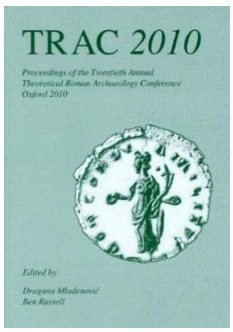

Paper Information:

Title: Approaching Architectural Recycling in Roman and Late Roman Villas
Author: Beth Munro
Pages: 76–88

DOI: http://doi.org/10.16995/TRAC2010_76_88
Publication Date: 14 April 2011

Volume Information:

Mladenović, D. and Russell, B. (eds.) (2011) *TRAC 2010: Proceedings of the Twentieth Annual Theoretical Roman Archaeology Conference, Oxford 2010.* Oxford: Oxbow Books

Copyright and Hardcopy Editions:

Approaching Architectural Recycling in Roman and Late Roman Villas

Beth Munro

Introduction

There has been growing interest over the past 15 years in the study of the functional re-use of Roman architecture and how re-used materials contributed to the reconstruction of ancient Roman and medieval buildings (Barker 2010; Bernard *et al.* 2008; Coates-Stephens 1998, 2002, 2003; Greenhalgh 2009). While recent studies of marble and stone *spolia* have broadened the way we think about stone re-use in ancient construction, there have been few studies that have examined other architectural materials, such as glass and metal, the reprocessing of such materials, or the rural built environment.

The aims of this paper are threefold: 1) to introduce a theory and model of the processes of architectural recycling, 2) to discuss evidence of rural recycling from late Roman villas, and 3) to consider how recycling might be preserved in different phases of villas throughout antiquity. The late phases of occupation at a selection of luxury Roman villas (fourth to sixth centuries A.D.) in modern Italy and France are used as the main sources of evidence to test a theory of systematic recycling. In these phases, many ephemeral features and workshops have been discovered, along with metal, glass, and stone working debris.

Recycling vs re-use

Before proceeding with an outline of the theory and a discussion of the evidence, an explanation is needed for the term 'recycling', as it is used throughout this paper. Roman glass, metal, and stone, had the potential to be 're-used', 'reworked', and/or 'recycled'. The term 're-use' indicates that there were no major physical or chemical alterations to the materials. Examples of this include stone blocks taken from the walls of structures to be used as stone blocks in the walls of new structures. When materials are re-used they maintain the same function in both the old and the new contexts. Two well known ancient examples of architectural re-use are the Roman columns in the church of Santo Stefano in Rotondo, on the Caelian Hill, and the Trajanic, Hadrianic, and Antonine reliefs on the Arch of Constantine (Alchermes 1994: 170; Deichmann 1975: 22; Kinney 2001: 138). By contrast, the term 'recycling' is used here to denote the heating or melting down of materials to significantly alter their physical shape or even sometimes their chemical composition, as is the case with the production of lime from white marble or limestone. In the recycling process, the materials can take on different functions in their new forms. 'Re-working' can be viewed as a stage intermediate stage between re-use and recycling, where elements may be retouched, or carved on the reverse, but not altered using heat.

Theoretical model of architectural recycling

Recycling - the process of melting and reforming materials - is rarely discussed in relation to antiquity, and indeed very few non-specialist studies even distinguish between the practices of re-use, re-working, and recycling (one exception is Nin and Leguilloux 2003: 141). One reason for a lack of discussion on architectural recycling, in particular, is due to the fact that recycled components are not easily recognisable in buildings. Recyclable materials often made up more structural or utilitarian parts of buildings (Coates-Stephens 2003: 342; Ward-Perkins 1984: 218), like iron nails, wall clamps, or fences, lead pipes or seals. These can be contrasted with re-used columns and other marble features, which have been well studied as a result of their recognisability and relatively high value. The theory introduced here is that recycling, in combination with reclaiming, re-use, and re-working made up an integral part of the construction industry in antiquity. It is argued that when villas fell into disuse they were systematically dismantled for their materials, some of which were melted down for further use on-site or transported elsewhere.

This theory has been developed by building on three premises. First, the physical and chemical properties of glass, metal, and limestone meant that these materials could be recycled. There is good archaeological and literary evidence supporting the practice of glass collection, transport, and storage for recycling throughout the Empire. For example, Martial and Statius refer to the door-to-door collection of broken glass (Mart. *Epigrams* I.41.3–5; Stat. *Silv.* 1.6.73–4; see also Keller 2004: 67–8); collections of broken glass (cullet) have been recovered on shipwrecks dating to the third century A.D. demonstrating long distance trade in glass destined for recycling (Tortorici 1994); and the storage of 50 kg of cullet was discovered in a second century A.D. glass workshop just outside the Roman amphitheatre in London (Allen 1998: 17). Less is known about the practices of iron, bronze, and lead recycling in the Roman period, which have not been systematically studied; however, metal workshops, such as one uncovered in *Insula* VI at Herculaneum, show that metal objects (in this case, fragments of lead pipes) were being stored in workshops possibly for re-melting (Monteix 2006: 21). Recycling materials was a normal part of the production of objects in antiquity and often newly quarried or produced materials were combined with old to make objects (Foy 1998: 103).

