Judith Utz · Martin Fera · Marianne Mödlinger · Heike Schlie

Gates to Paradise

Metal Doors of the 11th and 12th Century

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Judith Utz · Martin Fera · Marianne Mödlinger · Heike Schlie (eds.)

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Introduction

Judith Utz · Martin Fera · Marianne Mödlinger · Heike Schlie

In the early days of the pandemic in 2020, Marianne Mödlinger encountered the subject of one of the famous "doors to Paradise", the metal doors of the 11th–12th century in Europe. She was surprised to discover that, despite the abundance of excellent literature on these doors,[1] particularly in the field of art history, there was a paucity of knowledge regarding the materials used and the techniques employed in their production. The initial questions that prompted the inception of the GAPAMET project were: were these doors all made of bronze? And who made them, where, and how? The project proposal was subsequently drafted and funding was provided by the Austrian Science Fund (FWF). Hosted by the Institute for Medieval and Early Modern Material Culture Studies at the University of Salzburg, the project commenced in January 2022, so still during the pandemic, with the documentation of the doors of San Marco, Venice. All other doors, apart from one, were subsequently documented. Unfortunately, the project was unable to proceed with the documentation of the Novgorod doors due to the invasion of Ukraine by Russia in February 2022.

But what makes these doors so special? Since the 5th century, it had been a common practice to adorn church doors with scenes from the Old and New Testaments. The most well-known examples of this practice are the wooden doors from Sant'Ambrogio in Milan (late 4th century), Santa Sabina, Rome (around 430), St Maria im Kapitol, Cologne (around 1049), and the marble doors from Chora Church (Karyie Camii), Constantinople (6th century). Subsequently, copper alloy panels were also applied to wooden doors, or the doors were constructed entirely of copper alloys (as in Aachen, around 800). Nevertheless, a considerable number of bronze doors, including those from the Basilica of Saint-Denis (ca. 1140), Hagia Sophia (6th century), St Sylvester in Rome (7th/8th century), and others, have not survived to the present day. The period between the 11th and 12th centuries saw the zenith of the production of such monumental bronzes. Twenty-eight doors survive to the present day, while at least eight or nine additional doors are believed to have existed, according to other sources. These doors form the biggest corpus of medieval monumental bronzes. Below we refer to the different bronze doors by their site name.

The doors are located in Germany (Augsburg, Hildesheim, Mainz), Poland (Gniezno), Russia (Novgorod; previously Płock, Poland), and Italy (23 doors). The doors can be divided into two groups according to their main construction type. While some of the doors were cast as a single piece, weighing over a ton (e.g. Canosa, Gniezno, Hildesheim, Mainz, Rome (Battistero Lateranense), and we can also include Palermo here), all other doors consist of a wooden base onto which the bronze panels, sometimes numbering over 50, were applied. Additionally, metal components such as frames, handles, nails, and sheets were used to complete the doors. In the course of our project, the species of wood used were also identified. Unfortunately, only in a few cases did parts of the original wooden base survive (Verona, Monreale main door),

1 Notably Banti 1999; Iacobini 2009; Salomi 1990.

as it had usually been repaired or completely replaced, primarily between the 17th and 20th centuries. This also led to changes in the layout of the individual panels on the surface of the wooden doors, making it difficult to reconstruct their original positions in the pictorial programme in some cases (the Venice main door, San Paolo Fuori le Mura in Rome). This is also the case with the Verona door, where the panels from the first phase of a presumably destroyed door, were supplemented with panels from a second and third workshop programme to form a new structure, thus complicating matters. The panels from the first phase may even have fitted a door from a completely different church. The door in Novgorod, which was intended for Płock, in Poland, that was fitted with additional panels and new inscriptions on the old panels at its new location, also has a complicated object biography.

The doors are often accessible to the public and frequently feature pictorial representations and narrative scenes from the Bible or Christian hagiography, occasionally combined with ornamental embellishments. There are exceptions to this general rule though. The doors of Montecassino, for instance, display inscriptions and crosses on one side, while the reverse side of some panels depicts prophets and saints. Similarly, the doors from Mainz are only inscribed with no images.

A variety of models were employed to portray the characters and scenes on the metal panels of the doors with wooden bases. The panels were cast in two distinct forms: deep relief and almost flat relief. The former was employed in the production of the doors from Benevento, Monreale (main door), Pisa, Troia (main door), Verona, and Novgorod; while the latter flat relief type was used in the creation of doors from Monreale (side door), Ravello, Trani, Rome (baptistery), and Augsburg. Only the characters (typically saints, angels, and/or Christ) depicted on some doors were engraved, with these engravings filled with different inlays, such as niello, silver, cinnabar, copper, or other materials. Unfortunately, a significant proportion of this inlay is no longer extant, having either been stolen or corroded away. Other doors exhibit engraved inscriptions, including the examples from Canosa, Mainz, and Montecassino, which were sometimes filled with inlay, usually silver or niello.

With some doors, the location of production could be identified. For instance, the doors from Amalfi, Atrani, Montecassino, Monte Sant'Angelo, Rome (San Paolo), Salerno, and Venice were produced in Byzantium, and Barisanos' door was produced in Monreale.[2] In the majority of cases, the name of the artist responsible for the door is known, or can at least be associated with a specific artist with a high degree of certainty, such as the Pisa door, which is attributed to Bonanno due to stylistic similarities with the door he made for Monreale.[3] However, it is difficult to ascertain who was responsible for which aspect of the door's production: the wax modeller or the caster? For example, the only artist named on the doors from Canosa is the bell caster Ruggero of Melfi (Amalfi?). In the case of Novgorod, three artists are depicted and named (one of whom is responsible for the later repairs and additions in Novgorod), and as their attributes are crucible tongs and scales, it is more probable that they are the casters, but it remains unclear if they were also involved in the design or wax modelling of the doors. Some of the artists signed the doors with their names (e.g. for Novgorod, Trani, and the Monreale main door), while others were named in documents or exhibited a distinctive style, as exemplified by Barisano of Trani. Oderisius of Benevento is believed to have been the artist responsible for the two doors from Troia,[4] and it is also possible that the doors from Benevento were created by him. To date, other artists have been linked only to individual doors. It is also important to consider that different artists may have collaborated on the same project (as in Novgorod), or that the same artist may have worked on different pieces at different times (as at Verona).[5]

Another challenge arises from the possibility that some panels may have originated from other doors and

2 Mödlinger et al. 2025b; Asmus et al. 2025.

3 Mödlinger et al. 2025a.

4 Mödlinger et al. 2025c.

5 Mödlinger et al. 2024.

been subsequently rearranged, as evidenced by the case of Montecassino. Almost none of the 38 panels there appear to be from 1066, the year of construction of the object, yet, at least 40 years later, they were on the door, as is evident from the text, which lists the possessions of the abbey. Equally, nine of the panels display figures of prophets and saints on their reverse sides, which are likely to have been produced in Byzantium.

Previous restorations or accidents have also led to severe damage and/or rearrangements of the panels, or further additional changes. As such, very few of the doors are still in the condition in which they were created in the 11th or 12th century. In Troia, for example, inscriptions on the main portal refer to the poor condition of the door, which made restoration necessary. The early modern restorers then took the opportunity to "inscribe" themselves on the object; the main portal has several panels with the coats of arms of Bishops Prospero Rebiba (1560–1593) and Antonio Di Sangro (1675–1694), replacing medieval panels. In other cases, natural disasters or wars meant that medieval doors did not survive at all, as in the case of the Oderisius door in Benevento, the door of Abbot Suger in St Denis, or a Barisanus door in Bari.

Art historical research has mostly focused on historical data, such as the door donors, as they are mentioned or depicted on several examples (Amalfi, Monte Sant'Angelo, San Paolo Fuori le Mura in Rome, Hildesheim). Other topics of discussion has been their construction history or changes that the doors underwent, for example triggered by their partial destruction (as in Verona and at San Paolo). Byzantine and Italo-Byzantine doors, produced by Byzantine artists in their respective styles, but tailored to Western iconography, theological references, and liturgical functions, have been examined as cases of a special cultural transfer. Their pictorial programmes, i.e. their choice of motifs and their depiction on the door, have also been analysed, especially in their depiction of prophets and saints (Venice) as well as their biblical or hagiographic narratives. Other methodological approaches, such as material iconological studies or pictorial strategies (i.e. the way the narratives were depicted), have been rather neglected. Some authors have pointed to the fundamentally different aesthetics of the flat and chromatic Byzantine or Italo-Byzantine doors in contrast to the plastic panels of images and decorations cast into forms of higher relief. However, the explanation for such aesthetic choices can be found in trading connections and political networks rather than in an artistic or local clerical choice for a specific function. Indeed, there are also fundamental differences between the more sculpturally panelled doors themselves. The protruding figures in front of flat architecture in Hildesheim or Verona reflect a different understanding of imagery (*Bildverständnis*) compared to the panels in Pisa, where a cast with multiple undercuts creates complex spaces through architectural and botanical elements.

Bronze doors are all made of copper alloys and by the lost-wax casting technique, but in terms of type and *Kunstwollen* they form very different groups. Some doors with figures are more ornamental (Trani), while others are more figurative, sometimes exhibiting an almost *horror vacui*, as on the panels in Benevento, whose cycle is one of the most extensive in the Middle Ages. Indeed, what is the reason for the strange roundels in flat relief on the Canosa doors, that are combined with flat niello depictions and sculptural figures? Other topics that have not been much discussed concern the relationships between the artist who made the draft, the wax cutter who shaped the forms, the caster who transformed this form onto another material, and the artist who did the finishing by engraving and refining the shape. These are all questions and observations that need further discussion.

We cannot answer all of these desiderata, but we hope that the new data provided – the chemical analyses, the holistic photographic documentation and the 3D models – and the fact that it is open access, will stimulate further research on these doors.

The contributions in this volume stem from the interdisciplinary collaboration in the project (Fera, Mödlinger, Schlie, Utz), and from a workshop held in September 2023 in Verona. They are complemented by the contributions of John Morrisey, Maddalena Vaccaro, Fabio Coden, Tomasz Węcławowicz, Gaetano Curzi, Antonio Milone, Sebastian Ristow, and Giorgia Ghiara.

John Morrisey's article focuses on cross-cultural relations in the Mediterranean region. For centuries,

the Italian maritime republics were engaged in commercial activities with neighbouring states in the Mediterranean, and this gave rise to the appearance of Byzantine doors in Italy, which are the subject of Maddalena Vaccaro's article that follows. She examines the Byzantine door in Salerno and asks new questions. In addition to iconographic considerations, she situates the door within its ritual context over the centuries, analysing some of the well preserved Salernitan manuscripts. Fabio Coden investigates the palimpsest of bronze panels on the Veronese door and traces its object biography regarding the different cultural, political, religious, and aesthetic contexts at the times where these material changes are thought to have taken place. Tomasz Węcławowicz gives an overview of the research questions relating to the door in Gniezno, regarding its artistic provenance, the techniques used and the different workshops that may have worked on it; he also analyses its hagiographical programme in terms of *christoformitas*. Gaetano Curzi in turn examines the bronze door of San Clemente a Casauria in its architectural and landscape setting, and thus shows that the door was planned and executed in a unique way for such a setting. Antonio Milone then analyses the image programme of the Benevento door regarding its political and religious function and the history of the episcopate there. He also proposes a dating of the door by comparing it to the sculpture of the Benedictine monastery of Santa Sofia. In her contribution, Heike Schlie focuses on the iconology of the materials, the techniques, and of the objects themselves in order to examine how the doors are staged as entrances to their respective churches, and as virtual entrances to the heavenly Jerusalem, through their specific material and pictorial *concepti*. Judith Utz's article is dedicated to the object biographies of the doors analysed in the project. Restorations and additions to the doors point to a perpetual or reawakened appreciation for these objects over time, while updates in inscriptions indicate their later utilisation by lay or clerical dignitaries. Lost or destroyed doors are also discussed, and how they have been remembered to this day. Sebastian Ristow presents his new data from his technological investigations of the Carolingian bronzes in Aachen. His findings suggest that the raw materials for their production were extracted near Aachen and processed in the excavated foundry next to the cathedral. Marianne Mödlinger's and Giorgia Ghiara's contribution focuses on the interpretation of the chemical analyses of the doors from Benevento, Canosa, Casauria, and Palermo. Finally, in his article, Martin Fera discusses the current methods and possibilities for photo-based documentation of these art objects. He explains the technical background to the creation of distortion-free orthomosaics and their advantages for the research community.

