It is really difficult here to establish if this production had a market towards southern Italy or if, on the contrary, they were produced in *Bruttium* and transported to Rome. The furnishing of 25,000 bricks annually to Rome, indicated in a famous letter of Cassiodorus,⁹¹ came from *Porti Licini*. These *figlinae* were possibly from Rome's territory, inside a productive brand active in the 2nd and in the 3rd centuries and still active at the beginnings of the 6th century.⁹² The only 'imperial' *figlina* surely attested by stamps during Theoderic's time is the *Claudiana*, with numerous examples



Fig. 4: Brick (the so called 'giuliano' production) from the church of St. Michael in *Africisco*. Ravenna, half of the 6th c. (after Augenti 2006).

⁸⁷ Augenti 2006, 110.

⁸⁸ *CIL* XV, 1, 1714.

⁸⁹ Porta Asinaria, Porta Appia and Porta Flaminia (Coates Stephens/Parisi 1999). For the stamp brick see also: *CIL* XV, 1665b, 27; Birch 2015, 20. Other Theoderic's bricks have been also identified in a Rome's suburban bath, close to 'fosso di Prima Porta': see Messineo 2001, 16.

⁹⁰ *CIL* X, 8042, 139; Arthur/Whitehouse 1983, 528.

⁹¹ Cassiodorus, *Variae* I, 25.

⁹² Steinby 1975, 73–74; Saitta 1993, 116, n. 334.

and variants in Latin⁹³ (Fig. 3.7) and one in Greek.⁹⁴ *Officinatores* linked to Theoderic's *figlinae* are also various: Iustus,⁹⁵ Bonitus,⁹⁶ Metellus⁹⁷ and probably Laurentius.⁹⁸ A possible landowner is also known, the *dominus* Abundantius.⁹⁹ Long trade commerce of bricks has also been suggested by the identification of some bricks surely produced in the Bay of Naples, found in 5th and 6th centuries contexts at Carthage, although they may have been residuals.¹⁰⁰ Quite contemporary are the bricks produced during the episcopate of Pope Symmachus (AD 498–514)¹⁰¹ as well as ones attested to the period of Pope John I (AD 523–525) or John II (AD 533–536) at Rome, with the name stamped.¹⁰² Several new bricks (most of them *in situ*) with stamps have been recently found in the ecclesiastical complex of St. John of Canosa in Apulia, with bishop Sabinus' monogram, dated to the beginnings of the 6th century (Fig. 2.5).¹⁰³ In the same site, decorated square bricks (29.5–30 x 3–4 cm) are also attested.¹⁰⁴ The *giuliane* bricks are not to compare to bricks from Constantinople produced during the 6th century until AD 540, square in shape but with different dimensions (36.9 x 4.2 cm). In the second half of the 6th century, Byzantine bricks of Constantinople became rectangular (35.5 x 33.5 x 4.1 cm) but always much smaller than that of Ravenna's production.¹⁰⁵ Augenti recently demonstrated that *giuliane* bricks were used in other Ravenna's building, like Saint Agatha and the *Moneta Aurea*¹⁰⁶ and reused inside the medieval church of Saints Philip and Jacob¹⁰⁷ as well as inside some rural churches ('pievi') in the territories of Ravenna and Rimini, for instance at St. Martin in *Barisano*, St. Michael in *Acervoli*, St. Pancratius and Santarcangelo di Romagna, where a massive quantities of 'giuliane' type bricks have been reused.¹⁰⁸

Excavations in northern Italian sites, Monte Barro for instance, demonstrate that Lombardy brick production (primarily roof tiles, both *tegulae* and *imbrices*, but

⁹³ *CIL* XV, 1, 1563.

⁹⁴ Steinby 1974, n. 24.

⁹⁵ *CIL* XV, 1, 1664, 1668.

⁹⁶ *CIL* XV, 1, 1680.

⁹⁷ *CIL* XV, 1, 1703.

⁹⁸ *CIL* XV, 1, 1697.

⁹⁹ *CIL* XV, 1, 1676.

¹⁰⁰ Arthur/Whitehouse 1983, 529. For the commerce of ancient bricks coming from northern Italy, see: Righini 2008.

¹⁰¹ *CIL* XV, 1, 1714. It is uncertain if the Symmachus written over the stamp is the Pope or another public owner.

¹⁰² *CIL* XV, 1, 1695.

¹⁰³ Giuliani/Leone/Volpe 2013, 1139.

¹⁰⁴ Arthur/Whitehouse 1983, 534, fig.7.2–3.

¹⁰⁵ Bardill 2004; Augenti 2006, 113.

¹⁰⁶ Augenti 2005, 27.

¹⁰⁷ Augenti 2007.

¹⁰⁸ Gelichi/Delogu/Gabrielli 2000, 159, 162–163.

Table 6: Late antique and medieval (1st–8th c.) brick dimensions in Italy.

Name	Measure	Chronology
‘Sesquipedale cisalpino’ (Ravenna)	45 x 30 x 5–8 cm	1st–3rd c.
‘Mezzo sesquipedale’ (<i>semilater</i>) (Ravenna)	45 x 16 x 5–8 cm	1st–3rd c.
<i>Bessale</i> (Ravenna)	22 x 22 x 5 cm	1st–3rd c.
<i>Santerni Armentaria</i> product. (Ravenna)	47.5 x 31 x 4.5 cm	4th–5th c.
Galla Placidia’s bricks (Ravenna)	40 x 29–30 x 9–10 cm	5th c. (AD 425–450)
Lomello’s bricks	60 x 30 x 6 cm	414 ± 90
‘Giuliano’ (Ravenna)	50 x 33 x 4–4.5 cm	First half of the 6th c.
Theoderic’s bricks (Rome)		First half of the 6th c.
Constantinople bricks	36.9 x 36.9 x 4.2 cm	First half of the 6th c.
Canosa’s bricks	29.4 x 29.4 x 3–4 cm	First half of the 6th c.
Constantinople bricks	35.5 x 33.5 x 4.1 cm	Second half of the 6th c.
Early medieval ‘sesquipedalis’ (Northern Italy)	44.4 x 29.6 x 6–8.5 cm	6th–8th c.

also bricks) was still active using the same typologies of the previous centuries.¹⁰⁹ It also seems that brick production in most of northern Italy continued using quite similar dimensions to the traditional *sesquipedalis* (44.4 x 29.6 x 6–8.5 cm),¹¹⁰ but possibly destined for specific buildings or a single order for monastic communities,¹¹¹ new churches¹¹² or fortifications.¹¹³ A new format (30–55 x 14–16 x 6.5–7 cm) was used from the 9th century in northern Italy, with numerous variants until the 11th century all inside rural and urban sites.¹¹⁴

There is no evidence of other brick production in Ravenna between the second half of the 6th century and before late medieval times (13th century).¹¹⁵ Although, it is possible that some brick production also continued in the early Middle Ages, as happened in Rome. Here, some bricks with a stamp inside a ‘*tabula ansata*’ with

¹⁰⁹ Ubaldi 2000, 13.

¹¹⁰ Negro Ponzi 2000, 54.

¹¹¹ Parenti 1994; Moran 2000.

¹¹² Fiorilla 1986.

¹¹³ Blake/Maccabruni 1986.

¹¹⁴ Negro Ponzi 2000, 55.

¹¹⁵ Novara 2000, 129–132; Augenti 2003.

the name ‘†IΩANN(ES)’ were found in the Atrium of Vesta,¹¹⁶ possibly produced during the times of the pope John VII (AD 705–707) (Fig. 2.4) for the construction of a bishop’s palace close to Santa Maria *Antiqua*.¹¹⁷ A bit of evidence is also coming from monastic contexts. For instance at Farfa, where brickstamps have been found that date between the second half of the 6th and the end of the 7th centuries (Fig. 2.6).¹¹⁸ Carolingian production of bricks and roof tiles is also attested at Santa Maria *foris portas* in Castelseprio, confirmed by archaeometric analyses,¹¹⁹ as well as at Cividale del Friuli and Aquileia.¹²⁰

Tegulae and *tubuli*, cylindrical ceramic pipes (vaulting tubes) used to build domes and vaults, and overall *imbrices*, roof tiles whose production has never been interrupted, are different cases. In addition to 5th century stamped *tegulae* found at Sant’ Apollinare, they are also found in Rome with the stamp of King Athalaric (AD 526–530) (Fig. 3.1).¹²¹ Three *tegulae*, probably produced at the beginning of the 5th century, have been identified inside late antique funerary contexts at the site of villa Clelia (Imola) with stamps of ‘S(an)c(t)i Martyris Cassiani’ (Fig. 2.3).¹²² New *tegulae* were probably also produced later for the church of San Severo at the end of the 6th century. This church was built using the same size and plan of the basilica of Saint’ Apollinare inside the city walls of Classe, reusing bricks from every type of construction and period, some with Alexander Severus’ stamp (Fig. 5) and others with bricks of Pansiana or Hadrian.¹²³ Production of *tegulae* is also witnessed in north Italy, for instance at Milan,¹²⁴ in the cathedral of Monza,¹²⁵ at Terno d’Isola (Bergamo) using thermoluminescence,¹²⁶ and in eighth-ninth centuries contexts at Treviolo (Bergamo)¹²⁷ and Brescia.¹²⁸ A famous ninth century artisan “Iuvenus magister

116 De Rossi 1870; Lanciani 1883, 494–495; Arthur/Whitehouse 1983, 526, fig. 1.

117 *Lib. Pont.*, I, 385.

118 McClendon/Whitehouse 1982.

119 Martini/Sibilia/Spinolo 1985, 215–217; Della Torre et al. 1988, 135–138.

120 Fiorilla 1987; Buora 2000, 87.

121 *CIL* XV, 1, 1675; Camilli/Vatta 2001, 225, I.10.4.

122 Donati/Susini 1979, 44; Righini 1986, 394; Curina et al. 1990, 202–205; Righini/Biordi/Pellicioni Golinelli 1993, 72.

123 Cirelli 2011.

124 One *tegula* with the inscription ‘Reg’ identified close the Dome and in Via Croce Rossa, linked to Lombard kingdom urban investments. At the same seventh-eight centuries production are referred also bricks and other productions with the stamp ‘REX’, reused in SS. Nazario and Simpliciano, and in Concorrenzo and Gropello Cairoli out of Milan. See: Ubaldi 1991, 155, tav. CCV, 17–18; Ubaldi 2000, 17, fig. 5.

125 More than three hundred *tegulae* recovered from St. John the Baptist church, built by Theodelinda, one with the eighth-century inscription written before cooking: *S(an)c(t)i Ioh(annis)*. See: David 1988, 97; Ubaldi 2000, 15.