Second, since many Roman architectural components were made of glass, metal, and limestone, they had the potential to be recycled. Indeed, some architectural components were melted and formed on construction sites, even when buildings where built using newly acquired materials. Although items like nails, pipes, windows, and iron clamps were likely standardized, there were still certain parts that needed to be melted and fitted by specially trained craftsmen on-site (DeLaine 1997: 98). Lead seals for iron clamps used in ashlar construction were one example of this. Thus there must have been small hearths and furnaces devoted to refinishing materials on construction sites and an associated labour force, such as blacksmiths and metal-workers, who would have been responsible for these small workshops. These specialist craftsmen would have been familiar with the properties of the materials, and it is not, therefore, unreasonable to expect that they had the skills to recycle materials.

Third, the quantity of re-used and reworked materials that has been noted in Roman and Late Roman construction suggests that there was a regular and active dismantling and collection of old materials. Several examples of Late Roman and Early Medieval re-use were noted in the introduction to this paper, but examples of re-use in architecture have also been observed from earlier periods (Barker 2010). For example, building materials were found

collected for re-use in the Casa del Giardino di Ercole in *Regio* II, *Insula* 8 in Pompeii (Nappo 1995: 46, fig. 5). Reusing materials was most likely a common practice throughout the Roman and Late Roman periods, and thus it follows that recycling of architectural materials also had the potential to be undertaken on a regular basis, for use in construction and elsewhere.

The recycling process as it applied to architecture can be understood by isolating various processes (Fig. 1): 1) materials acquisition and systematic removal, 2) organization, 3) transport, 4) reprocessing, and 5) final use. When materials were being re-used or reworked without undergoing any major physical or chemical changes, they would have undergone stages 1, 2, and 5 or 1, 2, 3, and 5 if they were being transported to a new site for use. When materials were being recycled, they would have undergone stages 1, 2, 4, and 5 or 1, 2, 3, 4, and 5, including a stage for reprocessing either at its original site or at its new destination. The transportation of materials could have occurred before or after reprocessing, however, since the focus of this paper is on-site reprocessing, transportation, if it occurred at all, would have occurred after reprocessing.

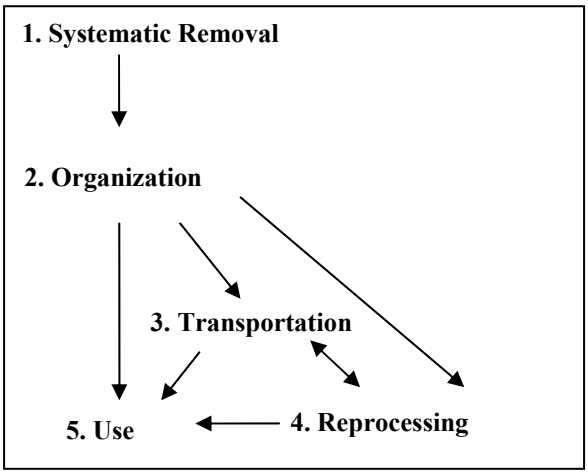

Figure 1: Stages (1–5) involved in re-use and recycling.

All of these processes can be detected archaeologically, but they have rarely been well documented, as will be examined below. The following section details what types of archaeological evidence might be used to verify these processes. As will be apparent, relying on one type of evidence alone is impossible. For example, evidence for the removal of material without any reprocessing installations cannot be used to argue for recycling, nor can the remains of installations without any metal, glass, or stone residues.

The systematic removal of architectural materials might be detected archaeologically in two ways: 1) by identifying an absence of expected collapsed building debris, and 2) by identifying physical traces of material removal. The first method is problematic, however, because architectural material may not be visible in excavation, due to the natural decomposition of organics, ploughing activity, and erosion. Evidence for the second process – the organization of materials – might appear as hoards or piles of metals, glass, and stone, as was shown above in the Casa del Giardino di Ercole in Pompeii, and in the form of pits or containers used to store materials prior to reprocessing. In most cases, the recyclable materials

were entirely reprocessed, and thus only the undesired materials or the containers that stored them have been left visible in the archaeological record. The reprocessing of materials would have occurred in hearths, ovens, or kilns. Installations can be identified with reprocessing on the basis of residues, off-cuts, crucible fragments, moulds, tools, and even in some cases, like with lime kilns, based on size and shape. Glass and metal recycling installations can also be identical to 'secondary production' installations or blacksmith's hearths. Archaeological indicators of materials transportation might be a lack of materials on site, tracks or adequate space to load carts outside of the workshops, evidence of animal stables, and proximity of the reprocessing workshops to road or paths. Unfortunately, identifying the final use of recycled architectural materials is very challenging because if the recycling processes were skilfully undertaken, the newly recycled objects should bear no traces of their former shapes. If the recycling process was less skilfully performed or only partially performed, then it could be possible to identify objects that had been fused together using x-ray analyses, or in the case of glass, by examining the colour and clarity of the objects. To date, no chemical analyses have been successfully applied to identify recycled metals, though analyses have been undertaken successfully with glass, demonstrating an increase in glass recycling in the Early Medieval period (Uboldi and Varità 2003).