We would very much like to draw attention to the Open Access database of the project's results here: https://gapamet.imareal.sbg.ac.at. This gives access to all the analytical results, the high-resolution orthophotos of whole doors, and thus of every single panel on them. Everything is freely available online, so providing a useful resource for further research on the almost 30 metal doors from the 11th–12th century in Europe.

Last but not least, we would like to thank all those who made this research possible: the Austrian Science Fund (FWF) who funded the research of the GAPAMET project, the IMAREAl, who hosted our project, the reviewers of the project proposal, the two reviewers of this monograph, everyone who gave us access to the doors from the Vatican, the dioceses, cathedrals and churches, the Soprintendenze, and museums, and all our friends and colleagues who helped and supported us: thank you so much for your help! Moreover, we would like to give a warm thank you to the team of the Institute for BioEconomy of the National Research Council of Italy, in Trento, Jarno Bontadi, Marco Fellin, and Martino Negri, for carrying out the XRF-measurements, as well as our team members Giorgia Ghiara and Serhii Makhortykh, as well as our extended team members Sebastian and Iulia. Thank you!

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The Italian Maritime Republics

Commercial and Intercultural Networks (9th to 12th Century)

John Morrissey

The Hinge Between World Systems: The Mediterranean

What were the products that came from overseas? From Andalusia, North Africa, the Levant, Byzantium, the Black Sea Region, the Middle East, India, China, and South-East Asia? Mostly luxury goods: spices and pepper, silk and other fine fabrics, ivory, paper, glass, drugs and medicine, dyes, potash, alum, perfumes, incense, metal objects, cotton, sugar, wheat, furs, animal skins, olive oil, wine, mastic, gold, slaves. For products from Italy, western and transalpine Europe, the list is much shorter: silver, weapons, iron, wool and linen products, salt, cheese, honey, wine, grain, wood, pitch, and slaves. This seems to be little – and it looks like a negative trade balance with the Islamic and Byzantine worlds. But it was not. Why?

As Amalfi was the first maritime republic to build up a Mediterranean network, it is worth focusing on this small state (which gained its independence from Byzantium in 839, and was to be transformed into a Ducato about 200 years later, but without giving up its democratic structures). The main reason was no doubt Amalfi's immediate neighbourhood to the Byzantines, the Lombards, the Latin-Western Empire, Papal Rome and the Muslims in Sicily, North Africa and Spain.[1] Furthermore, the republic had (on its own territory and in the hinterland) access to products which were in high demand: flax, hazelnuts and walnuts, chestnuts, dried fruits, wine and wood. And there was wheat from Apulia where the Amalfitans had established a network of bases on the coast.[2]

With these goods, the Amalfitans headed for *Ifrīqiya* (roughly corresponding to present-day Tunisia). The Arabs often paid with gold which reached the North African coast on caravan routes from regions southwest of the Sahara. Then the Campanian merchants purchased luxury goods in Egypt and the Levant (especially spices and pepper).[3] The next port of call was Constantinople where they sold part of their goods and bought other luxury items (mainly silk).[4] Returning to Italy, there awaited the big business of selling Oriental and Asian products.

A century later the Venetians, Pisans and Genoese followed the Amalfitan example. Timber and iron were particularly important in trade with the Muslims, being considered strategic merchandise for the manufacture of ships and weapons. Despite papal and imperial embargoes, all maritime republics supplied these products. In a letter to the Caliph of Baghdad in 1182, Saladin stressed the value of close trade relations with the maritime republics. He talked explicitly about the goods that Pisa was to supply: "Arms and iron and wood and pitch"[5], which was an essential contribution to the arming of the Egyptian military forces.

1 Jones 1997, 76–80; Picard, Fois 2014, 259; Gargano 2014, 22; Morrissey 2022, 55–67, 77–84.

2 Balard 2014, 9.

3 Feldbauer 2019, 73–80.

4 Citarella 1968, 533; Jacoby 2014, 99–100.

5 Cited in Allmendinger 1967, 61.

All agricultural products exported by Italians to Muslim countries were sold in large quantities. "It seems incredible that through the alchemy of trade such an ordinary agricultural product as hazelnuts [...] was transformed into silk, spices and gold."[6] Gold for wood or hazelnuts – this carries us to an essential and often overlooked aspect of the commercial history of the Middle Ages: The role of indispensable, unspectacular mass goods and thus often overlooked by researchers in favour of expensive and exotic commodities.

Funduq and Colonial Expansion

The Mediterranean trading network of the Italians (but also of some maritime cities in southern France and Catalonia) was based on a system of trading posts which were usually called *funduq* or *fondaco.* As for the origin of the term, in Arabic a hotel is still called *funduq* or *fanadiq.* This word, however, is derived from the Greek *pandocheion*, which means hostel or "everyone-is-welcome".[7]

In the late 9th century, when Italian merchants began operating overseas, they settled in densely populated Mediterranean port cities, with highly developed urban structures in Islamic metropolises and the Byzantine Empire. In the *funduq,* a merchant entered a familiar world consisting of port facilities, trading offices, workshops, grocery stores, bakeries, warehouses, taverns, houses, churches, and sometimes monasteries with hospices. In Constantinople the Amalfitans also possessed a bronze foundry. A *funduq* was headed by a vicar or consul, who ran the administration according to Amalfitan-Venetian-Pisan-Genovese law and ruled on disputes among his fellow citizens. In conflicts between Italians and Muslims or Byzantines, the jurisprudence of the local ruler was applied. Despite extraterritorial status and extensive trading privileges (tax reductions and generous concessions), the trading post was subject to the ruler of the host country.[8]

The establishment of merchant colonies followed this pattern for centuries: a system of equal exchange, of commercial interaction at eye level. The appreciation for foreigners is reflected in the instructions of an 11th-century Egyptian high official: "Treat merchants of all countries, languages and colours in such a way that they think back on us with affection. Guard these people and their goods well, and do all you can to protect them from harm and danger."[9]

The earliest evidence of a *funduq* dates from about the year 800: it was an Amalfitan merchant settlement in Antioch in Syria, led by a vicar with the name Mauro. The traders purchased sugarcane and cotton, as well as indigo, metal products, glass and paper. And from Antioch, caravan routes led to the silk-producing centers of the Caspian Sea, and to Mesopotamia where cotton was grown.[10]

After the conquest of Egypt by the Muslim Fatimid dynasty in the year 969, the Amalfitans who closely co-operated with them were granted extensive concessions. In Cairo the Amalfitan *funduq* was close to the Jewish quarter whose merchants could look back on a long tradition of mercantile activities in the Mediterranean, and who benefitted from connections to India and the Far East. Soon, thanks to the Italians, almost all of Europe was included in this intersection of three world economic systems.

In this context, attention should be paid to the role of multi-ethnic Swahili traders in East Africa. They lived in cities like Mogadishu and Mombasa, or on the islands of Zanzibar. Their most important commodities were ivory from inland Africa and Indian spices. Like in the Mediterranean, urban social structures had developed there, and they can be considered as autonomous municipalities or city states.[11]

Of course, Constantinople was another center of long-distance trade – to the Levant, the Black Sea region, the Caucasus and China. As early as 944 the Amalfitans had their own district on the Golden Horn. In 1111 the Pisans became their neighbours, and the

6 Guérin 2013, 73.
7 Allmendinger 1967, 81.
8 Morrissey, Feldbauer 2023, 99–100.
9 Cited in Allmendinger 1967, 95–96.
10 Gargano 2014, 12–17; Jacoby 2014, 105–109.
11 Sonderegger 2017, 161–174.

Italian trade network, editing by Manfred Happenhofer (based on https://dmaps.com/carte.php?num_car=3136&lang=de) [last access: 15.04.2022]

Amalfitans, as agreed with the Greek Emperor, were to act as guarantors of the Tuscans. To the east of the Amalfitan quarter there was the quarter of the Venetians.[12]

In Byzantine and then Norman Apulia the Amalfitans established a system of *funduq* that included all the important cities on the coast: Otranto, Brindisi, Monopoli, Bari, Trani, Barletta, Manfredonia, and many more.[13] It is therefore no coincidence that the donor of the bronze door at Monte Sant'Angelo on the Gargano Peninsula was from Amalfi: Pantaleone de Comite Maurone, who will be mentioned later. And it is not surprising that Barisano, the creator of the Trani Cathedral gate, also designed the doors of Ravello (which was part of the Ducato of Amalfi), because particularly the Ravellese dominated Apulian trade – above all with wheat.

The First Crusade damaged Amalfi's position as a major trading power in the Eastern Mediterranean. They did not participate in the armed pilgrimages against the Muslims for various reasons (including good relations with the Egyptian Fatimids). Instead, the Venetians, Pisans and Genoese engaged in a race for trading bases and privileges from the 12th century onward. Their military and logistical support for the crusaders provided them with the opportunity to gain a foothold in the Eastern Mediterranean, and ultimately the Italian merchants were the real beneficiaries of the crusader movement. Unlike the Frankish barons, control of larger territories was not important

12 Jacoby 2014, 89–99; Balard 2014, 10–12.

13 Morrissey 2022, 122–127; Martin 2020, 17–25.

to them. They just preferred to penetrate economically into a region that was profitable in several respects, as the Levant offered an abundance of products which were increasingly in demand: sugarcane and cotton, as well as spices, indigo, metal products, glass, paper, and silk.[14] The Italians also made handsome profits from transporting pilgrims, warriors, horses, weapons, and food. As a result of these services, they were granted trade privileges and tax concessions. Thus, soon districts of western merchants could be found in every major Levantine city port: in Acre, Tyre, Beirut, Sidon, Antioch and Laodicea.[15]

In the Western Mediterranean the development was similar. Where the Amalfitans already had bases, competitors from the north appeared in the late 11th century, especially the Pisans and Genoese. The expansion of the northern Italians was often marked by warfare against the Muslims of Spain and North Africa, although at the same time the Tuscans and Ligurians maintained peaceful, treaty-based contacts with the Moors and Saracens. In the ports of Tortosa, Almería and Málaga the Italians bought finest leather goods and cotton-rag paper from Cordova, as well as olive oil from Seville, and they purchased gold from trans-Saharan Africa in Bougia and Ceuta.[16]

From the 1260s onward, the importance of Italian settlements in the Byzantine Empire and the Black Sea region increased. Some *funduq* turned into formidable cities, such as Genoese Pera in Constantinople or Genoese Caffa in the Crimean Peninsula, and Venetian Tana on the Sea of Azov (today roughly modern Rostow). This was the end of the classic terrestrial Silk Road, allowing the Italians to trade directly with Central Asia and China on routes secured by the *pax mongolica*.[17] We should not forget the connection to Western Europe either, as there were Venetian or Genoese settlements in Galicia, Bruges, Southampton and London.

Amalfi had numerous bases abroad, but for many reasons it never penetrated into territories to establish a colonial economy as did Pisa in Sardinia, Genoa in Corsica, and Venice in Crete. Sardinia and Corsica were ideal ports of call for ships bound for al-Andalus, the Maghreb, Southern Italy and Sicily. Controlling Crete also meant better control of the sea routes to Egypt, the Levant and Constantinople.

There was a variety of goods these islands possessed: Sardinia had silver, salt, wool, wheat, wine, and cheese. Crete offered wine, cheese, wheat, leather, and wool. We know less about Corsica, but probably wood and wool were the island's most important products. As extensive farming methods did not enable the islands to provide sufficient quantities for export, the Italians did everything they could to intensify agriculture. The efforts were successful, but the price for parts of the local population was high: peasants, miners and salt workers had to suffer from precarious living conditions.[18]

Territorial colonies had one thing in common: there was the unconditional will of the northern Italians to gain control over larger territories and rule them, instead of simply being guests, like in a *funduq*. Venetian-Pisan-Genovese economic policy in the subjugated colonies meant an unequal exchange system and monocultural agricultural production geared toward export. Colonial trade operated according to completely different rules which were unilaterally determined by the colonial rulers.

Acculturation – transfer of knowledge and technology

Such an extensive trade network implies the exchange of knowledge and artistic skills, as well as technology. This phenomenon of innovation and acculturation in the Middle Ages impressively proves how much the image of a dark, retrograde era can be convincingly refuted.

