Bernardi (Philippe), Labbas (Vincent), Sosnowska (Philippe), Foulquier (Laura), Nectoux (Élise), Davoine (Charles), L'Héritier (Maxime), Barker (Simon J.), Guibert (Pierre), Urbanová (Petra), Lanos (Philippe), Prigent (Daniel), Esposito (Daniela), Spera (Lucrezia), « *Compendia* », *Ædificare*, n° 4, 2018 – 2, *Revue internationale d'histoire de la construction*, p. 299-311

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Recycling and reuse. The second life of construction materials. Introduction

Addressing the issue of reuse and recycling today means breaking down the barriers between remains. This thematic dossier reflects the innovative nature of the research undertaken in recent decades on these practices, the diversity of the objects to which they are applied, and the resolutely interdisciplinary nature of these approaches.

One of the questions addressed in this issue concerns the identification of reuse thanks to the renewal of the methods applied to detect reused elements: a fine reading of archaeological remains that combines a morphotypological approach and an investigation into the traces of the object's former life can indeed be successful provided it is careful and systematic. Moreover, cross-checking these results with dating methods offers new perspectives such as a direct dating of masonry and consequently of reused elements. Joining historical, archaeological and archeometric sources makes it possible to grasp the multiple functions and applications of reuse in construction, which can only be understood when taking into account the context of the salvaging and reuse of materials, guiding or constraining the builders' practices and choices and, therefore, the nature of reuse. For this reason, this thematic issue deals with many situations, from early medieval churches to 19th-century cathedrals, and from mountain shelters to urban construction, to highlight four major themes linked to reuse and recycling.

1. Reuse can generate new constructive techniques and could modify construction forms. The papers all demonstrate great diversity in terms of materials treatment depending on their quality, size, and state.

2. The economic aspects of salvaging and reuse are also crucial. They can take different forms, from a well-organized market to a more "opportunistic" supply. However, salvaging construction materials is never free: dismantling a monument is much more expensive and takes far longer than knocking it down.

3. Reuse therefore also has functional stakes. Salvaging construction materials deriving from the dismantling or collapse of a former monument is, first of all, a way to prevent blocking the public domain with the rubble. The reinterpretation of Roman and postmediaeval legal texts highlighted with archaeological remains makes it possible to grasp this typical urban tension throughout time and to study how public authorities were forced to write laws on reuse and adapt to extraordinary events.

4. The last aspect regards symbolism and the relation of society to Antiquity. Reused elements are sometimes designed to be visible in order to recall (or suggest) the ancient origins of the building to contemporaries. This question is addressed over a long time scale drawing upon the specific example of the Le Puy cathedral.

From the barn to the cathedral, from Antiquity to the 21st century, and from the column or the plank to rubble, this thematic issue testifies to the fact that reuse is omnipresent. Even if it is "normal and vital", it should not be made a commonplace. Material treatments and choices rely on very diverse and multiple justifications (economic, technical, ideological, cultural…) and the present issue aims to highlight this polysemy.

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The demolition, salvage, and recycling industry in Imperial Rome

The re-use of material has been a feature of construction throughout the ages. To date, most studies of re-use have been carried out within the specialised field of *spolia* studies, which is largely concerned with the visible re-use of architectural elements in Late Antiquity and the early medieval period. The extent and significance of such practices in the Roman building industry, however, are now being recognised. During the Republican and Imperial periods in Rome, while fresh supplies of building materials and decorative stones were being introduced to the city in ever-increasing quantities, much was also being salvaged and processed for re-use. This paper demonstrates that recycling was not only a continuous feature of Roman building practices but was also closely linked with demolition practises. As such, it highlights the practical aspects of recycling, such as the organisation and mechanisms of recycling, the processes involved in ancient dismantling projects, and, the importance of recycling for the success of urban construction. Rome's major public building projects often required a radical alteration of the city's urban fabric and recycling provided a practical and economically advantageous way to deal with material from large (and small)-scale demolition projects. Overall, archaeological evidence presents recycling as a normal and vital part of the Roman construction industry in Rome and throughout the empire. Of course, the extent of recycling activity would have been influenced by local circumstances, but the tremendous resource in terms of material and waste management is clear. The integral part played by salvaging and recycling in the late Republican and Imperial construction industries is vital to a comprehensive understanding of ancient urban landscapes, their management by local authorities, and their navigation by local citizens.