Supporting evidence for the recycling model

This theory of rural, on-site architectural recycling can be tested against the evidence present in the final phases of occupation at ten villas (Table 1), eight in Italy and two in France. Several recent studies on the 'end of the villa', focussed on the chronology and overall cultural, political, and religious reasons for the disappearance of villas in the late antique west, have noted the presence of unexpected features in the final phases of what were luxurious Roman villas – for example, small workshops, burials, and the remains of huts (Ripoll and Acre 2000; Francovich and Hodges 2003; Brogiolo *et al.* 2006; Chavarria *et al.* 2006). In general, such features have been attributed to 'squatters' or 'scavengers' who arrived at the sites after abandonment, however the high frequency of this types of evidence points to an organized recuperation and reprocessing of materials.

The ten villas were selected for examination because they contained not only 'basic' building materials, but also elaborate decorations, such as coloured stones and marbles, mosaic floors and glass. They are also well excavated and have well documented post-villa phases that contained hearths, ovens, or kilns, piles of materials, or an obvious large absence of materials. It is important to acknowledge that the 'final phases' of villas occurred at different times, in different locations. While some villas went out of use in the third to fourth centuries A.D., others did not go out of use until the fifth or sixth centuries A.D. Nonetheless, the practice of dismantling and recycling architecture seems to have occurred regardless of the dating of the final phase. Importantly, recycling has been detected inside former luxury rooms or directly outside of the villas in their last phases and has remained visible because there was no further construction over the area of the villa.

Table 1: Summary of evidence found at the selected villas.

Villa	Systematic Removal	Organization	Reprocessing	Transportation
Aiano-Torraccia di Chiusi (Tuscany)	Partial removal of mosaics	Pits filled with *c.* 6000 coloured glass *tesserae*	'Secondary' glass production/recycling oven, glass residues	
Cesson-Sevigne (Brittany)			Three 'secondary' glass production/recycling ovens, glass residues	
Faragola (Puglia)	Absence of lead pipes		Lead and iron working hearths/ovens, and debris	No finished lead products
Linguella (Tuscany)	Traces of removed marble paving	Broken pieces of marble paving piled in corner of room		Lack of intact marble paving
Milhaud (Languedoc-Roussillon)		Several *dolia* filled with broken window and vessel glass	'Secondary' glass production/recycling oven	
Monte Gelato (Lazio)		Pit and former 'fish pond' with collections of broken glass, small iron hoard, including architectural clamp	Iron/bronze-working hearth, lead- and glass-working oven, lime kiln	
Pieve di Manerba (Piemonte)			Iron-working hearths, possible bronze-working hearths	
San Felice, Gravina (Puglia)			Iron/bronze-working hearth, glass crucible recovered, lime kiln	
San Giovanni in Ruoti (Basilicata)	Absence of lead pipes and roof tiles		Several hearths/ovens of unknown function in final phase	Absence of roof tiles, veneer and metals
San Pietro di Tolve (Puglia)	Removal of floor paving		Two small hearths/ovens of unknown function in final phase	Absence of floor paving blocks
Settefinestre (Tuscany)	Removal of thresholds, mosaic flooring		Several hearths/ovens of unknown function in final phase	Absence of mosaic *tesserae*

1) Systematic removal

Identifying the systematic removal of building materials from villa sites is complicated by the fact that publications tend to be selective in their descriptions. For example, excavators often note the removal of roof tiles, but ignore stone wall blocks or window glass. When quantities of remaining architectural materials are noted, we can use estimates of the original totals to calculate how much was removed. This was undertaken by Small and Buck (1994: 128–34) for the roof tiles at San Giovanni di Ruoti in Basilicata. Based on an architectural reconstruction of the villa, they were able to estimate the expected total weight of roof tiles and compared this with the actual remains. The recovered roof tiles weighed significantly less than expected, which led to the conclusion that most of the roof tiles were removed from the structure, perhaps prior to collapse. This type of analysis could arguably be undertaken on any group of materials, provided that reasonable estimates based on an architectural reconstruction could be calculated (see DeLaine 1997 for these types of reconstruction analyses).