14 Luzzatto 1995, 16; Lopez 1997, 80–82.
15 Rösch 2000, 59–64; Crouzet-Pavan 2001, 72–76.
16 Herlihy 1990, 195–207; Constable 1996, 96–105, 191–196, 199–203; Salvatori 2002, 18–19.
17 Jacoby 2017, 21; Lopez 1997, 230–242.
18 Lane 1980, 120; Day 1984, 83–84, 137–138; Epstein 1996, 27; Abulafia 2013, 362–363.

Literature

Italians played an important role as translators of ancient and oriental texts – usually from Greek into Latin. The first travel guides were written, both for pilgrims to the Holy Land and for visitors to Constantinople. It was, in all likelihood, the abbot of the monastery Santa Maria degli Amalfitani at Mount Athos, Giovanni Amalfitano, who translated the book *Anonimo Mercati*a, a travel guide to the architectural wonders of Constantinople.[19] Like Marco Polo or the monks Giovanni da Piano del Carpine and Odorico da Pordone after him: All three travelled the Mongol Empire and wrote impressive reports about what they had experienced.

It can be assumed that in the maritime cities many people spoke two or even more languages, either because of their overseas experience, or because of the presence of numerous foreign merchants in Italy.[20] It was also due to the immediate vicinity of Arabs, Byzantines, Lombards and Normans as in the case of Amalfi, and of Slavs, Lombards and Byzantines in the case of Venice. The Norman chronicler Guglielmo di Puglia confirms this aspect of multiculturalism in his description of Amalfitan society:

> "They bring here various goods from the royal city of Alexandria and Antioch. These people sail many seas. Arabs and Libyans, Sicilians and Africans meet here. They are known throughout most of the world as those who take elsewhere what is worth buying …"[21]

Without doubt the origin of modern narrative prose lies in the milieu of the Italian merchant towns of the Middle Ages, which led to the emergence of late medieval writers like Il Novellino, Boccaccio (who was a bank clerk), Massuccio Salernitano, Sacchetti and Bandello. A down-to-earth and rational view of the world was quite typical of a society which not only lived on trading goods from all over the world, but also on exchanging ideas and news in clear (and sometimes even profane) language.

Science

One of the most influential books of the Middle Ages was written by the Pisan mathematician Leonardo Fibonacci who had spent his youth in Bugia, where his father was the public scribe of the Pisan *funduq*. Bugia (Béjaïa in present-day Algeria) was an outstanding centre of science, especially in the field of mathematics. Hundreds of students, including many Christian Europeans, attended the schools attached to the mosques – something the young Leonardo also did. In his *Liber Abaci*, published in 1202, Fibonacci explained the essence of Indo-Arabic mathematics, particularly how Arabic numerals and the zero digit can be applied.[22]

Costantino Africano (who was born around 1015 in *Ifrīqiya*) traveled for decades to North Africa, the Near and Middle East, and probably even reached India. He was a spice trader, and thus ideally qualified for his future vocation. In his sixties he emigrated to Campania, carrying with him numerous manuscripts. He enjoyed the patronage of the Norman ruler Robert Guiscard and of Alfano, Salerno's archbishop and (being a doctor himself) the director of the *Scuola Medica Salernitana*). Costantino was not only an author but also a translator of scientific texts written by widely recognised physicians and scholars, such as Isaak Israeli Ben Salomon, a north African Jew who wrote about nutrition, fever and the pulse. Or Persian Haly Abbas's encyclopaedia on the medicine of the Greeks and Arabs, as well as a manuscript by the Arab-Christian physician Ḥunayn ibn Isḥāq, which deals with eye diseases. After his death Costantino was given the title of *Orientis et Occidentis Magister*.[23]

Medicine

Not by chance Costantino settled in Campania, since one of the most famous and innovative centres of medical research in the world was located there: The *Scuola Medica Salernitana* where European, Indian and Arabic medicine was taught. From these traditions

19 Von Falkenhausen 2008, 35–36.
20 Von Falkenhausen 2008, 37.
21 Cited in Titchen 2002, 45–46.
22 Salvatori 2002, 19; Mitterauer, Morrissey 2015, 137.
23 Veit 2003, 124–137.

emerged new standards of care: "The Medical School was the first in Europe to combine regular medical training with public health. […] New teaching methods were developed, such as commentary and debate"[24] Spices and native herbs were considered remedies for all kinds of health problems. But in addition to taking medicine, the researchers and physicians of the Salerno Medical School emphasized hygiene and nutrition in the treatment of disease. They emphasised the importance of a balanced lifestyle to give the body a chance to heal itself or not to get sick in the first place. Thus, preventive medicine became part of Amalfi's maritime regulations: ship crews should take enough lemons on board, "to cure and prevent some diseases, not least for sailors to prevent scurvy."[25]

The model of the Salerno Medical School was exported to the Levant: Amalfitan Mauro de Comite Maurone founded hospices in Jerusalem and Antioch around 1060, granted by the Fatimid caliph al-Mustansir bi-llāh.[26] The hospital of San Giovanni a Gerusalemme gave rise to the Knights of St. John, from which the Order of Malta was to develop a few centuries later. The Order's coat of arms, which we know from the State of Malta, but also from ambulance cars in many European cities, is in fact the emblem of Amalfi.[27]

Technology

Amalfi and Fabriano in the Marche still duel over who was the first to bring Arabic paper to Italy. Whoever it was, rags of linen, hemp or cotton were used as the base material, and milling techniques were applied to grind these rags to pulp which could then be skimmed off as paper. The new writing material was much cheaper than parchment and began its triumphal march from Southern Italy through Europe.[28]

In glass production, decisive innovations came from Venice. Most likely the Serenissima's craftsmen were inspired by the Arab glass factories of the Levant, and with various raw materials coming from many regions of the Mediterranean, experimentation with technology led to two key inventions: transparent glass for large windows, and spectacles which until then had been cut from expensive crystal.[29]

We should not forget the innovations in maritime transportation, either. Increasingly, nautical instruments were used to enable navigation in difficult weather conditions, for example, the compass: The function of a magnetised iron rod had been known in the Mediterranean region since Hellenistic times. In the 13th century, the magnetic needle was connected to a vertical bronze peg in a case made of box wood, an extremely durable material. Sailors from Positano are likely to have played a key role in this innovation. By the way, the Italian word for box wood is *bosso,* and from this derives the modern term for the compass: *bussola*.[30]

We do not know the extent to which shipbuilding and armoury was influenced by Muslim technology, but the origin of the name *arsenale* is interesting: it comes from the Arabic *dār aṣ-ṣinā'a*, meaning "house of craftsmanship".[31] All maritime republics had impressive shipyards, and the arsenal of Venice probably became the largest industrial complex in the medieval world.

Financial and insurance systems were also strongly influenced by the models of the Muslim economic world. The *colonna* and the *commenda* (or *colleganza*) are considered examples of collective financing models – so to speak, they are precursors of crowdfunding (in the case of the *colonna*) and joint-stock companies (with the *commenda* which was implemented throughout the Mediterranean for trade financing).[32] For the *colonna* the financial burden was widely shared and thus it was attractive for all citizens. Undoubtedly, this form of cooperation promoted social mobility: peasants or aristocrats, everyone was literally in the

24 Goddemeier 2011, 2.
25 Falcone 2009, 100.
26 Caputo 2009, 152–157.
27 Morrissey 2022, 166–168.
28 D'Antuono 2014, 55–59.
29 Lane 1980, 239–243; Crouzet-Pavan 195–196.
30 Lane 1980, 189–191; CCSA 2015, 1.
31 Gargano 2010, 17.
32 Rösch 2000, 58; Crouzet-Pavan 2001, 102; Gargano 2014, 36–45.

same boat. "This contract is of great importance for the spirit of justice, for the safeguarding of collective interests, a reminder of the responsibility of all…"[33] Barbara Kreutz talks about the "egalitarian *colonna* system" and the "democratic flavour" inherent in this model. [34]

This also applies to one of the earliest collections of medieval maritime law, the *Tabula de Amalpha*. Based on Byzantine and Muslim maritime regulations, it was compiled in the 11th century and later modified and expanded. The *Tabula* regulated the procedure for the division of profits and the treatment of sick and injured seafarers. It also provided for the joint decision of the entire crew in certain situations, especially in case of hostile attacks or bad weather. Chapter 47 is clear about such calamities: It mentions "unpredictable cases of stormy weather, or in order to defend better against enemies."[35] So, it should be noted here: sailors were free men and not galley convicts in chains. This was also true for the fleets of Venice, Pisa, Genoa and other maritime cities. "Laid-back discipline and a cooperative, egalitarian spirit are generally characteristic of medieval maritime law."[36]

Pan-Mediterranean Protagonists: Mauro e Pantaleone de Comite Maurone

In this concluding chapter I would like to describe two individuals who are particularly typical of the Mediterranean spirit I have described in the previous pages. There would be a wide choice of outstanding characters to choose from: The Venetian doge Enrico Dandolo, mastermind of the Fourth Crusade and far-sighted strategist in building the Venetian colonial empire. Romano Mairano, a merchant from the Venetian middle class, who proved extremely resilient in the turmoil of the eastern Mediterranean. Archbishop Daimberto of Pisa, one of the most influential men of the First Crusade, who was more a tricky politician than an exemplary man of the Church. The chronicler Caffaro who vividly described the rise of Genoa to become a Mediterranean power. The Norman conqueror of Southern Italy, Robert Guiscard. The versatile Amalfitan women business women Tarsia della Lama and Grusa da Sancti. Trotula of Salerno – a woman teaching and researching at the *Scuola Medica*, and who made groundbreaking discoveries, especially in the fields of gynaecology and urology.

But as this book is about the *Gates to Paradise*, the choice is clear to me: Mauro and Pantaleone De Comite Maurone who are the founders of four bronze doors. Their wealth was based on trade: They had built a commercial empire including Sicily, North Africa, the Levant and Byzantium, and they traded in textiles, spices and olive oil. Their charitable work is well documented – for example, the above-mentioned foundation of the hospices in Jerusalem and Antioch.

Mauro de Comite Maurone was consul of the Amalfitan *funduq* in Constantinople. In the critical years around the Schism, his son Pantaleone served as vice-consul in the Eastern Roman capital and wielded great influence at the emperor's court. As a confidant of the Byzantine Emperor and at the same time as a citizen of a state close to the Papal Church, Pantaleone was predestined to be a mediator in the dispute between the Orthodox and Western Roman churches. However, his attempts at reconciliation failed. The gap between Rome and Constantinople was too wide.[37] He fared no better in another mission: a decade before the Norman Robert Guisacard seized power in Southern Italy, Pantaleone had tried to forge an anti-Norman alliance with the Pope, the Western Emperor and the Lombards of Salerno on behalf of the Eastern Roman Emperor Constantine. X Doukas. But the attempt proved unsuccessful due to the skepticism of Henry IV and the attitude of the pontiff.[38]

It is no coincidence that a citizen of a maritime republic was also a diplomat. The daily multicultural experience, combined with the cosmopolitan outlook of Mediterranean seafarers, destined these people to

33 Del Treppo 1977, 77.
34 Kreutz 1996, 89.
35 Quoted in Gargano 2014, 34.
36 Lane 1980, 93.
37 Caputo 2009, 147–149.
38 Morrissey 2022, 141.

act as mediators in conflicts of interest. Whether it was bargaining for the release of prisoners or negotiating peace treaties or trade agreements – Jews, Muslims and Christians relied on the gift of internationally experienced businessmen who fearlessly sought communication with the *other*, and who were ready to seek compromise. "It is obvious that cross-border cross-cultural commuters are used here. These mediators, who are familiar with Eastern customs and are probably also capable of speaking Arabic, are of great importance to the cultural history of this policy."[39]

The interculturalism of the De Comite Maurone family is also reflected in their commitment as patrons of culture: They were sponsors of literature, as evidenced by translations of oriental texts. The above-mentioned monk and translator Giovanni Amalfitano was a friend of the De Comite Maurone, and he showed his appreciation for the family by dedicating a book to Pantaleone, a translation of the *Liber de Miraculis,* a collection of Greek fables.

But it is the four bronze doors of Amalfi, Montecassino, Rome and Monte Sant'Angelo, as well as the enigmatic Cassetta di Farfa, that are today associated with the name De Comite Maurone. Here I would like to point out just two interesting iconographic aspects concerning the gate of Amalfi and the Farfa casket.