126 Martini/Sibilia/Spinolo 1986, 166.

127 Sibilia/Della Torre 1989, 80.

128 Della Torre 1990, 162.

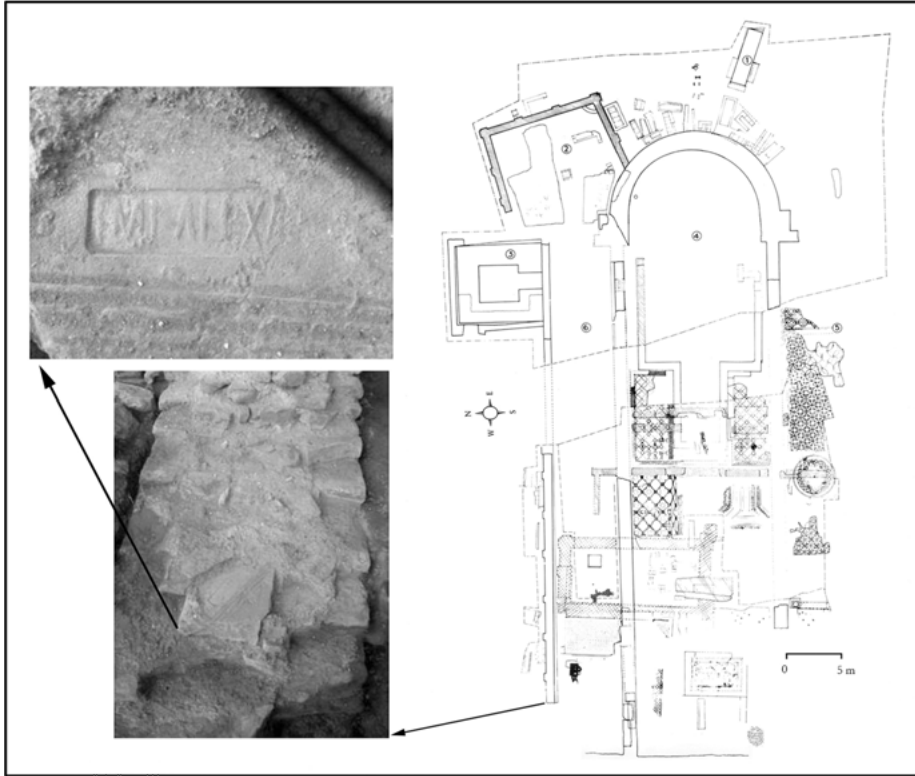


Fig. 5: Severus Alexander Emperor brickstamp reused in the basilica of St. Severus in Classe (end of the 6th c.) (photo E. Cirelli).

teularius" (IVVE/(N)VS/MAGIS/TE(R) TE/VLARIO), has left his name on a *tegula* prior to firing, which is preserved in the Archiepiscopal Museum of Ravenna (Fig. 6). It also testifies to roof-tiles production in this city during the Carolingian times¹²⁹ or at the beginnings of the 10th century.¹³⁰

The case of the production of *tubuli*, which have been largely found during old and new archaeological excavations inside Ravenna and Classe,¹³¹ is totally different. This type of material could not have been reused and its first use was also the last. If brick and roof tile production continued, even with different typologies and quantities during the Middle Ages as well, *tubuli fictiles* were not used in Ravenna after the end of the 6th century. What we know at the moment is that, following this, a construction

¹²⁹ Fiorilla 1986, 39. For Ravenna during Carolingian time see: Augenti 2008.

¹³⁰ Gelichi/Delogu/Gabrielli 2000, 139, fig. 1.

¹³¹ Augenti 2011; 2013.



Fig. 6: Ninth century roofing tile with *magister teularius* inscription (photo SBAAR, n 126375, published in Gelichi/Delogu/Gabrielli 2000). (Archbishop's Museum, Ravenna).

‘crisis’ was observed in Ravenna’s churches (Fig. 7).¹³² The last building where we have wide evidence of the use of *tubuli fictiles* is the last great ecclesiastical building of this gold age of construction: the huge church of San Severo.¹³³ Vaulting tubes were placed one inside the other, giving a lightweight vault and a good acoustic system, but overall to avoid the use of wooden centering (*centinae*) – temporary structure upon which the bricks of an arch or vault were laid during construction. Vaults built with *tubuli* were completely self-supporting, easier, quicker and cheaper to build (Fig. 8),¹³⁴ but with the use of the right mortar, small modular brick groin or barrel vaults were constructed without centering¹³⁵ (like those used in the construction of cisterns and small churches of Constantinople). It is a constructive method commonly

¹³² Augenti 2007; Cirelli 2007.

¹³³ Augenti 2009.

¹³⁴ Storz 1997; Lancaster 2009.

¹³⁵ Tomasello 2006.

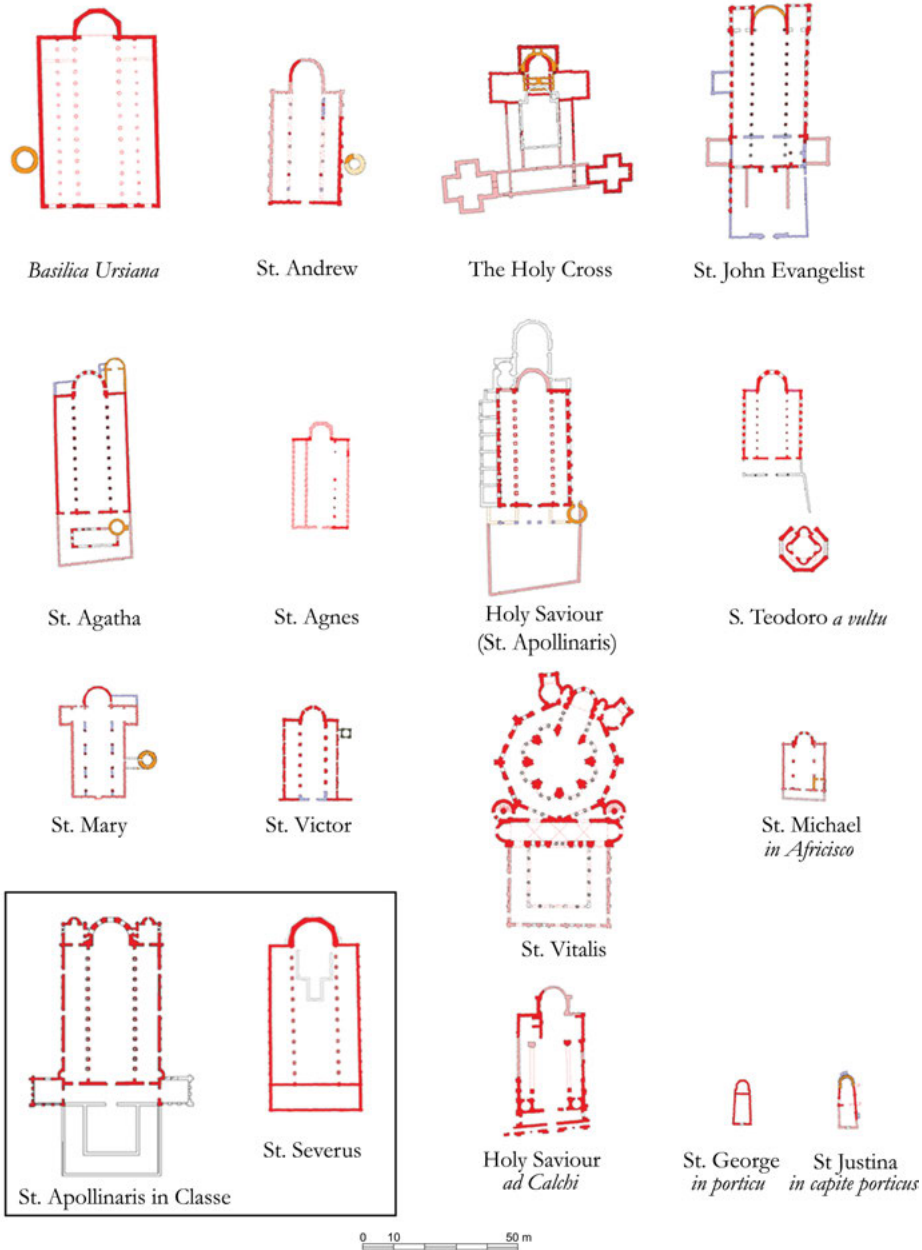


Fig. 7: Size and time. The evolution of Ravenna's church from 5th to 10th c. (after Cirelli 2007).

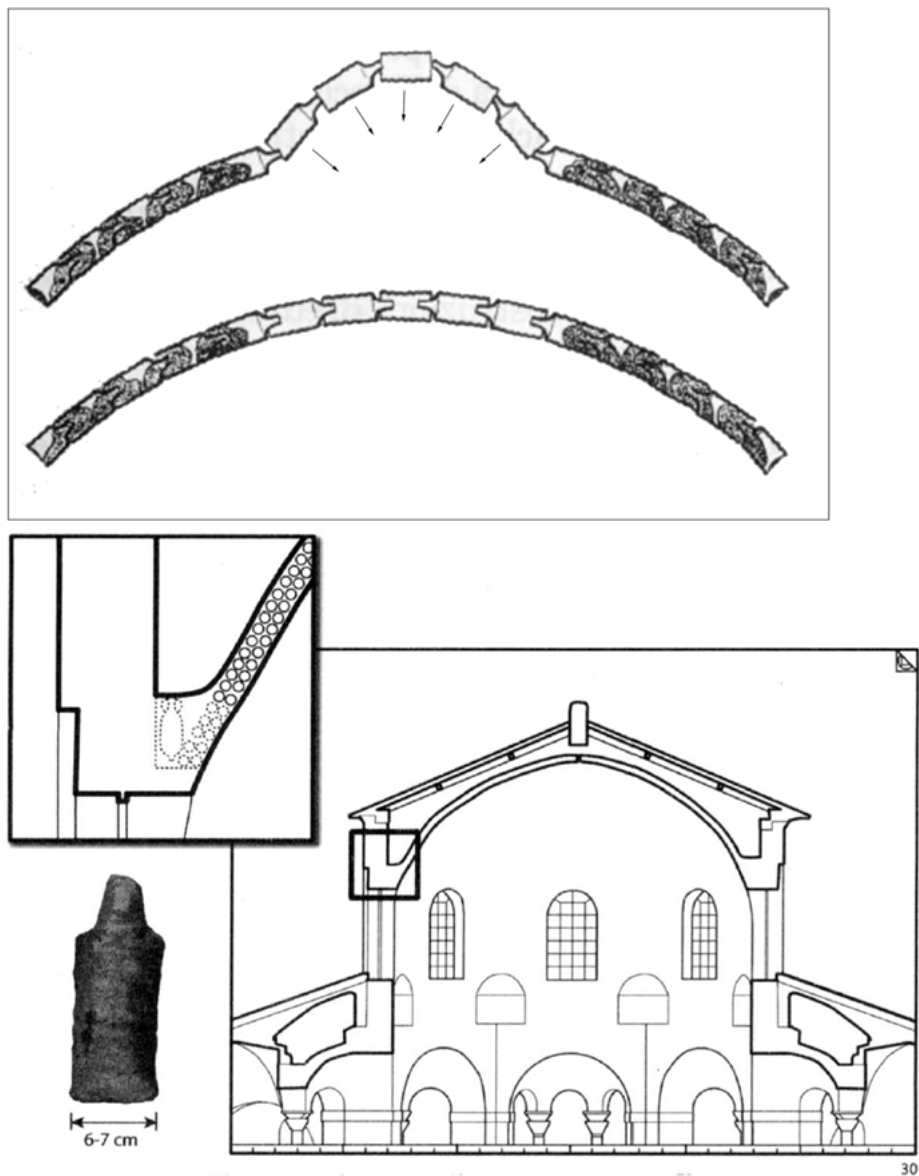


Fig. 8: Vaulting tubes installation system (after Lancaster 2009).

used in many Mediterranean territories, probably first experimented in North-Africa during the 2nd century.¹³⁶ Most late antique buildings in Ravenna have used this

¹³⁶ Lézine 1954; Wilson 1992, 108.