The systematic removal of metals is quite often assumed to have been undertaken due to a general lack of metal recovered in excavation (Volpe *et al.* 2009: 285). Indeed at villas in Italy, like San Giovanni di Ruoti, Faragola in Puglia, and Monte Gelato in Lazio, there was almost a complete absence of lead found in excavation, despite evidence for water features and baths (Small and Buck 1994: 146; Potter and King 1997: 30, 38; Volpe *et al.* 2009: 285).

Demonstrating the systematic removal of glass is more problematic because it is difficult to arrive at estimates when so little is known about the size and location of windows. In most cases, the walls at these villas are only preserved to 0.5 m or less, and thus we are forced to speculate about the location or size of the windows (though see Small and Buck 1997: 97 on possible window size at San Giovanni di Ruoti). Also, any glass that was not removed prior to villa abandonment probably ended up broken into pieces too small to be recorded or assigned any significance on excavation, unless they were hoarded. At the villa of Monte Gelato, no window glass was described in the finds catalogue. Two areas for collecting glass in the fourth to fifth centuries A.D. phase were noted, however, containing vessel and window glass, though only the diagnostic vessel fragments were described in detail (Potter and King 1997: 59–60, 265–86). Thus systematic removal of glass can probably only be determined in post-excavation analyses if glass was subsequently collected and stored, as will be examined in the following section.

An alternative method for identifying systematic removal is through observing imprints of the materials left behind on floors, preparation layers or in mortar. This is particularly useful for some metals, stone paving, or veneer. For example, the imprints of removed marble floor paving were left behind from the final phase of occupation (third century A.D.) of the villa at Linguella, on the island of Elba; this phase of systematic removal was sealed by a later roof collapse (Pancrazzi and Ducci 1996: 74). Identifying such sequences has not been as straightforward at other sites, but is clearly necessary to successfully argue for the systematic removal of materials prior to site abandonment.

2) Organization

The storage and organization of glass for recycling has been noted at a number of rural sites. At Milhaud, in Languedoc-Roussillon, several *dolia* were filled with broken glass, separated by colour, and placed next to an oven (Foy and Michel 2003: 332). Similarly, at the villas at

Aiano-Torraccia di Chiusi, in Tuscany, and Monte Gelato, several pits containing collections of broken glass were found cut into the floor surfaces of rooms that also contained small ovens for glass recycling. At Aiano-Torraccia di Chiusi, the glass collected in the bins was entirely made up of *tesserae* (totalling approximately 6000), which likely were removed from the nearby vaulted reception space (Cavalieri and Giumlia-Mair 2009: 1028). Similarly, but on a smaller scale, were a pit (E180) and an *opus signinum* lined tank at Monte Gelato where glass fragments were discovered (Potter and King 1997: 59–60). Pit E180 was located in the same room as a small furnace (Feature E193) which might have functioned to reprocess the glass (Fig. 2). The post holes around this feature likely supported a platform for holding the crucibles.

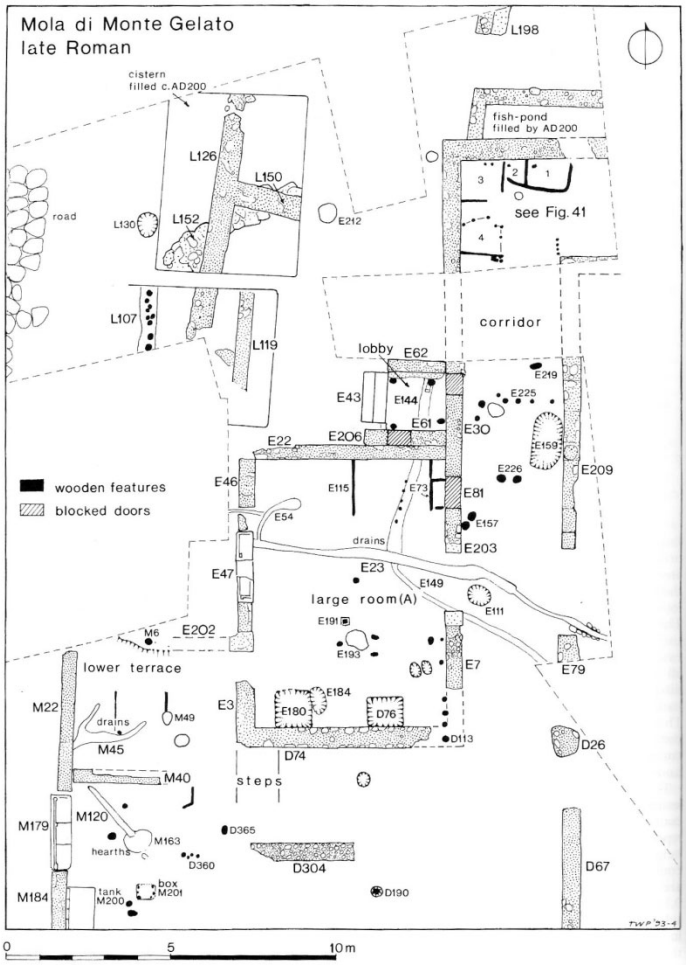

Figure 2: Detail of Late Roman plan of Monte Gelato, showing pit E180 (bottom centre) and the 'fish pond' (top right) which possible acted as storage for glass (Potter and King 1997: Fig. 39).