Let us start with the gate (which Pantaleone commissioned in Constantinople around 1060) and examine the figures of the apostles Peter and Andrew. "They are assigned precise roles, with the former being the expression of the Christian Church and the latter the patron saint of Amalfi and the cathedral."[40] But I think we should go beyond this interpretation: Andrew was considered a typical 'Greek' or 'Eastern' saint, Peter was regarded as being 'Roman' or 'Western'. Thus, the figure of Andrew next to his brother was clearly a political statement. In this way, Amalfi signalled its equidistance between Constantinople and Rome. After all, the schism that Pantaleone had experienced firsthand took place only a few years earlier.[41]

The Cassetta di Farfa leads us back to Mauro de Comite Maurone who was also the donator of this ivory casket which is now preserved in the Abbey of Santa Maria di Farfa northeast of Rome. It was created around 1070, and it served as a reliquary.

Along with gold and silver, ivory was the most sought-after material for making valuable items. Not only because of its shimmering, yet so intense matt colour and fine texture, perfect for carving, but also thanks to its origin in distant and exotic lands. Moreover, this noble material came from a powerful and legendary animal. Ivory mostly was transported from East Africa (via the trade network of the above-mentioned Swahili merchants) to Alexandria where the De Comite Maurone had an outpost in the Amalfitan *funduq*. However, the Farfa casket does not only impress by the prestigious material and its great craftsmanship. Let us have a look at details of the inscription and the iconography, because on the one hand the casket displays a puzzle, and on the other hand it demystifies a narrative that has been maintained until the present day.

Let us start with the puzzle: Biblical scenes are framed by a banner in which Mauro plays with the meaning of his name. The name Mauro means *dalla Mauretania* (from Mauretania or Moorish lands) or simply *il Moro* (the dark one). Furthermore, the text reveals that Mauro had dealings with dark or black (*nigr)* people or affairs. When Mauro connects his name with *nigr* people or deeds, what does he mean? Regret for contact with unbelievers or for some dishonest business practice? Being proud of his life as a successful businessman who also owed his wealth to partners in Egypt and North Africa? According to Sarah Guérin, Mauro wanted to point out unequivocally where the ivory came from, and what it had to do with him: "... from the trans-Saharan routes through *Ifrīqiya*, because they were *his* business partners, that was *his* network: the question was about *his* identity."[42] In addition to Mauro's pride in his career, this casket

39 Jaspert, Kolditz, 38.

40 Braca 2003, 64–65.

41 I owe this coherent interpretation to CCSA-member Michele Amendola.

42 Guerin 2013, 91.

also symbolizes Amalfi's position in the Mediterranean world.

And for the demystification, there is an image referring to a well-known cultural import from the Arab world, a detail historians and musicologists have paid little attention to. The first to write about this seemingly trivial scene was Antonio Braca. A side plate of the lid shows the birth of Jesus being announced to the shepherds – with the usual depiction of the angel, the stable full of animals, and two shepherds listening to another shepherd playing the lute. This is an unusual depiction because the lute originates from Arab culture and in the Early Middle Ages it became popular in the Iberian Peninsula, where the Spanish word *laúd* developed from the Arabic *oud*.[43] This means that the lute began its journey from Spain or Sicily to Europe before the end of the millennium, and did not go west from the Levant in the age of the Crusades. The Cassetta di Farfa, created before the First Crusade, proves this.[44] Amalfitan merchants visited Cordova as early as the 10th century and had fruitful contacts with Arab Sicily. Most likely paper was not the only innovation they introduced to Europe.

In the end, this brings us back to the subject of our joint project – the *Gates to Paradise*, some of which can be closely associated with the name De Comite Maurone. They are indeed emblematic protagonists of a pan-Mediterranean world which is characterized by impressive modernity.

Zusammenfassung

Seit dem frühen Mittelalter entwickelte sich im Mittelmeerraum ein Netzwerk wirtschaftlicher und sozialer Beziehungen, das drei Kontinente umspannte. Janet Abu-Lughod spricht von einem "Weltsystem", das mehrere Subsysteme miteinander verband und vielfältigen Austausch ermöglichte. Ein veritabler Globalisierungsprozess, auch wenn der amerikanische Doppelkontinent noch nicht dazugehörte. Italienische Küstenstädte spielten in diesem Prozess eine entscheidende Rolle: Kleine unabhängige Staaten, die zu wichtigen Handelspartnern und interkulturellen Vermittlern im komplizierten Machtgefüge des Mittelmeers wurden: Amalfi, Venedig, Pisa und Genua. Drei dieser Städte sind für die Geschichte mittelalterlicher Bronzetüren von besonderer Bedeutung.

Riassunto

A partire dall'Alto Medioevo, nella regione mediterranea si sviluppava una rete di relazioni economiche e culturali che abbracciava tre continenti. Janet Abu-Lughod quindi parla di un "sistema mondiale", che si intrecciavano nei modi più diversi. Un vero e proprio processo di globalizzazione, nonostante il doppio continente americano non facesse ancora parte di questo sistema. Le città costiere italiane giocavano un ruolo decisivo in questo processo – piccoli stati indipendenti che diventavano partner commerciali e mediatori interculturali indispensabili nella complicata struttura di potere del Mediterraneo: Amalfi, Venezia, Pisa e Genova. Tre di queste città sono particolarmente importanti per la storia delle porte di bronzo medievali.

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43 Braca 2009, 316–318.

44 Morrissey 2022, 164–165.

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In Front of the Bronze Doors

Patronage, Devotions and Rituals at Salerno Cathedral

Maddalena Vaccaro

The bronze[1] doors of the Salerno Cathedral are a masterpiece of European medieval art, well-known to scholars, who have so far investigated their technical, formal, and iconographic aspects, as well as their conservation (fig. 1).[2]

This contribution aims to add some reflections: (1) on the artistic and productive processes surrounding the door, (2) on its iconographic programme as part of the patronage effort, and finally, (3) on the role of the door as a fundamental element in "architectural scenography", as it was used as a liturgical installation in its specific context. A methodological approach, which integrates the relationship between works of art, architecture, and functionality in the mediaeval age, as demonstrated in other contexts, has proven particularly fruitful for the Salernitan context as well, thanks to the significant heritage of liturgical manuscripts from the cathedral now preserved at the Museo Diocesano "San Matteo".[3] The goal here is therefore twofold: to underline the multiplicity of factors that influenced the design of the door within the broader context of cultural and artistic exchanges in Italy and the Mediterranean, and to understand the 'long life' of the work beyond its initial commissioning context.

The metallic door leaves of Salerno are hinged within the so-called "Gates of Paradise" of the cathedral, built from 1080 onwards.[4] In 1084, the two main altars of the building were consecrated: the one in the *basilica maioris*, dedicated to the Virgin, and the one in the *basilica inferioris*, dedicated to St Matthew, i.e. in the crypt built specifically to house his relics in the altar at the centre of the hall, the focal point of the entire architectural design.[5] In reality, St Matthew had been co-patron of the cathedral along with the Mother of God since 954 when his relics were transferred to Salerno,[6] but he became a proper patron of the city by the end of the 11th century driven by the new political power held by the Norman Robert Guiscard. This is proven not only by the effort to build the cathedral, but also by the celebratory-dedicatory inscription on the façade, commemorating Robert's undertaking: *M.(atthaeo) A.(postolo) et evangelistae patrono urbis Robbertus dux r.(omani) i.(mperii) maximus triunphator de aerario peculiari*.[7] There is no unanimous agreement as to whether the cathedral here was actually built in

1 The term "bronze" is used for historiographical convenience and ease of identification. For all issues to do with materials, please refer to the research directed by Dr Marianne Mödlinger as part of the "GAPAMET – Gates to Paradise: Creating Metal Doors for 11th–12th Century Churches" project (https://gapamet.imareal.sbg.ac.at/en), also published in this volume. I take this opportunity to thank Dr Mödlinger, Dr Judith Utz, and the scholars of the Italian CNR-IBE, National Research Council, Institute of BioEconomy, for their cordial discussions and fruitful collaboration during the analyses of these doors.

2 Braca 2003; Gandolfo 2009; Della Valle 2009; D'Anzilio 2017.

3 Zanichelli 2019; Vaccaro, Brusa 2022, also for the methodological approach.

4 *Portam in paradiso* is how the door is referred to in the transcriptions of the *Chartularium* (Archivio della Diocesi di Salerno, Mensa Arcivescovile, Registro I), f. 4Av, derived from a lost liturgical manuscript.

5 Vaccaro 2018, 55; and, more generally: Vaccaro, Brusa 2022.

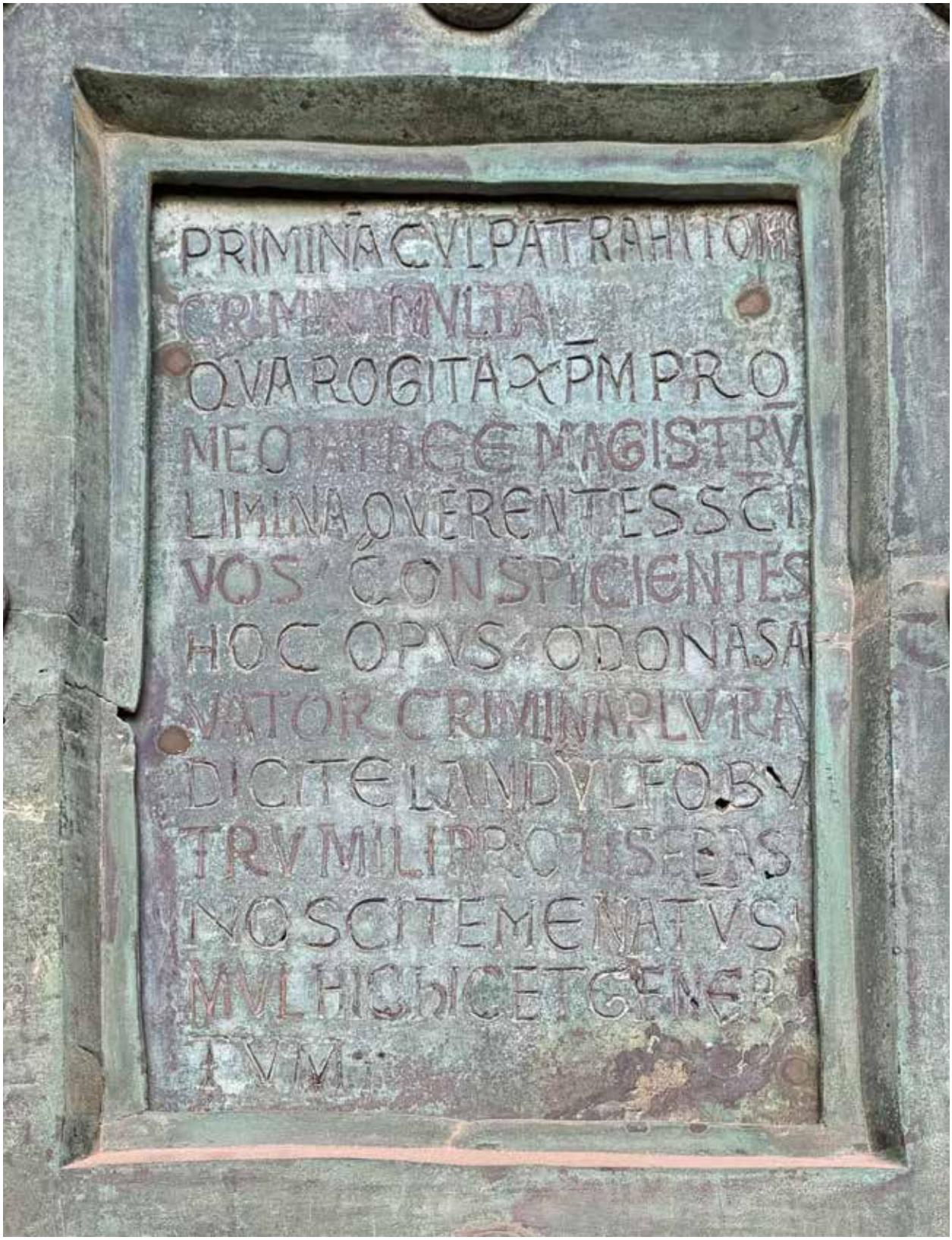
6 Galdi 1996.

7 "To the patron of the city Matthew, Apostle and Evangelist, the Dux of the Roman Empire, Robert, triumphant, at his own expense": Lambert 2017.

Fig. 2: Salerno, Cathedral. Bronze doors: St Matthew flanked by the standing patrons Landolfo Butrumile *protosebaste* and his wife Guisana (© Maddalena Vaccaro).