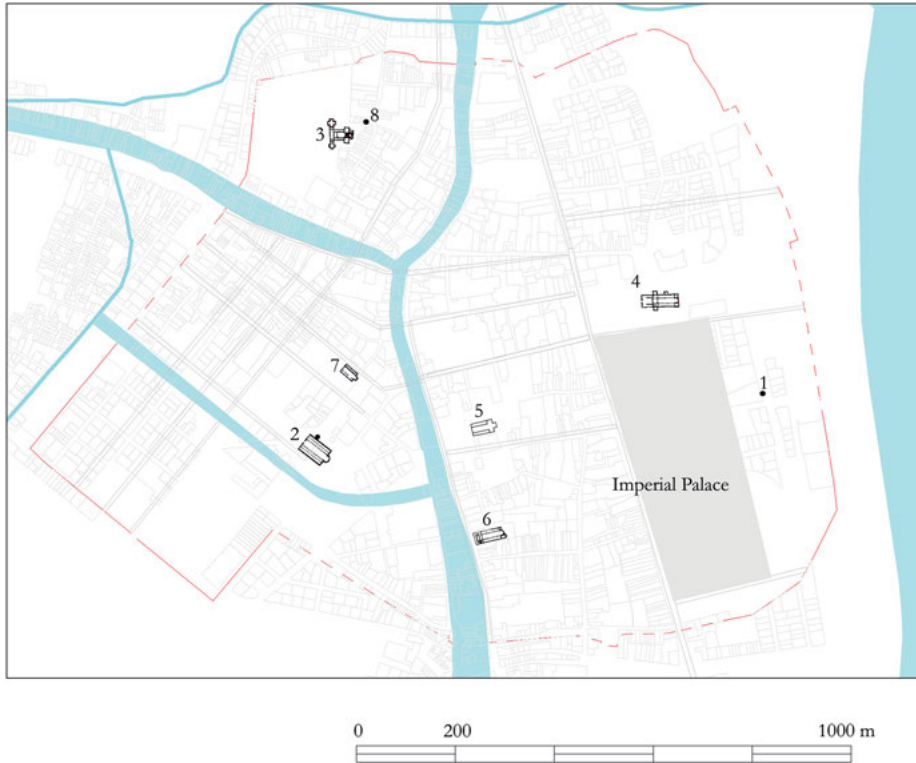


Fig. 9: Early churches and Christian buildings at Ravenna, within the late antique city walls (beginnings of the 5th c.): 1) Liberius mausoleum, St. Pullione (mid 4th c.); 2) *Basilica Ursiana* (beginnings of the 5th c.); 3) The Holy Cross and Galla Placidia's mausoleum (5th c.); 4) St. John Evangelist; 5) *Basilica Apostolorum*, now St. Francis (5th c.); 6) St. Agatha (5th c.); 7) St. Agnes (5th c.); 8) Ss. John and Barbatianus (5th c.) (after Cirelli 2008).

system: from the older church, the basilica Ursiana¹³⁷ and its Baptistry,¹³⁸ Santa Croce, San Vitale, Sant'Agata, Sant'Apollinare in Classe,¹³⁹ and the bishop's palace baths.¹⁴⁰ New impressive evidence comes also from Augenti's *basilica Petriana* excavations.¹⁴¹ With the same technique, a small building whose identification is still uncertain has also been built using ceramic vaulting tubes, close the Imperial Palace complex (Via Alberoni/Via Pallavicini)¹⁴² (Fig. 9.1). I proposed to associate this with

¹³⁷ Deichmann 1956, 37.

¹³⁸ De Angelis D'Ossat 1962, 146–147.

¹³⁹ Russo 1996; Novara 2000, 124; Russo 2003a, 4–9; 2003b.

¹⁴⁰ Cirelli 2008, 118.

¹⁴¹ Augenti/Boschi/Cirelli 2010.

¹⁴² Manzelli 2000, 151–152; Cirelli 2008.

monasterium Sancti Pullionis, known from *Liber Pontificalis*, where Agnellus said a bishop named Liberius (AD 377) was buried in the 4th century. This is the oldest building testified at Ravenna with evidence of *tubuli fictiles*.

Vaulting tube types are similar but change in shape and fabric color and composition even inside the same building and inside the same vault, as shown by Augenti's recent excavation evidence.¹⁴³ They were produced in different kilns and had long distance commerce, as show by their presence inside shipwrecks identified both in the Tyrrhenian Sea (mostly around Sicily: eight shipwrecks, Fig. 10, Table 7) and along the eastern coast of the Adriatic for instance.¹⁴⁴ Numerous

Table 7: List of the major underwater finds of vaulting tubes (from Wilson 1992).

Country	Site	Chronology
Spain (Balears)	Capo Bianco	3rd–6th c. wreck
Spain (Cartagena)	Cabo de Palos	3rd–6th c. wreck
France	Gruissan	3rd–6th c. wreck
France	Cap d'Agde	3rd–6th c. wreck
France	Dramont	3rd–6th c. wreck
France	Antibes	3rd–6th c. wreck
Italy (Tuscany)	Punta Ala	3rd–6th c. wreck
Italy (Tuscany)	Punta del Fenaio, Giglio	3rd–6th c. wreck
Italy (Sardinia)	Lavezzi	3rd–6th c. wreck
Italy (Sicily)	Marsala	1st c. BC–2nd c. AD wreck
Italy (Sicily)	Femmina Morta (Ragusa)	4th c. wreck
Italy (Sicily)	Ognina (Syracuse)	3rd c. wreck
Italy (Sicily)	Cefalù	6th c. wreck
Italy (Sicily)	Himera	4th–6th c. wreck
Italy (Sicily)	Filicudi (Capo Graziano)	2nd c. B.C. wreck
Italy (Sicily)	Lipari	3rd–5th c. wreck
Italy (Sicily)	Panarea	3rd–5th c. wreck
Italy (Apulia)	Acque Chiare	2nd–3rd c. wreck
Croatia	Hvar	6th c. wreck

¹⁴³ Augenti 2012.

¹⁴⁴ Bound 1987. Several unpublished vaulting tubes coming from close shipwrecks are visible in Stari Grad Museum in the island of Hvar.

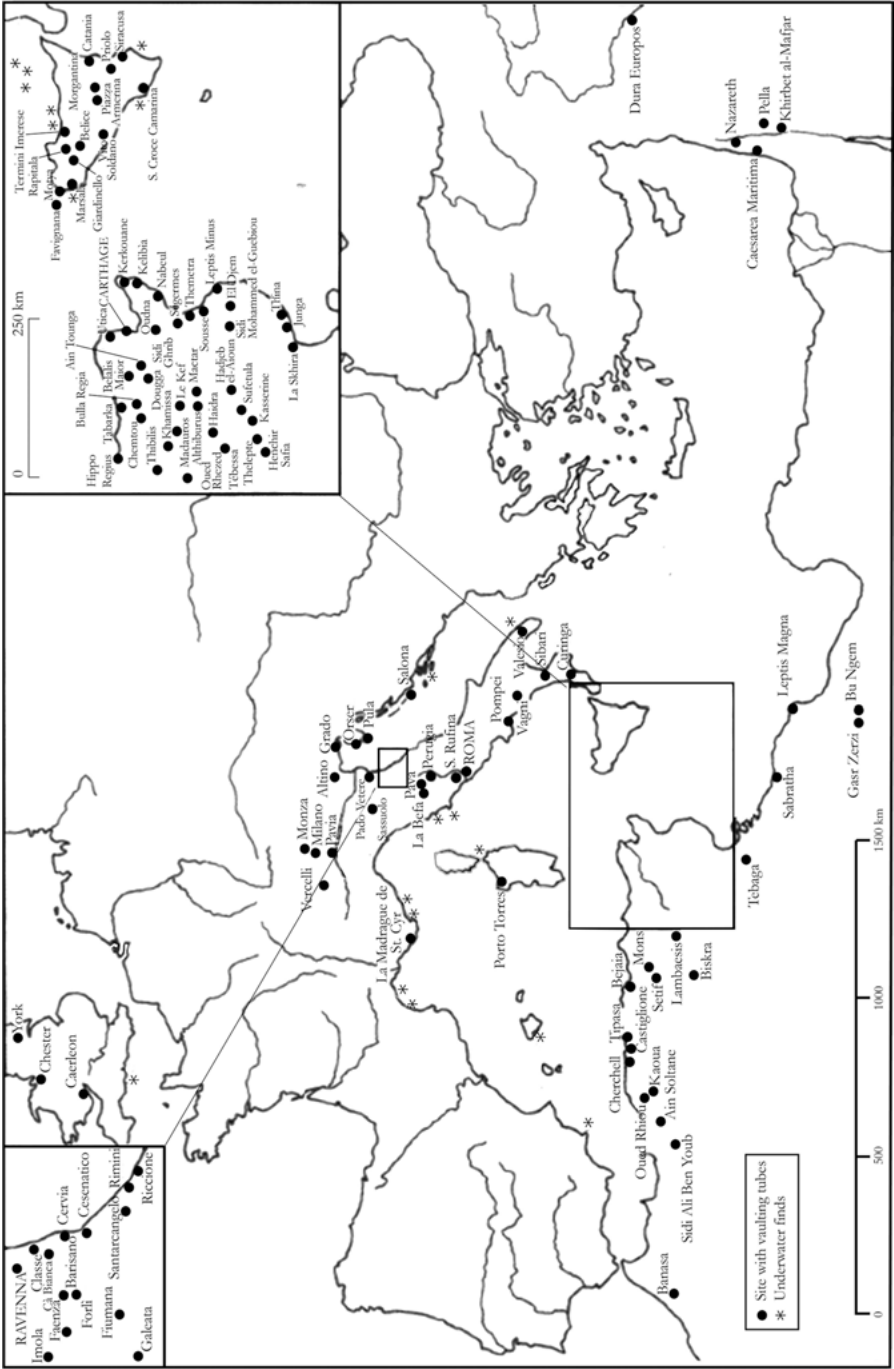


Fig. 10: Distribution map of buildings with vaulting tubes (1st-10th c.) and underwater finds (E. Cirelli).