The storage of metal objects has not been as well documented; in fact, very few metal hoards have been discovered at villas in Italy. This may have resulted from the complete recycling of the metal and its storage in perishable bags or baskets. A small hoard of iron tools and architectural clamps discovered against a wall adjacent to an iron working hearth at Monte Gelato, in the fourth to fifth centuries A.D. phase, led to the conclusion that these objects were likely stored in a cloth bag hung on the wall before being reprocessed (Potter and King 1997: 257–65). For whatever reason, these iron objects were never reprocessed, and thus when the bag disintegrated, they fell to the floor in a pile.

The collection and storage of stone for burning into lime has been convincingly argued to have been present at Ostia in the post-antique period, in close proximity to lime kilns (Lenzi 1998; Laird 2000). In this case fragments of marble statuary were collected into large pits, but this type of collection and storage has not been preserved in the rural context; the marble fragments left in the lime kiln at Monte Gelato were not being stored, but were the remains of an unfinished firing (Potter and King 1997: 64, 71). It is possible that such pits have not been recovered in rural contexts because there was no need to store the marble for any length of time, since the lime kilns were in close proximity to the villas.

3) Reprocessing

Preserved hearths, ovens, and kilns in the last phases of occupation at Roman villas suggest that at least some of the removed and collected architectural materials underwent reprocessing directly on site. To judge from the residues, off-cuts, debris and sometimes un-processed materials in the vicinity of installations, it was predominantly iron, bronze, lead, glass, and limestone that were being reprocessed. Importantly, the properties of these materials meant that they could be reprocessed but still remain visible in the archaeological record. Other materials, like wooden beams, also may have been reprocessed (for the production of charcoal or as fuel), but there is no way to trace this archaeologically. In addition, ceramics and tiles could not be melted down, but could be crushed and re-used as fill in walls or as make-up levels for floors.

Reprocessing installations usually appear as pits or cuts in floor or natural surfaces. In some cases, like 'Oven 3' at Cesson-Sevigne in Brittany, the bases of the ovens were lined with re-used tiles (Fig. 3) (Pouille and Labaune 2000: 138). Three of these ovens were associated with glass recycling on the basis of residues and glass debris in the vicinity. Glass reprocessing installations also existed at Aiano-Torraccia di Chiusi and Monte Gelato (Potter and King 1997: 59; Cavalieri and Giumlia-Mair 2009).

Most often the superstructures of such ovens have not been preserved though probably would have existed in order to better control the temperature of the installation. Superstructures could have been made of tiles or clay tempered with shells so that they were porous and heat resistant, as was the case in the glass recycling oven at Aiano-Torraccia di Chiusi (Cavalieri and Giumlia-Mair 2009: 1030). The five glass recycling ovens at the villas mentioned above were predominantly round and measured 0.2–0.4 m^2.

Metal-working installations make up the most common type of reprocessing installations at the selected villas, with eight examples at seven villas. Metal recycling installations had a greater variation in size and shape, depending on the type of metal being reprocessed. Those hearths with remains relating to blacksmithing or bronze-working – these might include blacksmithing slag, charcoal, and small iron and bronze fragments – typically have a 'keyhole' shape, with a bulbous end, and measure between 0.8–1.8 m^2, like those at San Felice in Puglia

and Pieve del Manerba in Piemonte (Carver *et al.* 1982: 237, 239 ; Myles McCallum, pers. comm. 2009). Lead-working installations, however, tend to be circular and smaller in size, ranging only from 0.2–0.4 m^2, like those at Faragola and Monte Gelato (Potter and King 1997: 59; Volpe *et al.* 2009: 285). The differences in size and function were most likely related to the technology required to reprocess certain materials, and the skills of the craftsmen. Different materials required different technological processes to achieve the desired transformation.

Figure 3: Photograph of 'Oven 3' at Cesson-Sévigné (Pouille and Labaune 2000: Photo 20).

The same is true for lime kilns, which were specially designed to hold large amounts of stone blocks. These were subjected to periodic firings, over a period of up to 2 weeks, at temperatures of up to 1000°C. The lime kilns identified at Monte Gelato and San Felice measured 12 m^2 and 7 m^2, respectively (Potter and King 1997: 69, Myles McCallum, pers. comm. 2009). By comparison, the small lead reprocessing installations described above were designed as such because they could quickly be heated to the melting point of lead, at only 330°C. Lead was melted in crucibles, held on an enclosed platform over the fire. The small size of the oven meant that optimal temperatures could be reached and controlled more easily. Thus to achieve the ideal results from reprocessing, the size and function of the installation had to meet certain specifications. While technically possible to perform reprocessing in any number of installations, the consistency in size and form, suggests that reprocessing was an intentional and organized activity undertaken by skilled craftsmen, who were familiar with the materials.