◄ Fig. 1: Salerno, Cathedral. Bronze doors as "Gates of paradise" (© Maddalena Vaccaro).

Fig. 3: Salerno, Cathedral. Bronze doors: panel B5: *fons vitae* (left); panel E5: intercessory inscription (right) (© Maddalena Vaccaro).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just five years, as claimed, as was the case with the abbey church of Montecassino,[8] but it is certain that the atrium structure was completed by the mid-twelfth century during the episcopate of William of Ravenna (1137–1152), as confirmed by an inscription in the bell tower.[9]

Among the most significant milestones characterising the decoration of the building is the execution and installation of its bronze door, by the end of the 11th century. The door is set within a sculpted portal consisting of jambs with figured scrolls, two lions at the base, and a reused architrave from the macellum of Pozzuoli (2nd century AD), that was reworked and inscribed to emphasise Guiscard's devotion to Matthew. The cubic capitals now present, reveal a rearrangement of the original layout, which was initially intended to include two columns in *verde antico*, now reused in the presbytery as candelabras framing the portal, as in Sant'Angelo in Formis or San Menna in Sant'Agata dei Goti.[10] However, the width of the stone portal does not appear to have been modified and corresponds to the dimensions of the bronze leaves, which underwent a restoration in 1730–1731, during which the panels were dismantled, cleaned, and reapplied to a new wooden structure.[11]

The 'bronze door' of Salerno is a monumental double-leaf structure measuring 3.4 × 5.2 m in total, making it one of the largest known doors of the Byzantine type, alongside the door of San Paolo Fuori le Mura in Rome. It is composed of 54 panels arranged in nine horizontal and six vertical registers, with its visual unity ensured by twisted moulded covers and frames between the panels. Most of these are decorated with crosses applied with nails, seven are figured, and one bears a devotional inscription. The epigraphic and iconographic apparatuses were executed with different inlays at a time subsequent to casting.[12]

Six figured panels are arranged on the same register (the fourth from the bottom) and feature, on the left leaf, from left to right: Christ; St Matthew flanked by the standing patrons Landolfo Butrumile *protosebaste* and his wife Guisana (fig. 2); and St Peter.

On the right leaf, from left to right: St Paul; St Simon; the Virgin. Despite the almost replication of the figures' arrangement, their attributes are varied to confirm their respective identities. This starts with the blessing Christ holding an open book inscribed *Ego hmi to Phos tou Kosmou* (I am the light of the world); Matthew and Paul have closed books referring to their respective Gospel and Epistles; and Peter and Simon have a closed scroll, the remains of the inlay visible. The Madonna shows the open palm of her right hand and holds the *mappula*,[13] recognisable by following the inlay groove departing from the left hand placed on her stomach and creating an inverted angle. In the fifth register from the bottom on the right leaf, i.e. above St Matthew, is the seventh figured panel showing the image of the *fons vitae* (fig. 3, left); on the same register above St Simon, is placed the panel with the long intercessory inscription (fig. 3, right).

It is not possible to know if the current arrangement order is the original one, considering the intervention of 1730–1731, which is documented but not in detail; some scholars have even hypothesised that during this work, some elements may have been lost.[14] The place of execution of the door is thought to have been in Constantinople, both due to the modular production technique used and because of some decorative details that find correspondences with other examples of Byzantine production, from the aforementioned door

8 Pace 1997.

9 Vaccaro 2018, 59–61, for an outline of the building sequence and the earlier bibliography.

10 Gandolfo 2009, 144–146.

11 Braca 2003, 64–73; Braca 2009. Gandolfo 2009, 145, does not exclude a reduction in the height of the door.

12 Iacobini 2009, 16. For all technical data related to the metals used, please refer to the works of the GAPAMET project and the other contributions in this volume.

13 See the case of the icon of Santa Maria Maggiore in Rome: *Salus popoli romani*. The Virgin in the Salerno panel is distinguished by her figurative type compared with the examples from Amalfi and Atrani, where she makes the gesture of intercession, addressing Christ. For this reason, it is possible that, originally, she was placed next to her Son, see Gandolfo 2009, 146.

14 Braca 2003, 73; Gandolfo 2009, 145.

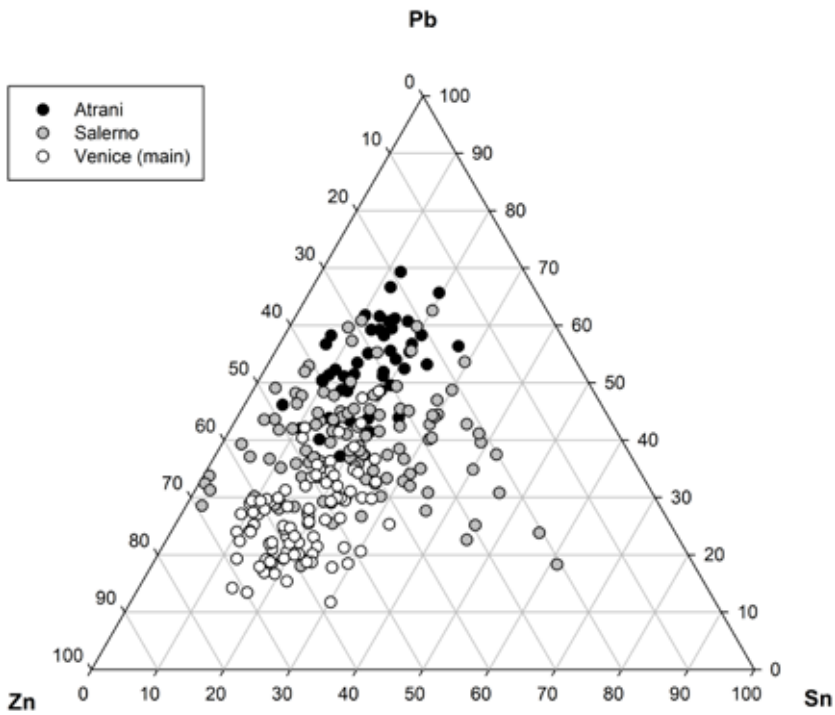

Fig. 4: Ternary plot of the normalized amounts of Sn, Zn, and Pb in the alloys of the panels from the doors from Atrani, Venezia main, and Salerno, Italy (© GAPAMET).

in Rome to examples closer by on the Amalfi Coast, as well as the San Clemente door in Venice.[15] This hypothesis is also supported by the patrons' culture, inferred both from the textual apparatus mentioning Landolfo's honorary titles (see above) and from the figurative data, especially from the attire in which the couple is represented.

Regarding the dating of the door, the proposals have so far varied between 1084, the year of the building's consecration, the year 1099 – mentioned by Luigi Staibano and accepted by Guglielmo Matthiae[16]– and the mid-12th century, in reference to the stylistic changes attested in the panel with the image of the *fons vitae.*[17]

To discover the place, context, and reasons for the door's production, studies have referred to historical-artistic data and analyses carried out during restorations.[18] However, the material analyses now conducted by the GAPAMET research group, not only allow us to make further evaluations that can be compared on a broader and more uniform scale with other doors, but it also enables us to gauge a detailed understanding of the metallic alloy composition of the individual panels. The Salerno door was produced using a quaternary alloy of copper, tin, zinc, and lead (Cu-Sn-Zn-Pb), whose percentages are very similar to the composition found in the Atrani door (1087) and the central example of San Marco in Venice (1112–1138),[19] especially regarding its Sn and Zn content (fig. 4).

15 The explicit reference to Constantinople recurs in the Chronica Monasterii Casinensis, III, 18 (MGH, SS 34, 385), and in the inscriptions of San Paolo Fuori le Mura in Rome and Monte Sant'Angelo; see Matthiae 1971, esp. 55–60, 75–76, 83. Cf. also Sinigalliesi 1999, 251–253; Braca 2003, 70; Milone 2020.

16 Staibano 1873, 242; Matthiae 1971, 35 and 95.

17 Della Valle 2009 and the cited bibliography. A 12th century date was proposed for stylistic reasons by Frazer 1973, 160 n. 62.

18 For Salerno, cf. Sinigalliesi 1999; Braca 2009; for the other doors, see the contributions in Iacobini 2009.

19 See the results in Mödlinger et al. 2024 and Mödlinger et al. 2023.

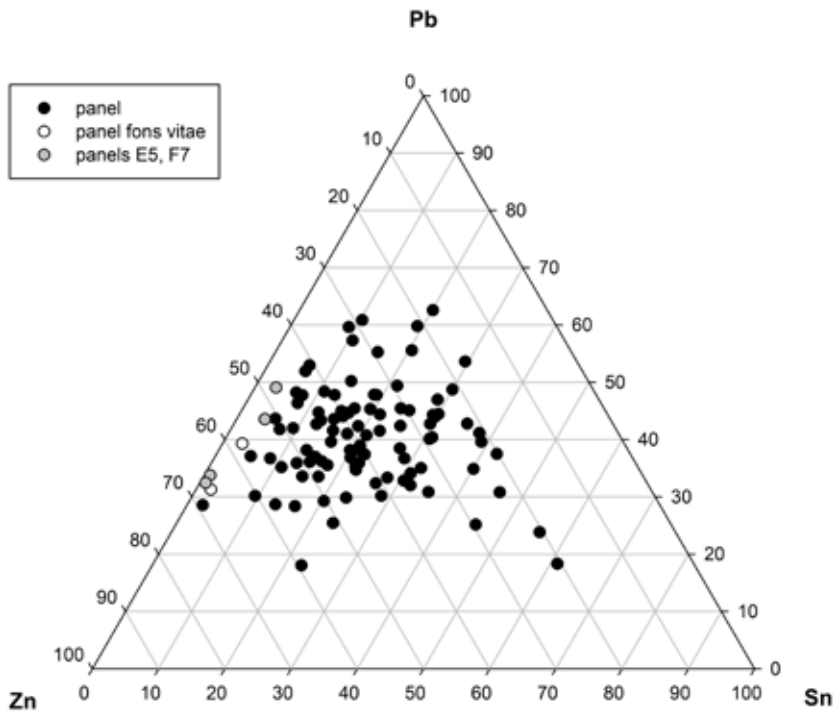

Fig. 5: Ternary plot of the normalized amounts of Sn, Zn, and Pb in the alloys of the panels of the doors from Salerno, Italy (© GAPAMET).

Only a slight variation in the amount of lead is recorded for the Atrani door.[20] However, within the Salerno door, three panels are made with a different alloy, and therefore via a separate casting, which was made with a ternary alloy of copper, zinc, and lead (Cu-Zn-Pb), that is, brass with lead but without tin: they are panels B5 (*fons vitae*), E5 (intercessory inscription) (fig. 3), and F7 (cross)[21] (fig. 5).

A similar ternary alloy with Cu-Zn-Pb was used for the doors of Amalfi (1057), San Paolo Fuori le Mura in Rome (1070), Monte Sant'Angelo (1076), and also the so-called 'door of San Clemente' in Venice (1081–1092), as evidenced by the graph (fig. 6).[22] The Montecassino door (1066) instead was made in major parts of leaded bronze.[23]

From the perspective of localising the door production, it should be noted that the new data does not deterministically define any workshops and chronologies, but it does tally with the hypothesis of a "continuity" of door production in Constantinople.[24]

The material outlier within the Salerno door overlaps with another well-known divergence. The *fons*

20 I would like to thank Dr Marianne Mödlinger for her generosity in making the data available and for discussing it with me; for the analytical methodology, see the contributions of the research team. Detailed results are available through these links:
https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_ATRANI.xlsx [last access: 15.03.2025]
https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_SALERNO.xlsx [last access: 15.03.2025]
https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_VENICE_main.xlsx [last access: 15.03.2025].

21 See Mödlinger 2025 for more detailed results.

22 The GAPAMET results are available for all the doors, while the San Clemente results are available at:
https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_VENICE_side.xlsx. [last access: 24.08.2024].
For the art historical studies on these artifacts, see Iacobini 2009.

23 https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_MONTECASSINO.xlsx [last access: 15.03.2025].