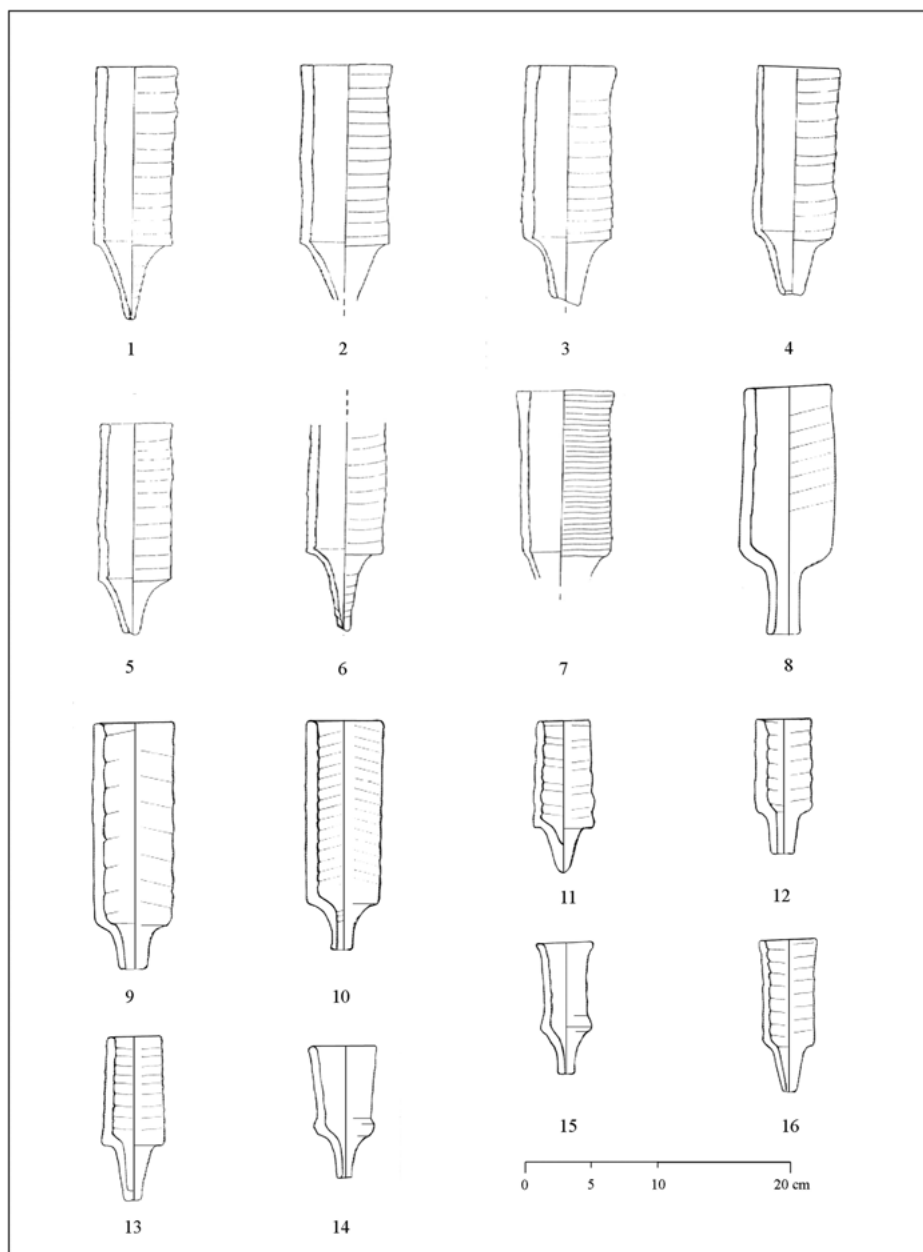


Fig. 11: Sample of vaulting tubes from Ravenna and Classe (E. Cirelli).

Table 8: Late antique and early medieval vaulting tubes in Italy (3rd–10th c.).

Site	Building	Context of use	Chronology
Ravenna	Liberius mausoleum (St. Pullione, Via Alberoni\Via Pallavicino)	dome	4th c.
Ravenna	Basilica Ursiana	Hemispherical vault (apse)	First quarter of the 5th c.
Ravenna	Neonian Baptistery	Dome	Half of the 5th c.
Ravenna	<i>Basilica Apostolorum</i> (San Francesco)	Hemispherical vault (apse)	Second half of the 5th c.
Ravenna	San Giovanni Evangelista	Hemispherical vault (apse)	5th–6th c.
Ravenna	San Salvatore (Sant'Apollinare Nuovo)	Hemispherical vault (apse)	End of the 5th c.
Ravenna	St. Andrew at Bishop's Palace	Hemispherical vault (apse)	Second quarter of the 6th c.
Ravenna	San Vitale	Dome	Second quarter of the 6th c.
Ravenna	Sant'Agata	Hemispherical vault (apse)	Half of the 6th c.
Ravenna Classe	Bishop's Palace Bath Basilica Petriana	Dome Hemispherical vault (apse)	6th c. 5th c.
Classe	Small building close to St. Apollinaris	Dome	6th c.
Classe	San Severo	Hemispherical vault (apse)	End of the 6th c.
Cà Bianca (Ravenna)	St. Demetrius	Hemispherical vault (apse)	End of the 5th–6th c.
Faenza	Kilns	Vaults	3rd c.
Forlì	Kilns	Vaults	3rd c.
Galeata (Forlì)	Theoderic Villa (Bath)	Dome	End of the 5th–6th c.
Fiumana (Forlì)	Kilns	Vaults	4th c.
Barisano (Forlì)	St. Martin	Hemispherical vault (apse)	6th c.

Table 8 (continued)

Site	Building	Context of use	Chronology
Santarcangelo (Rimini)	Kilns (S. Ermete)	Vaults	3rd c.
Santarcangelo (Rimini)	St. Michael <i>in Acervoli</i>	Hemispherical vault (apse)	6th c.
Santarcangelo (Rimini)	Kilns (via Palazzina\Via Resistenza)	Vaults	6th c.
Santarcangelo (Rimini)	Kilns (Lott. Spina)	Vaults	6th c.
Rimini	Various and sporadic finds		3rd-second half of the 6th c. contexts
Rimini	Chirurgo <i>Domus</i>	Vaults	End of the 3rd–4th c.
Rimini	Kilns	Vaults	End of the 3rd–4th c.
Riccione	Kilns	Vaults	3rd c.
St. Mary <i>in Pado Vetere</i> (Ferrara)	Baptistery	Dome	6th c.
Orser (Istria)	Basilica	Hemispherical vault (apse)	Mid 5th c.
Pula (Istria)	Basilica	Hemispherical vault (apse)	6th c.
Grado	St. Euphemia	<i>Martyrium</i> dome	Second half of the 6th c.
Pavia	St. John <i>Domnarum</i>	Hemispherical vault (apse)	7th c.
Pavia	Sts. Gervasius and Protasius	Vault	6th c.
Milan	St. Aquilinus in St. Lawrence	Hemispherical vault (apse)	End of the 4th c.
Milan	St. Simplicianus	Archway soffit branches	End of the 4th–5th c.
Milan	St. Vittore in Ciel d'Oro in St. Ambrose	Dome	Mid 5th c.
Milan	St. Tecla	Hemispherical vault (west semi-apse)	End of the 5th c.
Milan	St. Lawrence	Dome	10th c.
Monza	Theodelinda's basilica	Archway soffit	6th–7th c.

Table 8 (continued)

Site	Building	Context of use	Chronology
Vercelli	St. Eusebius	Hemispherical vault (apse)	6th c.
Pava (Siena)	Bath villa under St. Peter's church	Dome	4th–5th c.
La Befa (Siena)	Bath villa	Dome	4th c.
Rome	St. Rufina, mausoleum		4th c.
Rome	Holy Cross in Lateran, Baptistry	Dome	Mid 5th c.
Rome	St. Stefano Rotondo	Vaults	5th c.
Rome	Sts. Cosmas and Damian	Hemispherical vault (apse)	6th c.
Rome	St. Anastasia		4th–5th c.?
Rome	St. Costanza, in St. Agnes	Vaults	4th c.
Rome	St. Agatha <i>dei Goti</i>	Hemispherical vault (apse)	End of the 5th c.–6th c.
Vagni (Salerno)	villa		4th c.?
Curinga (Catanzaro)	Bath villa	Dome	3rd–4th c.
Sibari			Mid 4th c.
Valesio (Brindisi)	Bath	Dome	3rd–4th c.
Syracuse	Daphne bath	Dome	7th c.?
Marsala (Lilibeo)	Bath villa	Cross vault	3rd–4th c.
Piazza Armerina	Various rooms	Vaults	4th–5th c.
Mothia	<i>Domus</i>		4th–5th c.
Porto Torres	Sporadic		5th c.

vaulting tubes identified at Ravenna show Tunisian fabrics and they might have been imported from northern African ateliers, together with the many Red Slip vessels, lamps and amphorae imported between the 5th and the 7th centuries in its extraordinary late antique port.¹⁴⁵ Fabrics and dimensions are different (Fig. 11) and

¹⁴⁵ Cirelli 2015.

it is not possible at the moment have an idea of the evolution from one type to another.¹⁴⁶

Many other northern Italian sites show the use of this materials and techniques during Late Antiquity. For instance in Piemonte, where they are found inside the episcopal complex of St. Eusebius at Vercelli, restored by bishop Flavianus (dead AD 542).¹⁴⁷ Here, ceramic vaulting tubes also have different dimensions (h. 10.5–15.4 cm; ø 4.4–4.5 cm).¹⁴⁸ In St. Eusebius finds have also been analyzed using petrographic and chemical methods showing the contemporary presence of at least two main groups of products, one coming from close kilns and the other probably imported from Po Valley ateliers.¹⁴⁹ Numerous ceramic pipes for vaults have been also identified in Milan's underground excavations¹⁵⁰ as well as at St. Tecla,¹⁵¹ St. Simplicianus,¹⁵² and S. Vittore in Ciel d'Oro.¹⁵³ These have also been found in buildings still standing in Rome like St. Stefano Rotondo (on the Celian Hill), also with different size and types of *tubuli* used inside the same vault.¹⁵⁴ The main site where we have this technique and material during Late Antiquity is Ravenna and they were used also inside other close cities like Rimini, where possible kilns have been discovered,¹⁵⁵ but also at rural sites such as St. Michael in *Acervoli* at Santarcangelo di Romagna.¹⁵⁶ However, *tubuli* have been used in many other places such as Istria, France, Spain, England, Syria, Jordan and Palestine.¹⁵⁷