4) Transport

The paving blocks removed from Linguella in the fifth century A.D., mentioned above, and the mosaics removed from Settefinestre in the late third century A.D. might have been transported to other villas undergoing reconstructions in the third to fifth centuries A.D. or to a nearby urban centre (Carandini 1985: 82; Pancrazzi and Ducci 1996: 74). The removed paving slabs from Linguella were evidently only desired for transport if they were intact suggesting that these were going to be re-used rather than recycled; broken slabs were left piled in a corner of

Room 4 (Pancrazzi and Ducci 1996: 74). Most materials that needed to be reprocessed before they could be used, like features made of glass and metal, underwent this transformation at the villa sites before onward transportation. The proximity of the reprocessing installations to the 'raw' materials, in particular, means that initial transportation could have been kept to a minimum. At Faragola, the lead-working furnace was located between the baths and the dining room which had a water feature; while at Monte Gelato, the lead-working furnace was located next to the baths (Potter and King 1997: 59–60; Volpe *et al.* 2009: 285). No lead pipes have been uncovered at either site suggesting they were entirely reprocessed.

The presence of lime kilns on site also shows that transport prior to reprocessing was avoided for stone when the lime was used on-site. The lime kilns at Monte Gelato and San Felice were both located outside the former walls of the villa, likely due to their large size, but would have been used to recycle the white marbles and limestone from the former villas to produce lime for mortar (Potter and King 1997: 69; Myles McCallum, pers. comm. 2009). This mortar was then most likely used to build the church at Monte Gelato and the late Roman building, located about 200 m away, at San Felice.

5) Use

Determining the final use of recycled glass, metal, and lime, particularly when these materials have been transported off-site after reprocessing, is not currently possible. At present, no chemical analyses have been undertaken to link recycled materials with the hearths where they were reprocessed. We can, however, consider the importance of the rural recycling process in relation with the urban recycling process to understand the possible movement of recycled materials used in construction.

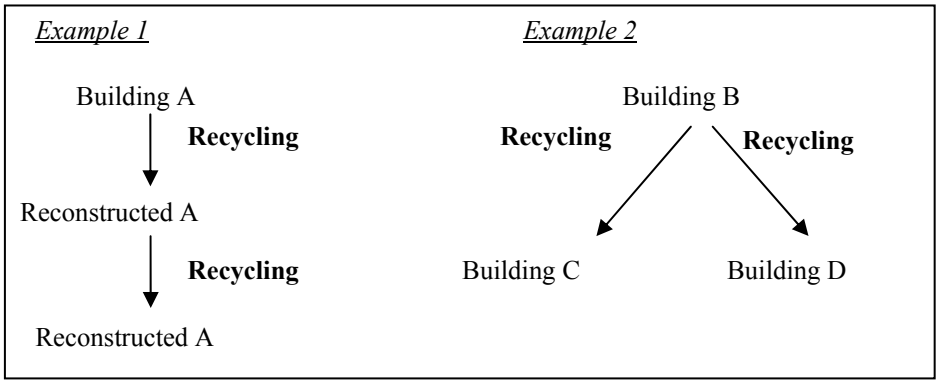

Figure 4: Models of the movement of recycled materials.

Figure 4 presents two simplified models for the movement of recycled architectural materials. Example 1 shows how a building that might be reconstructed a number of times, in part reusing and recycling the materials available from former buildings on site, while example 2, on the right, shows how a building that was abandoned or in decay might have supplied materials for new construction projects or repairs at other sites.

In the rural environment in late antiquity, there is evidence to support both models. At some sites, like Faragola, the lack of further construction on-site suggests that the reprocessing of the architectural materials facilitated construction elsewhere, or that the materials were being sold or traded either as finished objects or as 'raw' materials (Volpe *et al* 2009: 287). At other villas, like Monte Gelato and San Felice, the reprocessing of materials probably facilitated the construction of new structures on-site in the same phase (fourth to fifth centuries A.D.). The recycling of materials, in this case, would have provided some of the necessary and desired architectural fittings, from the stones and mortar to build walls, to iron fittings like railings, to the glass for the windows. Crucially, in these examples the new construction projects did not overlie the old villas; this has enabled the identification of the reprocessing installations.

Approaching rural recycling

The single-site recycling model (Example 1, Fig. 4, above), which was developed based on the presence of recycling at Late Roman villas that supported church construction, might also be applied to the earlier Roman phases at rural sites. Small and Buck (1994: 123) have demonstrated, for example, that the villa of San Giovanni di Ruoti was reconstructed several times between the first and fifth centuries A.D., always using at least some of the materials from the former structures. They noted re-use of the tiles and wall blocks, but there is no reason to believe that other materials were not re-used and indeed recycled as well.