24 "Continuity" is the term used by Matthiae 1971, 53–60, to frame the overall production, also noting the foundry for the doors was owned by the Mauroni: Matthiae 1971, 76. See also Milone 2020, 496–497, on the possible role of Duke John II of Amalfi as a political

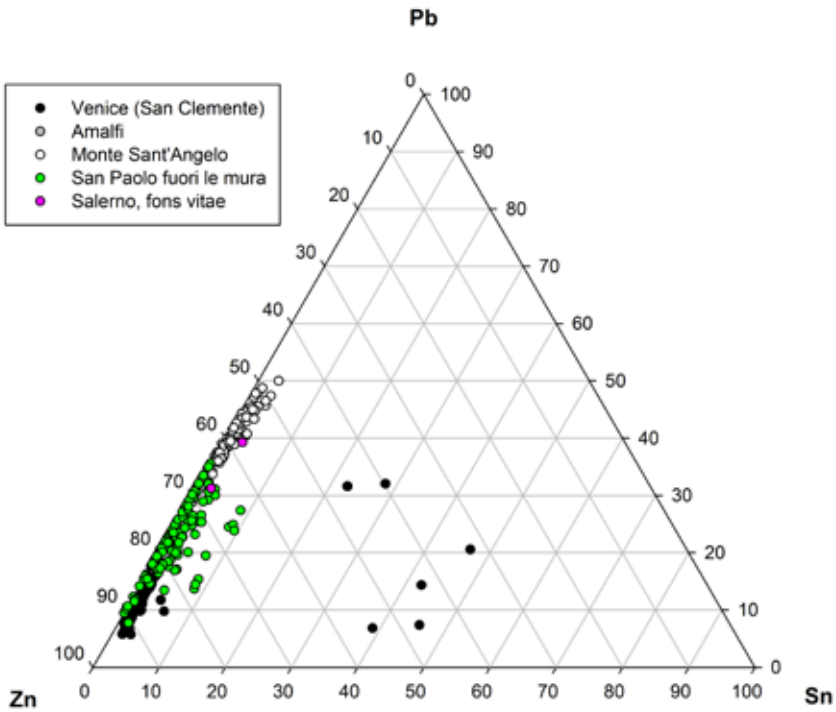

Fig. 6: Ternary plot of the normalized amounts of Sn, Zn, and Pb in the alloys of the panels from the doors from Amalfi, San Paolo Fuori le Mura, Monte Sant'Angelo, Venice (San Clemente), and the panel *fons vitae* from the doors from Salerno, Italy (© GAPAMET).

vitae panel was initially intended to be decorated with a cross, as discovered during the most recent restoration of the door, that revealed the trace of a cross profile on the reverse side (now not visible).[25] Additionally, it was observed that the inlay decoration on this panel was carried out later, as indicated by the slight misalignment of the cross at the top of the structure shown, to avoid the hole.

From an artistic perspective, the image of the *fons vitae* does not differ from the style of the other six figured panels of Salerno. However, the decorative scheme with the raceme frame corresponds well with that present in the lower register panels of the door of San Clemente in Venice, which have identical scrolling frames and other zoomorphic themes in the centre.[26] For these reasons, scholars have hypothesised about the place and time of execution of this panel. Antonio Braca proposed a later reworking of the piece in Salerno, i.e. during the installation of the door,[27] however his hypothesis does not account for the substantial coherence of the figurative parts. Mauro Della Valle argued rather that this reworking may have occurred during the production phase, in Constantinople, precisely referencing the stylistic coherence of the decoration.[28]

What is certain is that two discontinuities in the production process are visible: one in the production of the panels, requiring the insertion of three elements created with a separate casting, and one in the decoration, involving a *pentimento* to introduce an image with a precise meaning. However, none of these actions need imply that such interventions occurred

bridge between Amalfi and Constantinople; and Utz 2024. On the diversity of alloys within the same workshop, see the example of the doors of Barisano di Trani (Mödlinger et al. 2025).

25 Sinigalliesi 1999, 251.

26 Paribeni 2009, 303.

27 Braca 2003, 71.

28 Della Valle 2009, 187; Sinigalliesi 1999.

significantly far apart in time; for example, the ternary rather than quaternary composition of the alloy could have been due to a contingent reason such as material availability, while the iconographic change could have been in response to a request from the patron.

Studies have questioned the reasons leading to the reworking of the panel with the *fons vitae*. It refers to concepts of purification and salvation,[29] as well as baptismal and Christological references, as first argued by Margaret English Frazer, emphasising the symbolism of the work as the Gate to Paradise.[30] In 2003, Antonio Braca suggested that the doors may have been commissioned by the powerful Mauroni family of Amalfi – responsible for the doors of Amalfi, Montecassino, San Paolo Fuori le Mura in Rome, and Sant'Angelo on Monte Gargano[31] – as *ex voto* initiatives for the expiation of sins. Braca attributes the creation of the Salerno door to the same motive, referencing the text requesting intercession to St Matthew.[32] However, the system of communication through images and texts displayed in Salerno is expressed in entirely original ways, as will be seen.

Firstly, it is important to highlight that the image of the donors, depicted standing beside St Matthew, and the image's connection with the epigraphic apparatus, distinguishes the Salerno door within the production of 11th-century bronze doors in southern Italy, dominated by the aforementioned Mauroni family. The donors are Landolfo Butrumile and his wife Guisana, identified with inscriptions beside their figures. The long inscription on the panel mentions only Landolfo: the text records a prayer addressed to St Matthew, asking him to intercede with Christ for the forgiveness of the many sins caused by the fall of Adam. This is followed by a request to the pilgrim/viewer to participate in the prayer for Landolfo's salvation (*Limina querentes Sancti, vos conspicientes hoc opus..*: And you, who seek the threshold of the Saint, behold this work…). With a change of subject in the sentence, Landolfo addresses the worshipper directly, to reaffirm his full belonging to the city of Salerno, by earthly and spiritual birth (*natum… et generatum*: born… and baptized) (fig. 3, right).[33]

Landolfo Butrumile *protosebaste*, as argued by Paul Magdalino, was a high-ranking Byzantine naval official in the service of Emperor Alexios I Komnenos (1081–1118), of Lombard, and specifically Salernitan, origin, something explicitly declared in the inscription. He is likely the same Landolfo mentioned as *mega doux* in Anna Komnena's *Alexiad*, who held office from 1099 to 1108, and to whom belongs the seal now in the Byzantine Museum of Athens, which bears on one side the invocation "Lord, help the sebastos Landulf", and on the other the bust of St Matthew, a rare image on a seal that was used as a sign of personal devotion (fig. 7).[34]

The high social position achieved by the Butrumile couple is evidenced by their richly fashioned Eastern garments, worthy of high dignitaries of the Byzantine court.[35] The two stand beside the figure of St Matthew in the centre (*Matheus Apostolus*), in a relationship of closeness that not only honours the cathedral's patron but also reaffirms their personal devotion, already expressed textually in the aforementioned epigraph, and now translated into a figurative form (fig. 2). This solution is particularly interesting because it visually represents, for the first time in a public space in Salerno,[36]

29 Matthiae 1971, 95; Della Valle 2009, 187; D'Anzilio 2017.

30 Frazer 1973, referring to Underwood 1950. As mentioned, in Salerno it is named the *Portam in paradiso*: *Chartularium* (Archivio della Diocesi di Salerno, Mensa Arcivescovile, Registro I), f. 4Av.

31 Milone 2020 with earlier bibliography.

32 Braca 2003, 65–66.

33 *Primi na(ti) culpa trait om(nes) | crimina multa. | Qua rogita Chr(istu)m pro | me, o Mathee, Magistru(m). | Limina querentes S(an)c(t)i, | vos conspicientes | hoc opus: 'O dona, Sal|vator, crimina plura', | dicite, 'Landulfo Bu|tromili Protisebasto. | Noscite me natu(m) si|mul hic, hic et | genera|tum*. English translation after Bloch 1986, I, 154–155: "The first man's guilt drags all men into many sins. Therefore, O Matthew, beseech Christ, the Master, on my behalf. And you, who seek the threshold of the Saint, behold this work and say: 'O forgive, Savior, Landulfus Butromilis, the Protosebastos, his many sins'. Know that I was born and baptized here".

34 The hypothesis by Magdalino 2003 has been accepted by the most recent studies (Ristovska 2017; Zanichelli 2017) despite the reservations of Della Valle 2009. For the reading of the seal and the rarity of Matthew, see Cheynet, Morrisson 1995, 16–20; and also Cotsonis 2020, II, 90, which notes only one other seal with a St Matthew, dated to the 10th century, of anonymous ownership.

35 Zanichelli 2017, 14.

Fig. 7: Byzantine and Christian Museum of Athens. Seal: on one side the bust of St Matthew, and on the other the invocation "Lord, help the sebastos Landulf" (BXM 849) (© Greek Ministry of Culture/Byzantine and Christian Museum).

Matthew, who has now risen to the status of the protecting and identifying *numen* of the place (in the inscription he is referred to as *limina… sancti* and *hic*), as a real *patrono urbis*, as proclaimed in the dedication epigraph by Guiscard.

In the figure of the saint, personal devotion overlaps with civic devotion. While the role of the local saint as a unifying element in a political and social sense during this phase of Norman rule is not surprising,[37] the couple's desire not to limit the invocation of the principal local saint to verbal form but to associate with Matthew in an original figurative triad, is significant. They stand with raised hands directed towards him, and in this respect Landolfo and Guisana distinguish themselves from other donors, who are more often represented in *proskynesis*, as seen in the bronze doors of Amalfi, Venice (San Clemente), Rome, Bari, and later, Ravello, or in other notable examples in other artistic media, such as the mosaic of Santa Maria dell'Ammiraglio in Palermo with George of Antioch, half a century later. Their gesture also distinguishes them from other standing donor figures, such as Abbot Desiderius (1027–1087) in Sant'Angelo in Formis offering the model of the church to Christ (ca. 1087), or the later mosaic at the entrance to the abbey church of Grottaferrata, where Igumen Nicholas II (1085–1122) is inserted between the Virgin and the throne of Christ, with arms crossed over his chest (ca. 1100).[38]

In the Salerno door, the composition is tripartite, and follows a compositional scheme very different from other triadic scenes. In terms of artistic medium and chronology, the closest example is in the bronze door of Monte Sant'Angelo (1076), but the meaning of the scene is entirely different. In this latter case, it is a representation of Saints Cecilia and Valerian, to whom the half-bust *angelus Domini* (the angel of the Lord) offers floral crowns, a figurative reference found in sumptuous Byzantine productions from the last quarter of the 11th century[39]. Another significant triadic image from the Byzantine sphere, with a central standing figure larger than the side characters, this time a secular matrimonial couple, is the Paris plaque depicting the consecration of Emperors Otto II and Theophano, both shown in richly embroidered garments (Paris, Musée de Cluny, inv. Cl. 392, 982–983).[40]

36 St Matthew appears in the cited seal of Landulf, but also in a later seal of Archbishop Romualdo II Guarna (second half of the 12th century), preserved in the Diocesan Museum of Salerno.

37 On the devotional strategies pursued by the Normans in southern Italy from the late 11th century, see Oldfield 2014, 275–276.

38 Pace 1994; Pace 2012; Tranchina 2018.

39 Tancredi 2022, with earlier bibliography; Flaminio 2009.

40 https://www.musee-moyenage.fr/collection/oeuvre/ivoire-christ-otton-theophano.html [last access: 15.03.2025]. On the Byzantine iconography of the imperial couple, see Flaminio 2009, 347. Cf. also Frugoni 1977, 955; Iacobini 1991. In the Salerno area, an image of a couple is depicted in the so-called Charta of Abbot Donato (1210) from the abbey of Montevergine, in which the spouses are held by a monk, guaranteeing the economic agreement: De Duonni 2022, 147–158.

However, the gestural lexicon in the Salerno panel differs profoundly, as it does not merely represent a subordinate reception to the eminent figure (recognition of sanctity / legitimisation of imperial sanctity), but a dynamic interaction in which Landolfo and Guisana address Matthew in prayer, directing their hands towards him, while simultaneously receiving his blessing from the saint's gesture, which precisely replicates Christ's hand gesture in the nearby panel, with only the index and middle fingers raised.[41]

This feature of intercession and prayer thus appears decisive considering its devotional nature, expressed through the door's iconographic programme, which leverages a personalised hagiography. It represents the conjunction between the personal devotions of the patron and the collective identity of the Church of Salerno: Christ and the Virgin, Peter and Paul referencing Rome,[42] Matthew the patron, and then Simon, whose cult is not subject to particular feasts in the Salernitan calendars[43] nor is linked to specific relics in the cathedral.[44] The presence of this last saint could instead be motivated by the personal wishes of the patrons, oscillating between local cultural ties of Lombard descent and professional success in the East, to which the complex hagiographic fortunes of the saint are more connected.[45] In Byzantine doors in Italy, the figure of St Simon recurs in San Paolo Fuori le Mura in Rome (1070), standing and in the scene of his martyrdom,[46] and in the door of San Clemente in Venice (1082–1092).[47] In the Lombard territories closest to Salerno, the image of the apostle is rarely attested, but he does appear in half-bust form with a scroll on the cover of the Evangeliary of Capua, dated to the 12th century, now in the Diocesan Museum.