At the moment, the only attested example of a later than sixth-century use of vaulting tubes in Italy has been found inside the ecclesiastical complex of St. Lawrence in Milan (10th century), dated using archaeometric analyses (Table 8).¹⁵⁸ However, we have one other early medieval example in Palestine, at Khirbet al-Mafjar, inside the eighth-century bath of Hisham Palace,¹⁵⁹ inside the ninth-century Aghlabide baths at Dougga, in Tunisia,¹⁶⁰ in the Hafside mosque at Sidi ben Aïssa à Gabès and in El-Abdeliya Library at Marsa.¹⁶¹

146 Lancaster 2009, 6.

147 Pantò/Uggé 2004, 25.

148 Lancaster 2009, 14.

149 Pantò/Uggé 2004, 29.

150 Ubaldi 1991, 154.

151 Ruffolo 1970, 65.

152 Verzone 1938, 8–9.

153 Monneret de Villard 1924, 150–151.

154 Storz 1995, 680–681.

155 Stoppioni 1993, 80–87, 109–112;

156 Russo 2003, 210.

157 Wilson 1992, 125–129; Russo 2003, 192–198.

158 Pantò/Uggé 2004, 32, 34; Antico Gallina 2011, 23–24.

159 Hamilton 1959; Creswell 1989, 183.

160 Louhichi 1998, 110.

161 Mrabet 1997.

Conclusions

Brick production in Ravenna and its territory did not stop during Late Antiquity and had two main peaks of fabrication: at the beginnings of the 5th century and then in the first half of the 6th century with the Ostrogothic kingdom. That is the same trend that we may observe for the building activities during the same period, when the small Roman city became an imperial residence and when King Theoderic renewed the construction activity with the idea of a new capital for its imperial chair. Evidence for this production comes from archaeological excavations and from standing buildings in Ravenna. Two different centers of fabrication produced fifth-century bricks from the close territories in Bagnacavallo and one probably from the south-eastern hinterland, when ferrous clay was much more diffused. One other great center of production, whose center of manufacture has not been established, was instead active at the beginnings of the 6th century and was used for buildings whose construction started during Ostrogothic administration of the city (San Michele in Africisco, San Vitale and Sant' Apollinare in Classe). Their petrographic characteristics are identical to the Po Delta's territory, close to Ravenna. Augenti already demonstrated that they do not come from Constantinople, where bricks were completely different both in size and fabric at this moment. This brick production was flanked by a massive reuse of bricks from the ruins and demolition of the older Roman houses and temples. Systems of set up, different size of brick or mortar joint dimensions and curtain wall finishing were not so important for the aesthetic perception of these buildings, once covered with painted plasters, now destroyed and removed for our naked aesthetic idea. During the same period (4th–6th centuries) bricks atelier in the territory of Ravenna also produced cylindrical ceramic pipes used for vaults and domes. Roofing tiles were produced without interruption, including after the 6th century for new buildings and restoration of the older monuments. This framework is partly similar to other territories. During Late Antiquity, Italian cities in northern Lombard territories, as well as other traditional Roman landscapes, saw brick production decrease but not a total abandonment. Dimensions, quantities and systems of production completely changed from Antiquity, but Ravenna's materials and building techniques are the same of a tradition Roman city in Western Europe.

Bibliography

Primary Sources

Lib. Pont. = *Le Liber Pontificalis. Texte, introduction et commentaire* par L. Duchesne, vol. I. Paris 1886.

Secondary Sources

- Antico Gallina, Maria Vittoria, 2011: “«Si vero forno [. . .] cum caccabos fecerit» (Mem. 7a). Spunti per la rilettura di una tecnica nella lunga durata.” *Archeologia dell'Architettura* XV: 9–30.
- Arena, Maria S., Delogu, Paolo, Paroli, Lidia, Ricci, Marco, Sagui, Lucia and Vendittelli, Laura. 2001. Eds. *Roma dall'antichità al medioevo. Archeologia e storia nel Museo Nazionale Romano Crypta Balbi*. Milano.
- Arthur, Paul and Whitehouse, David. 1983. “Appunti sulla produzione laterizia nell'Italia centro-meridionale tra il VI e XII secolo.” *Archeologia Medievale* X: 525–537.
- Augenti, Andrea. 2001 “La città: dalla tarda antichità all'età comunale.” In *Volterra da Ottone I all'età comunale*, Catalogo della Mostra, edited by Andrea Augenti, 25–29. Siena.
- Augenti, Andrea. 2003. “La chiesa di S. Nicolò: archeologia dell'architettura”. In *Domus del Triclinio. Alla scoperta di Ravenna romana*, Catalogo della mostra, 29–33. Ravenna.
- Augenti, Andrea. 2004. “Fonti archeologiche per l'uso del legno nell'edilizia medievale in Italia.” In *Civiltà del legno. Per una storia del legno come materia per costruire dall'antichità ad oggi*, edited by Paola Galetti, 37–69. Bologna.
- Augenti, Andrea. 2005. “Archeologia e topografia a Ravenna: il palazzo di Teoderico e la Moneta Aurea.” *Archeologia Medievale* XXXII: 7–33.
- Augenti, Andrea, ed. 2006a. *Le città italiane tra la tarda Antichità e l'alto Medioevo*. Firenze.
- Augenti, Andrea. 2006b. “L'architettura: i materiali per l'edilizia.” In *Santi Banchieri Re. Ravenna e Classe nel VI secolo. San Severo il tempio ritrovato*, Catalogo della mostra (Ravenna, 4 marzo-8 ottobre 2006), edited by Andrea Augenti and Carlo Bertelli, 110–113. Milano.
- Augenti, Andrea. 2007. “San Michele in Africisco e l'edilizia ecclesiastica ravennate tra V e X secolo.” In *San Michele in Africisco e l'età giustiniana a Ravenna, Atti del convegno “La diaspora dell'arcangelo: San Michele in Africisco e l'età giustiniana”*, Giornate di studio in memoria di Giuseppe Bovini (Ravenna, 2005), edited by Claudio Spadoni and Linda Kniffitz, 233–247. Cinisello Balsamo.
- Augenti, Andrea. 2008. “A tale of two cities. Rome and Ravenna between 7th and 9th century AD.” In *774, ipotesi su una transizione*, edited by Stefano Gasparri, 175–198. Thurnout.
- Augenti, Andrea. 2009. “Dalla villa romana al monastero medievale: il complesso di San Severo a Classe.” In *Ideologia e cultura artistica tra Adriatico e Mediterraneo orientale (IV-V secolo). Il ruolo dell'autorità ecclesiastica alla luce di nuovi scavi e ricerche*, edited by Raffaella Farioli Campanati, 245–260. Bologna.
- Augenti, Andrea. 2010. *Città e porti dall'Antichità al Medioevo*. Roma.
- Augenti, Andrea, ed. 2011. *Classe, indagine sul potenziale archeologico di una città scomparsa*. Bologna.
- Augenti, Andrea. 2012. “Strategie della memoria: la topografia monumentale di Classe alla luce delle ultime scoperte archeologiche.” In *Martiri, santi, patroni – per una archeologia della devozione: Atti X Congresso Nazionale di Archeologia Cristiana (Università della Calabria, 2010)*, edited by Adele Coscarella and Paola De Santis, 537–553. Arcavacata di Rende.
- Augenti, Andrea. 2013. “Classe: archeologia di una città scomparsa.” In *Potere e politica nell'età della famiglia teodosiana*, edited by Isabella Baldini Lippolis and Salvatore Cosentino, 219–236. Bari.
- Augenti, Andrea. 2014 “Archeologia della città medievale.” *Archeologia Medievale* XL extra: 173–182.
- Augenti, Andrea and Bertelli, Carlo, eds. 2006. *Santi Banchieri Re. Ravenna e Classe nel VI secolo. San Severo il tempio ritrovato, Catalogo della mostra (Ravenna, 4 marzo-8 ottobre 2006)*. Milano.