By understanding technological processes of materials production and building construction in the Roman period, it seems that there was the convention, skill, technology, and willingness to recycle materials. The ovens and kilns, hoarded materials, and evidence of systematic removal that we can observe in the final and late phases of villas should exist as part of the reconstruction phases during earlier periods as well. However, we currently have no archaeological evidence of this. Perhaps this is because all the evidence for these processes was removed when the construction crews left the sites. Or perhaps this is because we do not know how to recognize it in the archaeology. It is also certainly the case that scholars have previously not been concerned with the 'transitional' phases (that is those between the occupation phases) of rural buildings while excavating and have thus missed this evidence. Or perhaps we should be looking for traces of recycling outside the villas; in the final phase most hearths and furnaces were placed directly inside the former rooms, often cut through the floor because there was never any intention to reoccupy the building. It is possible that in earlier phases, they did not want to destroy the floors of the rooms, they were potentially using as foundations for the future building.

In summary, the evidence for recycling of architecture that existed in the last phases of villas provides useful support to a theory of how recycling could have been undertaken in the rural context in antiquity. Given the similarity in technology and skills of the labour force both in the Roman and Late Roman periods, we must now begin to think about how these processes formed part of the reconstruction phases of villas in earlier periods, and how we might identify these processes archaeologically.

Department of Classics, University of Manitoba

Bibliography

Ancient sources

Martial (Translated by G. P. Goold 1994). *Epigrams.* Cambridge: Harvard University Press.

Statius (Translated by D. R. Shackleton Bailey 2003) *Silv*ae. Cambridge: Harvard University Press.

Modern sources

Alchermes, J. 1994. Spolia in Roman cities of the Late Empire: legislative rationales and architectural reuse. *Dumbarton Oaks Papers* 48: 167–78.

Allen, D. 1998. *Roman Glass in Britain*. Princes Risborough: Shire.

Barker, S. 2010. *Reuse in Roman Construction 100 BC–AD 275*. PhD thesis, University of Oxford.

Bernard, J. -F., Bernardi, P. and Esposito, D. (eds.) 2008. *Il reimpiego in architettura: recupero, trasformazione, uso*. Rome: École française de Rome.

Brogiolo, G. P., Chavarria, A. and Valenti, M. (eds.) 2006. *Dopo la fine delle ville: le campagne dal VI al IX secolo: 11. Seminario sul tardo antico e l'alto medioevo, Gavi, 8–10 maggio 2004.* Mantua: S.A.P.

Carandini, A. (ed.) 1985. *Settefinestre: una villa schiavistica nell'Etruria romana*. Modena: Panini.

Carver, M. O. H., Massa, S. and Brogiolo, G. -P., 1982. Sequenza insediativa romana e altomedievale alla Pieve di Manerba (BS). *Archeologia medievale* 9: 237–98.

Cavalieri, M. and Giumlia-Mair, A. 2009. Lombardic glassworking in Tuscany. *Materials and Manufacturing Processes* 24:9: 1023 – 1032.

Chavarria, A., Arce, J, and Brogiolo, G. -P. 2006. *Villas tardoantiguas en el Mediterráneo occidental.* Madrid: Consejo Superior de Investigaciones Científicas.

Coates-Stephens, R. 1998. The walls and aqueducts of Rome in the early middle ages, A.D. 500–1000. *Journal of Roman Studies* 88: 166–78.

Coates-Stephens, R. 2002. Epigraphy as *spolia*. The reuse of inscriptions in early medieval buildings. *Papers of the British School at Rome* 70: 275–96.

Coates-Stephens, R. 2003. Attitudes to *spolia* in some Late Antique texts. In L. Lavan and W. Bowden (eds.) *Theory and Practice in Late Antique Archaeology*. Leiden: Brill: 341–58.

Deichmann, F. W. 1975. *Die Spolien in der spätantiken Architektur : vorgetragen am 5.7.1974.* Munich: Verlag der Bayerischen Akademie der Wissenschaften.

DeLaine, J. 1997. *The Bath of Caracalla: a Study in the Design, Construction, and Economics of Large-scale Building Projects in Imperial Rome.* Portsmouth, R.I.: Journal of Roman Archaeology.

Foy, D. 1998. L'accès aux matières premières du verre de l'Antiquité au Moyen Âge en Méditerranée occidentale: la confrontation des sources. In M. C. Amouretti and G. Comet, (eds.) *Artisanat et matériaux: La place des matériaux dans l'histoire des techniques.* Aix-en-Provence: L'Universite de Provence: 101–25.