If an ecclesiastical *concepteur* is certain for the design of the doors of Montecassino and Rome,[48] private initiative seems decisive in the choice of images in the examples from the Amalfi Coast – even in the later case of Ravello[49] – as well as in Salerno, starting with the choice of the hagiography. It is patronage I believe that lies behind the choice of replacing a cross – a motif that is as much symbolic as it is common on doors – with this more complex image. It better corresponds, both in meaning and compositional balance, to the panel with the epigraphic text, all of which are focused on the request for forgiveness of sins. This close connection between the two panels is now confirmed by the production process of the door, as they were made from the same alloy, as presented above, and probably at the same time.

We do not know the reasons a different alloy was used here, perhaps a response to workshop contingencies, but this data reinforce the idea that these three panels were conceived together: either they were newly created to be inserted into the door or, instead, if they had already been produced, they were *repertoire* elements that consequently played a modular role, and the new tiles in quaternary alloy would have been proportioned accordingly.

The presence of repertory material cannot be excluded, since among the ternary alloy elements, the *fons vitae* was initially conceived with an applied cross, following the same techniques known since the Amalfi door (1057). Now, it is crucial to underline that the new icongraphic decoration finds a precise counterpart in the door of San Clemente in Venice both in material correspondence and above all in artistic features. The Salerno element is closely comparable, in compositional and decorative schema, to the panels in the lower band of the Venetian door, confirming another serial and repeatable characteristic of these productions. Therefore, it may be that the five panels with the vegetal

41 Zanichelli 2017, 14.

42 Gandolfo 2009, 146.

43 Salerno, Museo Diocesano "San Matteo", mss 3 and 4, for which see Galdi 2000; Zanichelli 2019. Frazer 1973, 160 with the hypothesis that Simon represents an important monastery in the city. This does not seem convincing, since only an attestation of an ancient church in Castel San Giorgio, about 20 km from Salerno, can be found: Crisci, Campagna 1962, 225.

44 *Chartularium* (Archivio della Diocesi di Salerno, Mensa Arcivescovile, Registro I), ff. 7A–9A, in which other apostolic relics besides those of Matthew, Peter, and Paul are clearly mentioned. These are Andrew, James the Lesser, Philip, and Barnabas, but not Simon.

45 Magdalino 2003; Frankopan 2007. See also Zanichelli 2017, 14. For St Simon, see *Acta Sanctorum*, *Octobris*, vol. XII, 28.

46 Matthiae 1971, 73–82; Bloch 1986, I, 149–150; Bevilacqua 2009.

47 Matthiae 1971, 97–101; Bloch 1986, I, 164–166; Paribeni 2009.

48 Milone 2020, 494.

49 Sabino 2019.

frame (four on Venice San Clemente door, and one in Salerno) result not only from a common iconographic design but also from a temporally closely executed production, dating around 1090, i.e. in a period closer to the production of the ternary alloy doors (fig. 6).

Furthermore, it is necessary to reconsider that the rest of the Salerno door is made of a quaternary alloy very similar to the Atrani door (1087), and that the overall artistic conception and composition of the iconographic apparatus, especially in the position and gestures of the figures framed under the arches, make the two doors particularly similar. For this reason, their creation can be thought of as not too far apart in time, i.e. once again around the year 1090.

If this were the case, either the entire production of the Salerno door, which most scholars date to 1099, would need to be anticipated, or the three ternary alloy panels should be considered as dating much earlier than the rest of the door. However, it is likely that their intended use had already been defined: a cross was retained, a cross was replaced with a specific subject for the central field featuring a recurring frame pattern, and a panel was inscribed with a personalized text for the same donor depicted in the *formella* with St. Matthew, in a quaternary alloy. On one hand, the donor's inscription ensures a connection with his image; on the other, the iconographic *pentimento* in favour of the *fons vitae* constitutes material evidence of a link between the door productions for Atrani, Salerno, and Venice's San Clemente. There is a strong reason to support the hypothesis of the panel's reworking in the workshop during the execution phase, with an awareness of the final product's composition, to accommodate the requests of Londolfo Butrumile. In this context, there was clearly a will to insert a specific subject to complete the articulated semantic project, all centred on the request for forgiveness and salvation, provided by the interconnections between the epigraphic text and iconographic apparatus, now also materially proven.

As recently noted by Antonio Milone, there is a clear conscious use of writing in bronze doors not only for the "esposizione epigrafica degli attori", i.e. the epigraphic statements of the persons involved, but also to reinforce the door's artistic medium.[50] Indeed, already in Montecassino with the oldest inscriptions,[51] and also in Amalfi and Atrani, formulas typical of diplomatic culture are used, which seem to enhance the documentary value of the doors. This is even more explicit in the later reuse of Montecassino's door panels during the time of Abbot Oderisio II (ca. 1124), to the extent that Herbert Bloch speaks of them as a "meaningful document".[52]

However, although most inscriptions often appear in residual spaces, as in Rome, Monte Sant'Angelo, and Salerno, dedicatory inscriptions requesting intercession from the saint are assigned to specific panels, occupying the entire writing surface.[53] Nonetheless, in Salerno, such an inscription must have stimulated the iconographic change in favour of the *fons vitae* to deliberately trigger a dialogical relationship between text and image, whose cultural references are as broad as they are layered. The theme of the *fons vitae* indeed finds correspondences in Eastern contexts, from the mosaic floor of the baptistery of Ohrid (6th century) to the 10th–11th century tetraevangelion now in Parma (Biblioteca Palatina, Palatino, Ms. Pal. 5. 980–1100), produced between Constantinople and Messina. We also see such an image elsewhere on the Italian peninsula, due to its archaizing elements that recall the fountain in the atrium of old St Peter's, and for its iconographic themes seen in local plastic arts, such as the facing griffins.[54]

The "Western question" is further complicated by the fact that the *fons vitae* theme has long been the subject of transmedial migrations, tenaciously retaining its baptismal reference, as Paul A. Underwood demonstrated in relation to the Godescalc Evangeliary (Paris, BnF, ms NAL 1203, 781–783)[55] (fig. 8).

50 Milone 2020, 489–494.

51 Bloch 1986, I, 161.

52 Bloch 1986, I, 465–494; Moretti 2009. For the documentary value of the doors, see also Curzi 2025.

53 Matthiae 1971, 36, and the entries related to the doors. For San Paolo Fuori le Mura in Rome, see Bevilacqua 2009.

54 For the debate and bibliographic references, see Gandolfo 2009, Della Valle 2009; D'Anzilio 2017.

55 Underwood 1950.

Fig. 8: Godescalc Evangeliary (Paris, BnF, ms NAL 1203, 781–783), ff. 3v–4r: *fons vitae*, and the entry passage to the Gospel of Matthew for Christmas Eve (© Paris, BnF).

In this codex, not only is the image of the little temple also found, but here there is also an analogous dualism that makes the left illuminated page interact with the right inscribed page in its capital letters: an incipit that marks the entry passage to the Gospel of Matthew for Christmas Eve through images and words.[56]

Following an intuition by Matthiae, it can be said that for the iconographic apparatus of the doors, "the greatest incitement came from the miniature."[57] However, it should be noted that this exchange must have long sent stimuli in the opposite direction, from the metallic medium to the illuminated page, as suggested by the use of frames in the same Evangelistary, in which not only are geometric and vegetal decorations of early medieval origin found within it, but also calibrated plays of light and shadow, corresponding to the light and shadows of the frames applied to fix the metallic

56 https://archivesetmanuscrits.bnf.fr/ark:/12148/cc34648s [last access: 15.03.2025]: f. 3v: *I. In vigilia natalis Domini hora nonae. Statio ad Sanctam Mariam. Secundum Mattheum. Capitulo III. /f. 4r/ In illo tempore. Cum esset desponsata mater Iesu Maria Ioseph…* (On the eve of the Nativity of the Lord at the ninth hour. Station at Saint Mary. According to Matthew. Chapter III. /f. 4r/ At that time. When Mary, the mother of Jesus, was betrothed to Joseph…).

57 Matthiae 1971, 34, 93–95.

panels, emulating their three-dimensional thicknesses and corner joinings.

Another medial influence, within the diplomatic sphere, namely seals, might have triggered a dialogical reflection and sought complementarity between inscription and symbolic image. Seals habitually served as a space for self-representation through text and image to convey identity and social aspirations, as can be read for Landolfo himself in his seal, now in Athens. Alicia Walker has demonstrated well that this process of social affirmation can also be seen in the refined use of Islamising zoomorphic motifs,[58] from which the panel with griffins aligns itself, given its cited complexity of cultural references.

For all these reasons, I believe that the request to insert the *fons vitae* not only incorporates a multitude of cultural stimuli, but is also closely linked to the elaboration of the epigraphic text, and the new material data precisely confirm the close production of the two panels, confirming the mature and carefully planned design underlying the Salerno door.

The commissioning of such a door certainly responded to specific devotional needs and possibly to contingent political situations, particularly when considering the fluctuating relationship between Amalfi and the anti-Norman cultural strategy of the Mauroni, who donated the doors as an "imperishable message of the city's 'Byzantineness'".[59] However, this donation ultimately aimed to create a luxurious and enduring artistic artifact with high material value – comparable to gold – and symbolic significance, while also serving a specific functional purpose. The door marks the physical boundary of the cathedral's interior space and faces the atrium, a space similarly used for liturgical and paraliturgical rites.

Thanks to the manuscript heritage of the cathedral, we can add another element of information to our knowledge of the door: it also served as a liturgical installation, acting almost like a stage backdrop. The medieval manuscripts of Salerno Cathedral, specifically the liturgical texts[60], document that, at least since middle XII century, processions took place through the door, and eminent burials, such as those of the Butrumile couple and the noble Della Porta family, were located nearby.[61]

Furthermore, from at least the late 13th century, the initial part of the marriage rite took place in front of Salerno's bronze door, with blessings for the couple and the giving of the wedding ring to the bride in this location, as documented in the Sacramentary-Pontifical.[62] This practice seems consistent with the 13th-century stabilisation of the *consesus nuptialis* (wedding ceremony) conferred *in facie ecclesie* (lit. in the face of the church), followed by an entry procession and the celebration of the nuptial mass.[63] Moreover, this now established rite emphasised the *beneditio nuptialis* (wedding blessing) that established a connection with the baptismal water, referencing the "washing with water" with which Christ purified the Church, his Bride, as mentioned by Paul in Ephesians 5:25–27, in part. 26: "ut illam sanctificaret mundans lavacro aquae in verbo". Cyril Vogel believes that, on a liturgical level, this close connection is set between the blessing of baptismal water and the nuptial blessing between the late 11th and early 12th centuries. Thus, the nuptial blessing transforms marriage into a sacrament, just as the blessing over the font transforms ordinary water into baptismal water[64].

The image of the *fons vitae* may not have only been drawn from a workshop repertoire but was perhaps

58 Walker 2012.

59 On the commissioning of Byzantine doors with anti-Norman intentions, see Paribeni 2009; Milone 2020, 501. Cf. also Skinner 2013; Mathews 2017.

60 For the liturgical uses of Salerno, please refer to: Vaccaro, Brusa 2022, and Vaccaro 2023.

61 The Butrumile couple's plaque is unreadable, but residual traces of the inscriptions were read by Staibano 1873, 248–249. The figurative conception of the plaque, however, dates to the late 13th century, making its identification still up for debate: Vaccaro 2019.

62 MuDi, ms. 5, from f. 177r "Benedictione sponsi et sponse. Statuantur ambo ante ianuam ecclesie…" (Benediction of the groom and bride. Both stand before the church door...) to f. 179v "Deinde ingrediantur ecclesiam et incipit missam" (Then they enter the church and the mass begins).