- Augenti, Andrea, Boschi, Federica and Cirelli, Enrico. 2010. "Il sito della basilica Petriana a Classe. Dalla diagnostica archeologica allo scavo." *Ocnus* 18: 103–116.
- Augenti, Andrea and Cirelli, Enrico. 2016. "San Severus and religious life in Ravenna during the ninth and tenth centuries." In *Ravenna: its role in medieval change and exchange*, edited by Judith Herrin and Jinty Nelson, 297–321. London.
- Augenti, Andrea, De Brasi, Giulia, Ficara, Marilisa and Mancassola, Nicola. 2005. "L'Italia senza corti? L'insediamento rurale in Romagna tra VI e IX secolo." In *Dopo la fine delle ville: le campagne dal VI al IX secolo*, edited by Gian Pietro Brogiolo, Alexandra Chavarría Arnau and Marco Valenti, 17–52. Mantova.
- Baldini Lippolis, Isabella. 2001. *La domus tardoantica: forme e rappresentazioni dello spazio domestico nelle città del Mediterraneo*. Bologna.
- Bardill, Jonathan. 2004. *Brickstamps of Constantinople*. Oxford.
- Bergonzoni, Franco and Bonora, Giovanna. 1976. *Bologna Romana. Fonti letterarie - carta archeologica del centro urbano*, I. Bologna.
- Bertacchi, Luisa. 1986. *Le mura di fortificazione (Aquileia)*, in *Da Aquileia a Venezia*. Milano.
- Birch, Samuel. 2015. *History of Ancient Pottery*, vol. 2. Cambridge.
- Blake, Hugo and Maccabruni, Claudia. 1986. "Lomello (PV). Loc. Villa Marina. Stanziamento romano e medievale." *Notiziario. Soprintendenza Archeologica della Lombardia*: 175–177.
- Blake, Hugo and Maccabruni, Claudia. 1991. "Lomello (PV). Mura tardo antiche e strutture medievali." *Notiziario. Soprintendenza Archeologica della Lombardia*: 110–112.
- Bollini, Maria. 1985. "Claterna". In *Ozzano dell'Emilia. Territorio e beni culturali*, 13–21. Bologna.
- Bottazzi, Gianluca and Bigi, Paola, eds. 2010. *La produzione laterizia nell'area appenninica della Regio Octava Aemilia*. San Marino 2010.
- Bound, Mensun. 1987. "Tubi fittili (vaulting tubes) from the Sea. The Roman Wreck at Punta del Fenaio, Island of Giglio." *International Journal of Nautical Archaeology* XVI: 187–200.
- Brogiolo, Gian Pietro. 2000. "Capitali e residenze regie nell'Italia longobarda." In *Sedes regiae (ann. 400–800)*, edited by Gisela Ripoll and José M. Gurt, 135–162. Barcellona.
- Brühl, Carlrichard. 1967. "Remarques sur les notions de 'capitale' et de 'residence' pendant le haut Moyen Age." *Journal des Savants*: 193–215.
- Buora, Maurizio. 2000. "I laterizi in Friuli nell'alto medioevo." In *I laterizi nell'alto Medioevo italiano, Atti della giornata di studi (Ravenna, 1997)*, edited by Sauro Gelichi and Paola Novara, 75–92. Ravenna.
- Camilli, Luciano, Vatta, Germana. 2001. "Bolli laterizi." In *Roma dall'antichità al medioevo. La storia. Archeologia e storia nel Museo Nazionale Romano Crypta Balbi*, edited by Maria S. Arena, Paolo Delogu, Lidia Paroli, Marco Ricci, Lucia Sagui, and Laura Vendittelli, 223–226. Milano.
- Carile, Maria Cristina. 2012. *The Vision of the Palace of the Byzantine Emperors as a Heavenly Jerusalem*. Spoleto.
- Carile, Maria Cristina and Cirelli, Enrico. 2016. "Architetture e decoro del complesso vescovile ariano: ipotesi ricostruttive e modelli di riferimento." In *Il patrimonio culturale tra conoscenza, tutela e valorizzazione. Il caso della 'Piazzetta degli Ariani' a Ravenna*, edited by Giuseppe Garzia, Alessandro Iannucci and Mariangela Vandini, 97–127. Bologna.
- Catarsi Dall'Aglio, Manuela. 1998. "Parma. Un contesto di età tardoantica." In *Ceramica in Italia; VI-VII secolo, Atti del Convegno in onore di John W. Hayes (Roma, 1995)*, edited by Lucia Sagui, 607–609. Firenze.
- Catarsi Dall'Aglio, Manuela and Dall'Aglio, Pier Luigi. 1992. "Le città dell'Emilia occidentale fra tardoantico e altomedioevo." *Studi e documenti di Archeologia* 7: 9–29.
- Cavalieri Manasse, Giuliana. 1987. "Verona." In *Il Veneto nell'età romana*, vol. 2, 1–57. Verona.

- Christie, Neil. 2006. *From Constantine to Charlemagne: An Archaeology of Italy, AD 300–800*. Aldershot.
- Christie, Neil and Gibson, Sheila. 1988. "The city walls of Ravenna." *Papers of the British School at Rome* 66: 156–197.
- Cirelli, Enrico. 2007. "Élites civili ed ecclesiastiche nella Ravenna tardoantica." *HAM* 13/2: 301–318.
- Cirelli, Enrico. 2008. *Ravenna. Archeologia di una città*. Firenze.
- Cirelli, Enrico. 2011 "Spolia e riuso di materiali tra la tarda Antichità e l'alto Medioevo a Ravenna." *Hortus Artium Medievalium* 17: 39–48.
- Cirelli, Enrico. 2013a. "Le città dell'Italia del nord all'epoca dei re (888–962)." In *Italia, 888–962: una svolta, IV Seminario Internazionale (Poggibonsi, 2009)*, edited by Marco Valenti and Chris Wickham, 131–168. Turnhout.
- Cirelli, Enrico. 2013b. "La topografia della «Gaita di Santa Maria Maggiore» dall'Antichità al Medioevo." In *La basilica di Santa Croce. Nuovi contributi per Ravenna tardoantica*, edited by Max David, 67–92. Ravenna.
- Cirelli, Enrico. 2014. "La villa romana." In *Storia di Russi. Dalla villa alla città*, edited by Eraldo Baldini and Dante Bolognesi, 335–343. Ravenna.
- Cirelli, Enrico. 2015. "Dall'alba al tramonto. Il vasellame di uso comune a Ravenna e nel suo territorio tra la tarda Antichità e l'alto Medioevo (III-VIII sec.)." In *Le forme della crisi. Produzioni ceramiche e commerci nell'Italia centrale tra Romani e Longobardi (III-VIII sec. d. C.)*, *Atti del Convegno di Spoleto-Campello sul Clitunno, 2012*, edited by Enrico Cirelli, Francesca Diosono and Helen Patterson, 13–19. Bologna.
- Coates Stephens, Robert and Parisi, Antonella. 1999. "Indagine su un crollo delle mura aureliane." *Analecta Instituti Danici* XXVI: 85–98.
- Cosentino, Salvatore. 2006. "Le fortune di un banchiere tardoantico. Giuliano Argentario e l'economia di Ravenna nel VI secolo." In *Santi Banchieri Re. Ravenna e Classe nel VI secolo. San Severo il tempio ritrovato*, Catalogo della mostra (Ravenna, 4 marzo-8 ottobre 2006), edited by Andrea Augenti and Carlo Bertelli, 43–52. Milano.
- Cosentino, Salvatore. 2015. "Ravenna from imperial residence to episcopal city: processes of centrality across empires." *Rechtsgeschichte – Legal History* 23: 54–67.
- Cosentino, Salvatore. 2016. "Trasformazioni economiche ed egemonie sociali nelle città dell'Oriente mediterraneo tra Antichità e Medioevo." In *Paesaggi urbani tardoantichi: casi a confronto. Atti delle Giornate Gregoriane, VIII edizione (Agrigento, 29–30 novembre 2014)*, edited by Maria Concetta Parello and Maria Serena Rizzo, 9–15. Bari.
- Cracco Ruggini, Lellia and Cracco, Giorgio. 1977. "Changing Fortunes of the Italian City from Late Antiquity to Early Middle Ages." *Rivista di filologia e istruzione classica* 105: 448–475.
- Creswell, Keppel A.C. 1989. *A Short Account of Early Muslim Architecture*, revised and supplemented by J.W. Allan. Aldershot/Cairo.
- Curina, Renata. 1997. "Le mura di selenite di Bologna: una nuova testimonianza archeologica." *Archeologia dell'Emilia Romagna* 1: 77–84.
- Curina, Renata, Farello, Patrizia, Gelichi, Sauro, Novara, Paola and Stoppioni, Maria Luisa. 1990. "Contesti tardo-antichi e alto-medioevali dal sito di Villa Clelia (Imola, Bologna)." *Archeologia Medievale* XVII: 121–234.
- Dall'Aglio, Pier Luigi. 1999. "La primitiva «mater ecclesia» di Parma e il lato settentrionale delle mura tardoantiche." In *Terras . . . situmque earum quaerit. Studi in onore di Nereo Alfieri*, edited by Pier Luigi Dall'Aglio, 51–62. Imola.
- David, Max. 1988. "Un problema di storia edilizia: lo studio dei tetti degli edifici «a lunga durata» ed il caso del Duomo di Monza." In *Monza anno 1300. La basilica di S. Giovanni Battista e la sua facciata*, edited by Roberto Cassanelli, 95–105. Monza.

- David, Max. 2013. "Evergetismo imperiale e rinnovamento urbanistico a Ravenna in età teodosiana." In *La basilica di Santa Croce. Nuovi contributi per Ravenna tardoantica*, edited by Max David, 11–40. Ravenna.
- De Angelis D'Ossat, Guglielmo. 1962. "Nuovi dati sulle volte costruite con vasi fittili." *Studi Ravennati. Problemi di architettura paleocristiana*, vol. 2, 137–155. Ravenna.
- Deichmann, Friedrich W. 1956. *Studien zur Architektur Konstantinopels im 5. und 6. Jahrhundert nach Christus*. Baden-Baden.
- Deichmann, Friedrich W. 1969. *Ravenna. Geschichte und Monumente*. Wiesbaden.
- Deichmann, Friedrich W. 1974. *Ravenna. Hauptstadt des spätantiken Abendlands, Kommentar II/1s*. Wiesbaden.
- Deichmann, Friedrich W. 1975. *Die Spolien in der spätantiken Architektur*. München.
- Deichmann, Friedrich W. 1976. "Il materiale di spoglio nell'architettura tardo-antica", *CARB* 23: 131–146.
- Della Torre L. 1990. "Brescia. Casa Pallaveri. Analisi di datazione con dosimetria termoluminescente." *Notiziario. Soprintendenza archeologica della Lombardia*: 162.
- Della Torre et al. 1988. "Santa Maria foris portas: datazione con termoluminescenza." *Sibrium* XIX: 135–138.
- Delogu, Paolo. 1980. "Il regno longobardo." *Storia d'Italia*, I, edited by Giuseppe Galasso, 1–216. Torino.
- Delogu, Paolo. 1990. "Longobardi e Romani: altre congetture." In *Langobardia*, edited by Stefano Gasparri and Paolo Cammarosano, 111–167. Udine.
- Delussu, Fabrizio. 2008. "L'insediamento romano di Sant'Efis (Orune, Nuoro). Scavi 2004–2006. Nota preliminare." In *L'Africa Romana. Le ricchezze dell'Africa. Risorse, produzione, scambi. Atti del XVII Convegno (Sevilla, 2006)*, IV, edited by Julián González, Paola Ruggieri, Cinzia Vismara and Raimondo Zucca, 2657–2672. Roma.
- De Rossi, Giovanni Battista. 1870. "D'un singolar bollo di mattone trovato nell'Emporio Romano." *Bollettino di Archeologia Cristiana* II: 7–32.
- Donati, Angela and Susini, Giancarlo. 1979. "Le pietre iscritte." In *Imola dall'età tardo-romana all'alto medioevo. Lo scavo di villa Clelia*, 43–44. Imola.
- Ebanista, Carlo. 2008. "Interventi edilizi d'età medievale nella basilica di S. Felice a Cimitile." In *Il complesso basilicale di Cimitile. Patrimonio culturale dell'umanità? Convegno internazionale di Studi (Cimitile, 2004)*, edited by Mario De Matteis and Carlo Ebanista, 147–186. Napoli.
- Ferreri, Debora. 2011. "Spazi cimiteriali, pratiche funerarie e identità nella città di Classe." *Archeologia Medievale* XXXVIII: 59–74.
- Ferreri Debora. 2014. "Le trasformazioni del paesaggio della Valconca." In *Gli scavi di San Pietro in Cotto e il territorio della Valconca dall'età romana al Medioevo*, edited by Enrico Cirelli, 239–249. Rimini.
- Fiorilla, Salvina. 1986. "Bolle e iscrizioni su laterizi altomedievali del territorio lombardo." *Archivio Storico Lombardo* CXII: 1–85.
- Fiorilla, Salvina. 1987. "Laterizi decorati altomedievali del Museo Archeologico Nazionale di Cividale del Friuli." *Forum Iulii* X-XI: 41–45.
- Gelichi, Sauro. 1989. "Modena e il suo territorio nell'alto medioevo." In *Modena dalle origini all'anno Mille. Studi di storia e archeologia*, I, 153–165. Modena.
- Gelichi, Sauro. 1992. *Storia e archeologia di una pieve medievale: San Giorgio di Argenta*. Firenze.
- Gelichi, Sauro. 1998. "Regium Lepidi tra tardo-antico ed alto-medioevo." *Archeologia medievale in Emilia occidentale. Ricerche e studi*, edited by Sauro Gelichi, 11–16. Mantova.
- Gelichi, S. 2000. "Ravenna, ascesa e declino di una capitale!" In *Sedes regiae (ann. 400–800)*, edited by Gisela Ripoll and José M. Gurt, 109–134. Barcellona.