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The detection of material reuse in ancient construction. What is the role of dating methods?

In this paper, we examine the potential of physical dating methods to identify the reuse of building materials. The study is based on the dating of architectural ceramics (in particular bricks) originating from early medieval constructions or structures.

Twenty-five early medieval sites in South-East England (5) and France (20) were investigated. The initial aims of our research were focused on improving existing chronological data concerning the construction of the buildings being studied. We also investigated if the bricks were produced at the time of construction or, on the contrary, if they were recycled from earlier Roman (Gallo-Roman in France or Romano-British in England) monuments. For those cases where the bricks were manufactured at the time of construction, we checked whether or not their dating confirmed the chronology based upon interpretations of historical data and archaeological observations.

As a result, in the majority of cases, we determined that either all or a part of the bricks used in the early medieval monuments studied within this project originated from more ancient buildings. This is well illustrated in the study of the oldest parts of the Saint-Irénée church in Lyon (France), for which we observed a significant discrepancy between the dates obtained for the construction itself and for the brick making, the latter appearing to be older. In other cases, for example in the case study of the collegiate Saint-Martin of Angers (France), we observed a correspondence between the age of the brick making and the age of the mortar itself, with the latter being based on radiocarbon dating of charcoals. Therefore, in this particular case, the dating of the bricks made it possible to determine the dating of the construction of the building. To sum up, the reuse of bricks was a frequent but not systematic practice in the early medieval period (16 sites out of 25 contained bricks recycled from older structures).

The latest major methodological innovations occurred recently in the field of luminescence dating. Since 2015, it has been possible to perform

mortar dating by using Optically Stimulated Luminescence (OSL), based on the so-called single grain technique. In this case, the event dated corresponds to the last exposure of the sand grains to light during the manufacture of the mortar. Such an approach makes it possible to determine the dating of the construction and thereby to directly detect the possible reuse of bricks with certainty. The comparison between the results from the mortar and brick dating is illustrated by the case study of the Saint Seurin crypt in Bordeaux. New possibilities for a quantitative estimation of the reuse of bricks in constructions or for the detection of the reuse of other materials are suggested.

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Reuse in early mediaeval Rome. Observations from the Papal Basilica of St. Paul outside the walls

Buildings from the early Middle Ages are characterised by a widespread use of reused materials. This topic, addressed in several recent conferences and publications, now requires specific ideas to be developed based on new points of view, including the transformation procedure of ancient buildings into "quarries", their time of spoliation, storage, commercialisation methods, and the transport and treatment of salvaged materials. This paper focuses on these questions, which are crucial for achieving a better understanding of reuse in construction between the eighth and tenth centuries. Monumental structures excavated between 2007 and 2009 in the Papal Basilica of St. Paul outside the walls in Rome, next to the monks Garden located along the right side of the basilica, offer a very interesting point of view for undertaking some preliminary reflections and providing ideas and a method for further research.

A dense sequence of buildings related to the complex history of the city which developed around the apostle's basilica, including fifth-century *pauperibus habitacula* archaeological remains, marks the most ancient phases of the site. The site was systematically built only from the eighth century onwards. It was surrounded with walls in the second half of the ninth century and called *Johannipolis*, or Saint-Paul's castle. In the sixteenth and seventeenth centuries, the area was included in a wider space, well documented by many pictures, and used as a vegetable garden in the Benedictine monastery. All early mediaeval masonries

linked to the different construction phases show common constructive strategies. They are at first limited by the presence of a shallow phreatic table almost beneath the surface, which requires the building of one-metre-deep foundations at the most, with a constant thickness topped with walls which gradually set back and do not correspond to the level of the upper stories. They exclusively use salvaged material in the facing and furring of the walls.

The comparison between different ways of reusing construction materials in the complex located south of the Papal Basilica of St. Paul outside the walls would appear to highlight a difference between the composition of early (the convent and plan of the portico) and late eighth-century construction phases. In the first phases, reuse seems unsystematic and differentiated. The assembly of the elements might be slightly improvised. The buildings associated with the actions of Pope Adrian I are far more homogeneous and could be compared to other masonries from the same period, at least until the middle of the ninth century in Rome and its surroundings. This greater uniformity seems to be linked to the existence of well-organised systems or organisations dedicated to construction material recycling managed at a larger scale, which took care of the selection of materials to be salvaged in ancient monuments, sorted them and redistributed them in various building yards.