Foy, D. and Michel, D. 2003. Utilisation et récuperation du verre dans la villa de Milhaud (Gard) à la fin de l'antiquité (vaisselle gravée et verre architectural). *Revue archéologique de Narbonnaise* 36: 319–34.

Francovich, R. and Hodges, R. 2003. *Villa to Village: The Transformation of the Roman Countryside in Italy, c. 400–1000.* London: Duckworth.

Greenhalgh, M., 2009. *Marble Past, Monumental Present: Building with Antiquities in the Mediaeval Mediterranean.* Leiden: Brill.

Keller, D. 2004. Social and economic aspects of glass recycling. In J. Bruhn, B. Croxford and D. Grigoropoulos (eds.) *TRAC 2004: Proceedings of the Fourteenth Annual Theoretical Roman Archaeology Conference, Durham 2004*. Oxford: Oxbow: 65–78.

Kinney, D. 2001. Roman architectural *spolia*. *Proceedings of the American Philosophical Society* 145.2: 138–61.

Laird, M.T. 2000. Reconsidering the so-called "Sede degli Ausgustali" at Ostia. *Memoirs of the American Academy in Rome* 45: 41–84.

Lenzi, P. 1998. "Sita in loco qui vocatur calcaria": attivita di spoliazione e forni da calce a Ostia. *Archeologia Medievale* 25: 247–63.

Monteix, N. 2006, Les boutiques et les ateliers de l'*Insula* VI à Herculaneum – La metallurgie du plomb (VI, 12). In N. Monteix and G. P. Bulighin (eds.) *Contributi di archeologia vesuviana I. Studi della Soprintendenza archeologica di Pompei* 17. Rome: 'L'Erma' di Bretschneider: 19–23.

Nappo, S. C. 1995. Evidenze di danni strutturali, restauri e rifacimenti nelle *insulae* gravitanti su Via Nocera. In *Archäologie und Seismologie: la regione vesuviana dal 62 al 79 D.C.: problemi archeologici e sismologici: Colloquium, Boscoreale, 26.–27. November 1993*. Munich: Biering & Brinkmann: 45–56.

Nin, N. and Leguilloux, M. 2003. La gestion des déchets à Aix-en-Provence dans l'Antiquité. In P. Ballet, P.Cordier, and N. Dieudonné-Glad (eds.) *La Ville et ses Déchets dans le Monde Romain: Rebuts et Recyclages. Actes du Colloque de Poitiers (19–21 septembre 2002)*. Montenac: Monique Mergoil: 133–63.

Pancrazzi, O. and Ducci, S. (eds.) 1996. *Ville e giardini nell'Elba romana*. Florence: Octavo.

Potter, T. W. and King, A. C. (eds.) 1997. *Excavations at the Mola di Monte Gelato: a Roman and medieval settlement in south Etruria*. London: British School at Rome.

Pouille, D. and Labaune, F. 2000. L'atelier de verrier antique de Cesson-Sévigné. In M. -D. Nenna (ed.) *La Route du Verre: Ateliers primaires et secondaires du second millénaire av. J.-C. au Moyen Âge*. Lyon: Maison de l'Orient Méditerranéen-Jean Pouilloux: 125–46.

Ripoll, G. and Arce, J. 2000. The transformation and end of Roman *villae* in the west (4th – 7th century): problems and perspectives. In G. P. Brogiolo, N. Gauthier, and N. Christie (eds.) *Towns and their territories between Late Antiquity and the Early Middle Ages*. Leiden: Brill: 63–114.

Small, A. M. and Buck, R. J. 1994. *The Excavations of San Giovanni di Ruoti, 1. The Villas and their Environment* (Phoenix. Supplementary volumes, 33). Toronto: University of Toronto Press.

Small, A. M. and Buck, R. J. 1997. *The Excavations of San Giovanni di Ruoti, 2. The Small Finds* (Phoenix. Supplementary volumes, 34). Toronto: University of Toronto Press.

Tortorici, E. 1994. Il carico. In L. Babbini (ed.) *Operazione Iulia Felix. Lo scavo subacqueo della nave romana rivenuto al largo di Grado.* Mariano del Fuili: Edizioni della Laguna: 45–53.

Uboldi, M. and Verità, M. 2003. Scientific analyses of glass from Late Antique and Early Medieval archaeological sites in northern Italy. *Journal of Glass Studies* 45: 115–137.

Volpe, G., De Venuto, G., Goffredo, R., and Turchiano, M. 2009. L'abitato altomedievale di Faragola (Ascoli Satriano). In G. Volpe, and P. Favia (eds.) *V Congresso Nazionale di Archeologia Medievale (Foggia–Manfredonia 30/09–3/10 2009)*. Florence: All'Insegna del Giglio: 284–290.

Ward-Perkins, B. 1984. *From Classical Antiquity to the Middle Ages: Urban Public Building in Northern and Central Italy, AD 300–850*. Oxford: Oxford University Press.