- Gelichi, Sauro. 2001. "L'insediamento nella penisola italica durante il periodo longobardo: metodologie dell'analisi archeologica e risultati." In *Visigoti e Longobardi*, edited by Javier Arce and Paolo Delogu, 219–238. Firenze 2001.
- Gelichi, Sauro. 2005. "Le mura di Ravenna". In *Ravenna da capitale imperiale a capitale esarcale, Atti del XVII Congresso internazionale di studio sull'alto medioevo (Ravenna, 2004)*, 821–840. Spoleto.
- Gelichi, Sauro, Delogu, Alessandra and Gabrielli, Rossana. 2000. "Le pievi e l'uso dei laterizi nel territorio ravennate." In *I laterizi nell'alto Medioevo italiano, Atti della giornata di studi (Ravenna, 1997)*, edited by Sauro Gelichi and Paola Novara, 137–167. Ravenna.
- Gelichi, Sauro and Malnati, Luigi. 1986. "Modena e Reggio Emilia dal II al VII secolo." In *Società romana e impero tardoantico. Le merci e gli insediamenti*, edited by Andrea Giardina, 544–563. Roma/Bari.
- Gelichi, Sauro and Novara, Paola, eds. 2000. *I laterizi nell'alto Medioevo italiano, Atti della giornata di studi (Ravenna, 1997)*. Ravenna.
- Gentili, Gino V. 1979. "Il mosaico dell'Ercules bibax o del porto canale tra i mosaici di una domus adrianea a Rimini." *Bollettino d'Arte per i Beni Culturali e Ambientali* 44, 1: 49–56.
- Gentili, Gino V., Mansuelli, Guido A., Susini, Giancarlo and Veggiani, Antonio. 1967. *Sarsina. La città romana, il museo archeologico*. Bologna.
- Giordani, Nicoletta. 2000. "Modena." In *Aemilia. La cultura romana in Emilia-Romagna dal III sec. a. C. all'età costantiniana*, edited by Mirella Marini Calvani, 423–434. Venezia.
- Giuliani, Roberta, Leone, Danilo and Volpe, Giuliano. 2013. "Il complesso episcopale di Canosa nell'area di S. Giovanni dalle origini all'altomedioevo: una rilettura della topografia cristiana della città alla luce delle più recenti ricerche archeologiche". In *Episcopus, Civitas, Territorium*, Acta XV Congressus Internationalis Archaeologiae Christianae (Toleti, 2008), 1137–1160. Città del Vaticano.
- Guidobaldi, Federico. 2016. "La formulazione progettuale della basilica cristiana come ulteriore espressione dell'innovazione costantiniana nel campo dell'architettura." In *Costantino e i Costantinidi. L'innovazione costantiniana, le sue radici e i suoi sviluppi*, Acta XVI Congressus Internationalis Archaeologiae Christianae (Roma, 2013), edited by Olof Brandt and Vincenzo Focchi Nicolai, 461–492. Città del Vaticano.
- Hamilton, R.W. 1959. *Khirbat al-Maffjar: An Arabian mansion in the Jordan valle*. Oxford.
- Lancaster, Lynne C. 2009. "Terracotta vaulting tubes in Roman Architecture: A case study of Interrelationship. Between Technologies and Trade in the Mediterranean." *Construction History* 24: 3–18.
- Lanciani, Rodolfo. 1883. "L'Atrio di Vesta." *Notizie degli Scavi*: 434–514.
- Lepore, Giuseppe and Montevocchi, Giovanna. 2009. "Classe (Ravenna), suburbio." *Ocnus* 17: 155–157.
- Lézine, Alexandre. 1954. "Les voûtes romaines à tubes emboîtés et les croisées d'ogives de Bulla Regia." *Karthago* V: 168–181.
- Lippolis, Enzo. 2000. "Edilizia pubblica: fora e basiliche." In *La cultura romana in Emilia-Romagna dal III sec. a. C. all'età costantiniana*, edited by Mirella Marini Calvani, 106–115. Venezia.
- Louhichi, Adnane. 1998. "La céramique islamique de Dougga". In *L'Africa romana XVI. Mobilità delle persone e dei popoli, dinamiche migratorie, emigrazioni e immigrazioni nelle province occidentali dell'impero romano*, edited by. Aomar Akerraz, Paola Ruggeri, Ahmed Siraj, Cinzia Vismara I: 109–127. Roma.
- Lusuardi Siena, Silvia. 1984. "Ancora sulle torri 'tarde' delle mura di Como." *Archeologia Urbana in Lombardia. Catalogo della Mostra*, 67–77. Como.

- Maioli, Maria Grazia. 1984. "La casa romana del Palazzo Diotallei a Rimini (FO): fasi costruttive e pavimenti musivi." In *Atti del III Colloquio internazionale sul mosaico antico (Ravenna, 1980)*, edited by Raffaella Farioli Campanati, 461–474. Ravenna.
- Mancini, Fausto, Mansuelli Guido A. and Susino Giancarlo. 1957. *Imola nell'antichità*. Imola.
- Mansuelli, Guido A. 1941. *Ariminum*. Roma.
- Mansuelli, Guido A. 1954. "Mosaici sarsinati." *Studi Romagnoli* 5: 151–183.
- Manzelli, Valentina. 2000. *Ravenna*. Roma.
- Marini Calvani, Mirella. 1975. *Guida alla visita della zona archeologica e dell'antiquarium*. Parma.
- Marini Calvani, Mirella. 1990. "Archeologia." In *Storia di Piacenza* I/2. *Dalle origini all'anno Mille*, 765–906. Piacenza.
- Martini, Marco, Sibilia, Emanuela and Spinolo, Giorgio. 1985. "Ricerche del Laboratorio di Termoluminescenza applicata all'archeologia." *Notiziario. Soprintendenza Archeologica della Lombardia*: 215–217.
- Martini, Marco, Sibilia, Emanuela and Spinolo, Giorgio. 1985. "Terno d'Isola (BG). Presso la chiesa di S. Vittore. Strutture tardoantiche-altomedievali. Esame di un laterizio." *Notiziario. Soprintendenza Archeologica della Lombardia*: 166.
- Matijašić, Robert. 1983. "Cronografia dei bolli laterizi della figulina pansiana nelle regioni adriatiche." *Mélanges d'archéologie et d'histoire de l'École Française de Rome. Antiquité* 95, 2: 961–995.
- Mc Lendon, Charles and Whitehouse, David. 1982. "La badia di Farfa, Fara Sabina (Rieti): terza nota preliminare." *Archeologia Medievale* IX: 232–239.
- Medri, Maura. 2015. "Le mura di Aureliano: studio in corso sui paramenti laterizi della prima fase di costruzione." *Archeologia dell'Architettura* XX: 38–44.
- Meneghini, Roberto and Santangeli Valenzani, Riccardo. 2004. *Roma nell'Altomedioevo: topografia e urbanistica della città dal V al X secolo*. Roma.
- Messineo, Gaetano. 2001. "La villa Ad Gallinas Alba." In *Gallinas Alba: villa di Livia*, edited by Gaetano Messineo, 9–16. Roma.
- Monneret de Villard, Ugo. 1924. "Sull'impiego di vasi e tubi fittili nella costruzione delle volte." In *Sant'Agata dei Goti*, edited by Christian Hülsen, Carlo Cecchelli, Gustavo Giovannoni, Ugo Monneret de Villard and Antonio Muñoz, 149–154. Roma.
- Montevecchi, Giovanna and Leoni, Cristina. 2004. "Settore meridionale. Domus dei pugili: continuità d'uso (II-III d.C.)." In *Archeologia urbana a Ravenna. La "Domus dei Tappeti di Pietra". Il complesso archeologico di Via D'Azeglio*, edited by Giovanna Montevecchi, 43–47. Ravenna.
- Monti, Pietro. 1980. *Ischia, Archeologia e Storia*. Ischia.
- Moran, Matthew. 2000. "Produzione di laterizi in un monastero meridionale in epoca carolingia: San Vincenzo al Volturno (IS)." In *I laterizi nell'alto Medioevo italiano, Atti della giornata di studi (Ravenna, 1997)*, edited by Sauro Gelichi and Paola Novara, 169–184. Ravenna.
- Mrabet, Abdellatif. 1997. "Introduction à l'étude de la céramique architecturale d'Ifriqiya: état de la question. Données archéologiques et ethno-archéologiques." In *La céramique médiévale en Méditerranée* (VIe congrès de l'AIECM2, Aix, 1995), 591–600. Aix-en Provence.
- Negrelli, Claudio. 2008. *Rimini capitale. Strutture insediative, sociali ed economiche tra V e VII secolo*. Firenze.
- Negro Ponzi, Maria Maddalena. 2000. "La produzione e l'uso dei laterizi nei siti rurali dell'Italia settentrionale tra tardo antico e medioevo. I laterizi di Trino (VC)." In *I laterizi nell'alto Medioevo italiano, Atti della giornata di studi (Ravenna, 1997)*, edited by Sauro Gelichi and Paola Novara, 53–74. Ravenna.