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The reuse and recycling of lumber in the long term in peasant constructions in the Southern Alps. A dendrochronological and archeological reading of medieval and modern subalpine constructions in the Mercantour Massif (the French Alps)

This article is intended to offer clarifications on the practice of re-employing timber in mountain farm buildings from the Middle Ages to the 20th century. Based on a dendrochronological and archaeological approaches to agropastoral buildings in the Southern Alps and especially in the Mercantour mountains, this point of view brings new knowledge on uses of buildings that are still poorly understood outside of cities. These approaches also allow us to reach spaces that are hard to assess by means of textual sources only, which are scarce or even non-existent for these rural areas.

The archaeological records consist of 90 buildings spread over 58 sites, predominantly majority located in the subalpine area of the Mercantour mountains (only one building is located in the subalpine area for the Hautes-Alpes). These barns are mainly built with timber, which allowed us to employ a dendrochronological approach. Larch (*Larix Decidua* Mill.) is the principal species used in these buildings. Larches are also the main species which grow at this high altitude. The dendrochronological records consist of 583 woods dated from 1159 to 1927.

The wooden agropastoral buildings that remain are mainly buildings whose shape reflects that of the latest work conducted, mostly during the second half of the 19th century or even the beginning of the 20th century. However, they are the result of successive rebuilding work carried out, or overhaul and repair work conducted over the years; it was noted that this occurred every 20 to 40 years on average.

The oldest dates provided by dendrochronology determine that these constructions dated back to at least the 12th century. It would also seem to be the case that the pieces of wood were not all re-used in a similar way. Therefore, this leads to a selection of materials. Generally, the larger elements, such as beams, are of course the most frequently reused.

On the contrary, roof-planks are rarely reused but can be recycled for other functions.

Indeed, the re-use and recycling of wood for building purposes is a question that archaeologists must face in order to explain and reconstruct the history of these buildings. Re-use affects a significant part of the life-time of the building and its successive transformation, making it possible, at the same time, to restore the social and cultural aspects contained in the art of recycling. Moreover, if the use of wood testifies to the conforming of mountain communities to the stresses of their environment, its re-use as an economical and pragmatic practice is intrinsic to the art of building know-how and the local economy.

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The art of the reuse and transformation of materials in Brabant construction. Data and methodological problems from the example of Brussels (thirteenth-nineteenth centuries)

The question of the reuse, recycling, and transformation of building material, despite having attracted the attention of several European researchers, has not yet been the subject of a global approach in Belgium, nor even of a regional synthesis. Our contribution does not claim to fill this gap, but it does seek to establish a first state of knowledge on the subject in Brussels.

The results presented are based on historical sources (urban ordinances, construction accounts, bills of sale, etc.) and on data from preventive

archaeological operations concerning medieval or later buildings. This study assembles a corpus of 35 sites that includes houses and public or religious buildings, located mainly in urban areas. A few examples allow us to approach rural architecture. Architectural terracotta, lithic material, and wood are at the heart of this research.

The reflection implemented is essentially methodological. This study highlights that the exact determination of the presence or absence of reused material remains difficult. The fragmentary state of architectural terracotta can result both from a problem in the manufacture, transport, or even handling of a new material from dismantling or demolition. In the latter case, incompleteness may result from both voluntary and involuntary transformation, as demonstrated by research conducted on the reconstruction period following the 1695 bombardment. All the cases studied show that reuse results from "opportunistic" work or supply, aimed at reducing costs by using second-rate materials. These results are perfectly in line with the observations made for the city of Rome by Philippe Bernardi and Daniela Esposito or by Alain Salamagne for the city of Douai.

The analysis of the masonry shows that some of the brickwork used allowed for a relatively abundant use of new or reused fragmentary material, without creating disruption or disorder in the walls, as is the case with a cross bond for example.

In general, the study shows how complex this phenomenon is. Indeed, this practice characterises all architectural production without social distinction and cannot be considered as marginal in the history of construction in Brussels.