- Novara, Paola. 2000. "La produzione e l'impiego di laterizi nell'alto Medioevo Ravennate." In *I laterizi nell'alto Medioevo italiano, Atti della giornata di studi (Ravenna, 1997)*, edited by Sauro Gelichi and Paola Novara, 109–135. Ravenna.
- Ortalli, Jacopo. 1992. "Edilizia residenziale e crisi urbana nella tarda antichità: fonti archeologiche per la Cispadana." *CARB* 39: 557–605.
- Ortalli, Jacopo. 1996. "Bononia romana." In *Bologna. Da Felsina a Bononia: dalle origini al XII secolo*, edited by Giuseppe Sassatelli, Cristina Morigi Govi, Jacopo Ortalli and Francesca Bocchi, 29–45. Bologna.
- Ortalli Jacopo. 1997. "Topografia di Sarsina romana: assetto urbanistico e sviluppo architettonico." In *Architettura e pianificazione urbana nell'Italia antica*, edited by Lorenzo Quilici, Stefania Quilici Gigli, 117–157. Roma.
- Ortalli, Jacopo. 2000a. "Rimini: la *domus* del chirurgo." In *La cultura romana in Emilia-Romagna dal III sec. a. C. all'età costantiniana*, edited by Mirella Marini Calvani, 512–526. Venezia.
- Ortalli, Jacopo. 2000b. "La *domus* riminese del «chirurgo»: un percorso di ricerca", *Atti e Memorie della Deputazione di Storia Patria per le province di Romagna* 51: 171–192.
- Ortalli, Jacopo. 2001. "Formazione e trasformazioni dell'architettura domestica: una casistica cispadana." *Antichità Altoadriatiche* 49, I: 25–28.
- Ortalli, Jacopo. 2003. "L'insediamento residenziale urbano nella Cispadana." In *Abitare in città. La Cisalpina tra impero e medioevo*, edited by Michael Heinzlmann and Jacopo Ortalli, 95–119. Roma.
- Pantò, Gabriella and Uggé, Sofia. 2004. "Materiali fittili per edilizia di età altomedievale dalla chiesa di S. Eusebio a Vercelli." In *Produzione e circolazione dei materiali ceramici in Italia settentrionale tra VI e X secolo II Incontro di studio sulle ceramiche tardoantiche e altomedievali (Torino, 2002)*, edited by Gabriella Pantò, 25–37. Mantova.
- Parenti, Roberto. 1994. "Le tecniche costruttive tra VI e X secolo: le evidenze materiali." In *La storia dell'alto Medioevo italiano (VI-X secolo) alla luce dell'archeologia*, edited by Riccardo Francovich and Ghislaine Noyé, 479–496. Firenze.
- Pasquini, Laura. 2005. "L'immagine della croce come simbolo di potere in Ravenna capitale". In *Ravenna da capitale imperiale a capitale esarcale, Atti del XVII Congresso internazionale di studio sull'alto medioevo*, 1095–1105. Spoleto.
- Pellicioni, Maria Teresa. 1983. "Tipologia dei bolli laterizi ravennati." In *Ravenna e il porto di Classe. Venti anni di ricerche archeologiche tra Ravenna e Classe*, edited by Giovanna Bermond Montanari, 215–237. Imola.
- Pellicioni, Maria Teresa. 2010. "Punzoni e nominativi: spunti per un'ipotesi sul fenomeno della bollatura dai laterizi della *Regio Octava Aemilia*." In *La produzione laterizia nell'area appenninica della Regio Octava Aemilia*, edited by Gianluca Bottazzi and Paola Bigi, 17–27. San Marino.
- Riccioni, Giuliana. 1969. "Un complesso edilizio di età romana scoperto a Rimini nell'area dell'ex Vescovado", *Atti e Memorie della Deputazione di Storia Patria per le province di Romagna* 20: 313–333.
- Righini, Valeria. "Felix Roma – Felix Ravenna. I bolli laterizi di Teoderico e l'attività teodericiana in Ravenna." *CARB* 33: 371–398.
- Righini, Valeria. 1991 "Materiali e tecniche da costruzione in età tardoantica e altomedievale." In *Storia di Ravenna*, II/1. *Dall'età bizantina all'età ottoniana. Territorio, economia e società*, edited by Antonio Carile, 193–221. Venezia.
- Righini, Valeria. 2008. "I materiali fittili pesanti nella Cisalpina. Produzione e commercializzazione dei laterizi." In *Instrumenta Inscripta Latina II, Akten 2. Internationalen Kolloquiums (Klagenfurt 2005)*, edited by Manfred Haizmann and Reinhold Wedenig, 265–294. Klagenfurt.

- Righini, Valeria. 2010. "La produzione laterizia di età romana in Cisalpina ed in Cispadana." In *La produzione laterizia nell'area appenninica della Regio Octava Aemilia*, edited by Gianluca Bottazzi and Paola Bigi, 9–16. San Marino.
- Righini, Valeria, Biordi, Maurizio and Pellicioni-Golinelli, Maria Teresa. 1993. "I bolli laterizi romani della regione cispadana (Emilia e Romagna)." In *I laterizi di età romana nell'area nordadriatica*, edited by Claudio Zacaria, 23–91. Roma.
- Rossini, Giuseppe. 1938. *Le antiche iscrizioni romane di Faenza e dei Faventini*. Faenza.
- Ruffolo, Salvatore. 1970. "Le strutture murarie degli edifici paleocristiani milanesi." *Rivista dell'Istituto Nazionale d'Archeologia e Storia dell'Arte* XVII: 5–84.
- Russo, Eugenio. 1996. "Sulla cupola in tubi fittili di S. Vitale in Ravenna." *Rivista di Archeologia Cristiana* LXXII, 1–2: 285–329.
- Russo, Eugenio. 2003a. *L'architettura di Ravenna paleocristiana*. Venezia.
- Russo, Eugenio. 2003b. "Nuovi dati per la conoscenza delle volte in tubi fittili dallo scavo della chiesa di S. Agata in Ravenna", in: *Atti del VII Congresso Nazionale di Archeologia Cristiana (Cassino, 1993)*, 191–223. Napoli.
- Saitta, Biagio. 1993. *La civiltas di Teodorico: rigore amministrativo, "tolleranza" religiosa e recupero dell'antico nell'Italia ostrogota*. Roma.
- Sannazaro, Marco. 2014. "Lo sviluppo urbanistico di Milano in età paleocristiana", *Lanx* 19: 79–94.
- Scagliarini Corlàita, Daniela and Venturi, Emanuela. 1999. *Mosaici romani di Regium Lepidi*. Reggio Emilia.
- Sibilia, Emanuela and Della Torre, L. 1987. "Lomello (PV). Mura antiche della città. Analisi di datazione con dosimetria termoluminescente." *Notiziario. Soprintendenza Archeologica della Lombardia*: 219.
- Sibilia, Emanuela. 1989. "Treviolo (BG). Analisi di datazione con dosimetria termoluminiscente." *Notiziario. Soprintendenza Archeologica della Lombardia*: 80.
- Snyder, James R. forthcoming. "Bricks in the wall: an examination of brick procurement in fifth-century Ravenna." In *Economia e Territorio nell'Adriatico centrale tra tarda Antichità e alto Medioevo*, edited by Enrico Cirelli, Enrico Giorgi and Giuseppe Lepore. Bologna.
- Steinby, Eva M. 1974. "I bolli laterizi degli Antiquari del Foro e del Palatino." *Atti della Accademia nazionale dei Lincei. Classe di scienze morali, storiche e filologiche. Memorie* XVII: 63–109.
- Steinby, Eva M. 1975. "La cronologia delle figlinae doliari urbane dalla fine dell'età repubblicana ino all'inizio del III sec." *Bollettino della Commissione archeologica comunale di Roma* 84: 7–132.
- Steinby, Eva M. 1986. "L'industria laterizia di Roma nel tardo impero." In *Società romana e impero tardoantico. Le merci e gli insediamenti*, edited by Andrea Giardina, 99–164. Roma /Bari.
- Stoppioni, Maria Luisa. 1993. *Con la terra e con il fuoco: Fornaci romane nel riminese*. Rimini 2009.
- Storz, Sebastian. 1995. "La tecnica della costruzione delle volte con tubi fittili a Santo Stefano Rotondo a Roma." *CARB* XLI: 669–693.
- Storz, Sebastian. 1997. "La tecnica edilizia romana e paleocristiana delle volte e cupole a tubi fittili." In *Lo specchio del cielo. Forme significati tecniche e funzioni delle volte dal Pantheon al Novecento*, edited by Claudia Conforti, 23–42. Milano.
- Tamassia, Anna Maria. 1993. "Le antiche mura di Mantova." In *Mura delle città romane in Lombardia, Atti del convegno (Como, 1990)*, 145–152. Como.
- Tomasello, Francesco. 2006. "Volte 'leggere' a tubuli fittili tra Sicilia e Africa." *Sicilia Antiqua* 2: 145–155.
- Uboldi, Marina. 1991. "Prodotti laterizi." In *Scavi MM3. Ricerche di archeologia urbana a Milano durante la costruzione della linea 3 della Metropolitana. 1982–1990, Vol. 3.2, I reperti. Testo*, edited by Donatella Caporusso, 145–157. Milano.

- Uboldi, Marina. 2000. "Analisi dei prodotti laterizi in uso in alcuni insediamenti altomedievali della Lombardia." In *I laterizi nell'alto Medioevo italiano, Atti della giornata di studi (Ravenna, 1997)*, edited by Sauro Gelichi and Paola Novara, 11–29. Ravenna.
- Vatta, Germana. 2001. "Tegola con bollo di Gaudenzio." In *Roma dall'antichità al medioevo. Archeologia e storia nel Museo Nazionale Romano Crypta Balbi*, edited by Maria S. Arena, Paolo Delogu, Lidia Paroli, Marco Ricci, Lucia Saguì and Laura Vendittelli, 224. Milano.
- Veggi, L. 1964. "La basilica di S. Pietro in Sylvis di Bagnacavallo." *Felix Ravenna s. III*, 89–90: 84–126.
- Vernia, Barbara. 2005. "L'analisi delle strutture murarie degli edifici di culto di Ravenna: il caso del mausoleo di Galla Placidia". In *Ravenna da capitale imperiale a capitale esarcale, Atti del XVII Congresso internazionale di studio sull'alto medioevo (Ravenna, 2004)*, 1107–1131. Spoleto.
- Verzone, Paolo. 1938. "Le cupole di tubi fittili nel V e VI secolo in Italia". In *Atti del I Congresso Nazionale di Storia dell'Architettura (Firenze, 1936)*, 7–11. Firenze.
- Wilson, Roger J. A. 1992. "Terracotta vaulting tubes (tubi fittili): on their origin and distribution." *Journal of Roman Archaeology* V: 97–129.
- Zanini, Enrico. 2016. "Byzantine City and the Archaeology of the Third Millennium." In *Proceedings of the 23rd International Congress of Byzantine Studies (Belgrade, 2016)*, edited by James Crow, Jorge López Quiroga, Vujadin Ivanišević and Enrico Zanini, 34–143. Belgrade.
- Zuffa, Mario. 1944. "Mosaici di Bononia." *Emilia Romana* 2: 3–27.