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The multiple lifes of stones. Ancient reuses in the Puy-en-Velay Cathedral through nineteenth-century archaeology

In the first third of the 19th century, following the first patrimonial measures initiated by the French Revolution, the government sought to inventory and protect, often empirically, monuments of the past. In 1832, Victor Hugo wrote a pamphlet entitled 'War on Demolishers', published in *La revue des Deux-Mondes*, in order to stop "the hammer that is mutilating the face of the country" by destroying ancient monuments, and to call on the government to assume its responsibilities: "One law would suffice. Let us pass it. Whatever the property rights may be, we must not allow the destruction of a historical and monumental edifice by these ignoble speculators whose honor has been blinded by self-interest; miserable men, and so idiotic they do not even understand that they are barbarians!". Indeed, monuments collapse, when they are not assailed by destructions and plundering of all kinds. It was only in the second third of the 19th century, with the July Monarchy, that restoration activities were set up, step by step, under the aegis of a central authority. In this context, the cathedral is a site of memory, which holds meaning. The restoration of this monument was intended to restore its grandeur, but also to stage its role in the national story occurring at the time. The cathedral of Le Puy-en-Velay (Haute-Loire), a major monument for Romanesque architecture, was almost dismantled and reconstructed in the 19th century in order to "clean up" its structures. In its bulwarks, the monument contained a large amount of ancient fragments, re-used as rubble stones or ornaments. Some of these were reinstated during the restorations, while others were extracted to enrich the collections of the Musée Crozatier. While the restoration was radical and the building might be said to be a work of the 19th century, it did not "make up" this puzzle of ancient reuses in medieval construction. The practices of reuse were established well before. However, the restoration emphasised such reuses: Auguste Aymard, a scholar and pioneering archaeologist of the 19th century, followed these titanic works. He noted, described, drew, and measured entire portions of the construction, reflecting

on the transformation of materials and recording their modifications. He has bequeathed us with this knowledge through his archives. How should these disappeared or displaced remnants be studied? What fertile dialogue can we undertake between archives and archaeology to understand the transformation of recovered materials?

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Framing reuse. The destruction of buildings and reuse of materials in Roman legal texts (first-third centuries AD)

This article presents several Latin legal sources, accompanied by their translation into French and a brief commentary: these texts restrict the reuse of architectural elements in the Roman world. Texts 1 and 2 are two *senatusconsulta* recorded on the same bronze tablet found at Herculaneum (*CIL* X, 1401). The first one, known as *senatusconsultum Hosidianum*, was issued in 47 AD under the reign of Claudius; it forbids the purchasing of houses and villas with the purpose of demolishing

them and selling their materials. The *senatusconsultum Volusianum*, in 56 AD, makes an exception for one woman, whose villa near Mutina was already falling into ruin. These measures are clarified, amended, and completed until the 3rd century: a rescript of Severus Alexander in 222 AD, transmitted through the Code of Justinian (C.I. 8.10.2, text 3), cites an edict of Vespasian which forbade the removal of marble from a building for profit; an excerpt by the Roman jurist Marcianus, written in the early 3rd century and then copied in the Digest (D. 39.2.48, text 4), specifies that transferring marbles or columns from a house to a public building is an authorised practice.

Transferring materials is also restricted in the case of properties that are inherited. Text 5 is a long comment by Ulpian (D 30.1.41) on the *senatusconsulum* of 122 AD, otherwise unknown; it provides that the elements attached to a building, i.e., marbles, columns, statues, tiles, beams, libraries, and even wall-paintings, cannot be bequeathed separately from the rest of the building. There may have been exceptions to this prohibition (texts 6a, b and c: D. 30.1.114.9, D. 32.1.11.14, D. 32.1.21.2). Finally, a passage from the *Historia Augusta* (text 7) says that Hadrian forbade the destruction of buildings and the transfer of materials from one city to another.

These texts all demonstrate that building materials, and especially ornaments, were so highly sought after that people could demolish houses completely. Such massive destructions were considered as an aesthetic, economical, and political problem by the Roman State. Nevertheless, the salvaging and reuse of architectural elements is still possible if the transfer is made within the same estate or in favour of a public building. The Senate and the emperor endeavoured to maintain a balance between the owners' right to arrange their properties as they wished and the maintenance of urban landscapes. Roman jurists thus defined a very specific space where building materials could be moved.

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