63 Vogel 1977, 453–454.

64 Vogel 1977, 448–449.

deliberately chosen to emphasize the nuptial blessing of the Butromile couple, further personalizing an already original iconographic program, in which their role as patrons is celebrated alongside St Matthew. The interconnections between the panels, both material and iconographic, seem to reinforce the hypothesis of a unified conception for the bronze doors of Salerno. In this context, the iconographic *pentimento*—the *fons vitae*—does not indicate a disruption in the production process but rather serves as evidence of the cohesive design of the iconographic and textual program, and the workshop's skill in harmonizing panels crafted from two different alloys.

Zusammenfassung

Der Artikel untersucht die Bronzetür der Kathedrale von Salerno und konzentriert sich dabei besonders auf drei Aspekte: ihre Herstellung, ihre Ikonographie, die in Bezug zum Stifter steht, und ihre Rolle als Teil einer architektonischen Szenografie. Vor allem bei letzterem wird ein besonderes Augenmerk auf die liturgische Funktion der Tür gelegt. Der gewählte methodische Ansatz setzt die Tür, ihren architektonischen Kontext und ihre liturgischen Funktionen miteinander in Bezug und beachtet in besonderer Art und Weise auch die bedeutende Sammlung liturgischer Handschriften der Kathedrale von Salerno. Ziel ist es, die Vielzahl der Faktoren zu verstehen, die die Gestaltung der Tür bedingten, aber auch ihren weiteren Einfluss weit über die Zeit hinaus, in der sie hergestellt worden sind, zu untersuchen. Die Türen werden sowohl in technischer als auch in ikonographischer Hinsicht untersucht. Dank der neuen Materialanalysen, die im Rahmen des GAPAMET Projekts durchgeführt worden sind, wird die Verwendung verschiedener Legierungen evaluiert, diese mit anderen byzantinischen Objekten verglichen und die Produktionsphasen und -orte der Tür von Salerno analysiert. Die ikonographische Analyse konzentriert sich auf die schriftlichen und figurativen Aspekte der Tür, insbesondere auf die Stifterdarstellungen, wobei die Wechselwirkungen zwischen persönlicher und kollektiver Devotion untersucht werden. Abschließend hebt der Text die liturgische Verwendung der Tür im Rahmen von Prozessions- und Hochzeitsriten und ihren damit einhergehenden symbolischen und materiellen Wert als physische und spirituelle Schwelle der Kathedrale von Salerno hervor.

Riassunto

L'articolo esamina le porte bronzee della Cattedrale di Salerno, capolavoro dell'arte medievale europea, concentrandosi su tre aspetti principali: il processo produttivo e artistico, il programma iconografico nel contesto del mecenatismo e il ruolo delle porte come elemento di scenografia architettonica, con particolare attenzione alla loro funzione liturgica. L'approccio metodologico adottato integra l'analisi di opere d'arte, architettura e funzionalità liturgica, valorizzando l'importante patrimonio di manoscritti liturgici della cattedrale. L'obiettivo è comprendere la molteplicità dei fattori che hanno influenzato la progettazione della porta e studiarne la "lunga vita"; oltre il contesto della sua commissione originale. Le porte sono esaminate sia dal punto di vista tecnico che iconografico. Grazie alle nuove analisi materiali condotte dal gruppo GAPAMET, l'articolo approfondisce l'utilizzo di leghe diverse, mettendole a confronto con altre produzioni bizantine e analizzando le fasi e i luoghi di realizzazione della porta di Salerno. L'analisi iconografica si concentra sugli apparati testuali e figurativi, con particolare riferimento ai donatori, valutando le interazioni tra devozione personale e collettiva. Infine, il testo sottolinea l'uso liturgico delle porte nel contesto dei riti processionali e matrimoniali, evidenziando il loro valore simbolico e materiale come soglia fisica e spirituale della cattedrale di Salerno.

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The Bronze Door of San Zeno

Developments and Techniques

Fabio Coden

Introduction

The bronze door of the church of San Zeno in Verona has always been a difficult puzzle to solve from different points of view.[1] Although much data is available on the stages of its evolution, it is not easy to trace the precise indicators of the transformative phases that led up to the current appearance of the two wings.[2] To understand the complicated palimpsest of the Zenonian bronzes, it is therefore necessary to carefully evaluate the cultural, political, religious, and aesthetic matrices of the leading evolutionary phases of the artefacts and their intertwining, and relate them directly to the personalities who worked on the panels at different times.[3]

The starting point for any discussion is the craftsmen. Three workshops,[4] associated with groups of distinctive works, have long been conventionally connected to the doors in the critical literature (figs. 1 and 2):[5]

- the 'First Master', who had a large retinue of helpers (or 'First atelier'), to whom we owe 28 large panels (five representing Old Testament scenes; nineteen New Testament ones; two with demonic mask door handles; one allegorical scene; and one scene with St Michael), eight small panels with the Elders of the Apocalypse, two rectangular panels with a palm tree, twelve frames and 22 studs (in yellow in the diagram);
- the 'Second Master', with an equally varied retinue of collaborators (or 'Second atelier'), to whom can be ascribed sixteen large panels (fifteen Old Testament scenes; and one New Testament one), six rectangular plaques with saints and holy men and women under arches, one palm tree plate, 27 frames and twenty studs (red);
- the 'Master of St Zeno', to whom are attributed four panels with miracles and one figure under an archway, together with possibly 47 frames, four palm tree plates and one stud (blue);
- and an unknown master to whom two frames are to be assigned in the north wing (green).[6]

Although it is impossible to determine with certainty the authorship of the three series of later frames, it may be that the more iconographically articulate ones can be associated with the workshop of the 'Second Master' and the others, which repeat a single simplified scheme, with the 'Master of St Zeno'. Two of them (FN_48; FN_49) are different from the others and seem to be the result of a later work (fig. 3).

1 Boeckler 1931, 6; Trecca 1938, 50–53; Gazzola 1965, 5, 8–9, 53–54; Neumann 1979, 9–11; Mende 1981, 232; Adami 1984, 115–128; Polak 1989, 5–26; Aliberti Gaudioso, Pietropoli 1990, 422–423; Frugoni 1991, 165; Mende 1994, 57.

2 Da Lisca 1941, 216–232; Zuliani 1990, 407–409.

3 This is possible due to a careful evaluation of the metalworking techniques and the traces left on the visible face of the elements: Da Lisca 1941; Valenzano 1993.

4 The topic is approached even in the earliest research on the doors (von Sacken 1865, 135; Boeckler 1931, 9, 41; Da Lisca 1941, 201, 205–210; Arslan 1943, 71–73) and their conclusions are largely accepted by more recent works (Neumann 1979, 22–23; Polak 1989, 31; Mellini 1992, 17; Mende 1994, 57–73; Valenzano 2008, 129–130; Mödlinger et al. 2024).

5 The diagram, already published in Coden 2014, 49, has been adapted and corrected for the present publication.

6 Analyses by Mödlinger et al. 2024 partly confirm the consistency of this additional group.

Fig. 1: Diagram with the colours of the bronze door made by different ateliers: First master (yellow); Second master (red); Master of San Zeno (blue); unknown master (14th century?) (green) (updated by Coden Franco 2016, © BamsPhoto Brescia).

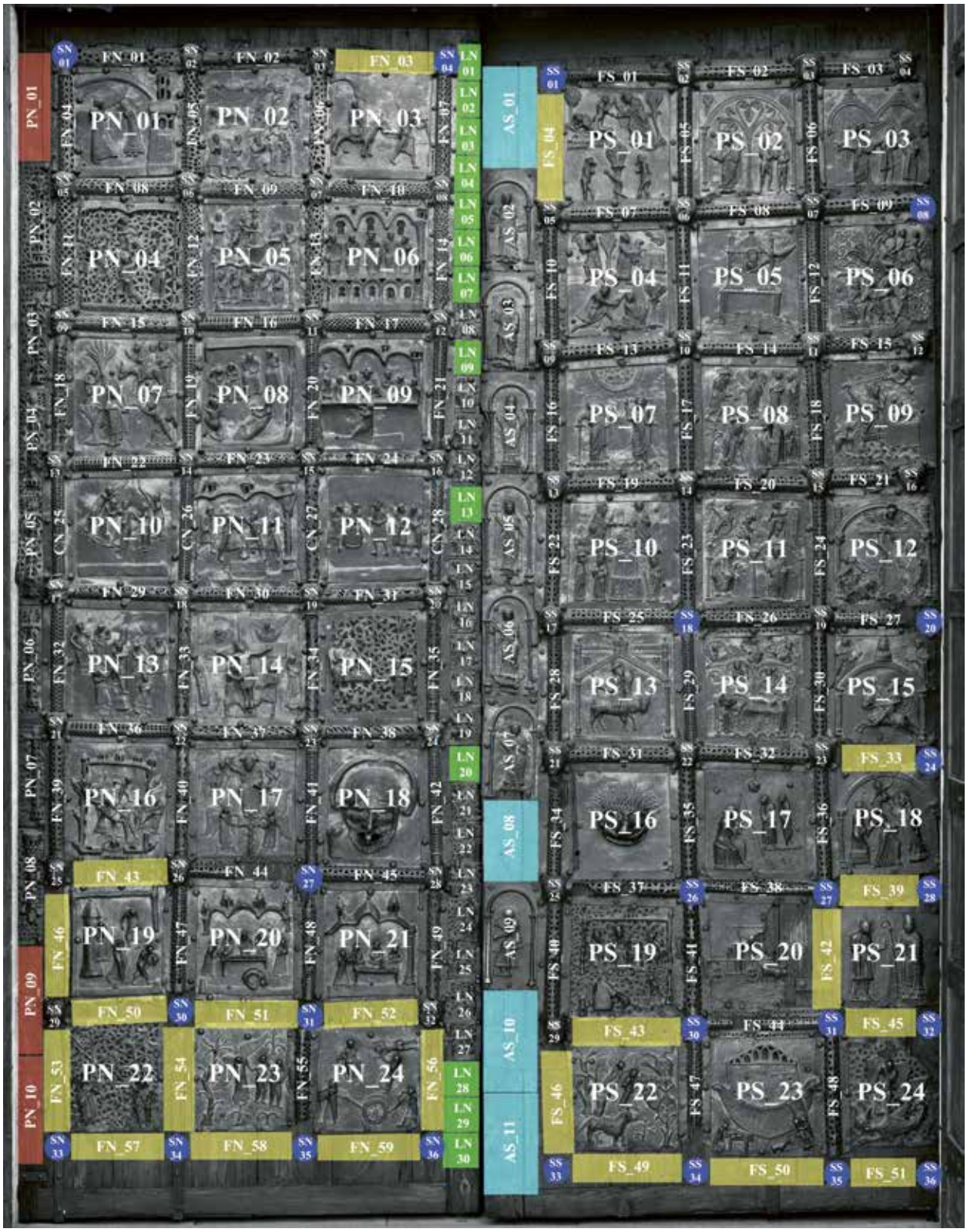

Fig. 2: Diagram with unique codes for each bronze panel. Alpha-numeric code: PN/PS_00, large main panels (north/south); FN/FS_00, frames (north/south); SN/SS_00, studs (north/south); PN_00, panels with palm (north); LS_00, little panels with seated figures and allegories; SS_00, panels with figures under arches (south). Colour code: missing pieces by type (adapted by Fabio Coden, © BamsPhoto Brescia).

Fig. 3: Frames FN_48 and FN_49 arranged after the second phase to repair some missing parts (© BamsPhoto Brescia).

The first phase of the door and its context

Regarding the first door phase, the starting point and inspiration for every subsequent transformation, it is worth remembering that there have been many chronological proposals for it.[7] Leaving aside the less acceptable ones that suggest a chronology between the 9th and 10th centuries, i.e. between Pacificus of Verona and Bishop Ratherius, the most accredited studies put its construction between the 11th century and the first half of the 12th.[8] In this regard, it is essential to take into consideration some fundamental events in the life of the monastery which may have some relationship to the commissioning of the metal doors. These include: the re-founding of the *coenobium* in the mid-11th century; the 1117 earthquake and the restoration campaigns in the 1120s; the enlargement of the church around 1138; and the raising of the roof between the end of the 12th and the beginning of the 13th century.[9]

After the foundation of the monastery in Carolingian times, the most extensive monumentalisation campaign is attested under Abbot Albericus (ca. 1043–1061).[10] In the first year of his ministry the bell tower was built (1043),[11] as the epigraph at the base of the plinth specifies: […] *Albericus Abb(as) an|no primo sue consecrationis hanc turrim cum fra|tribus sui*[*s*] *inchoavit*.[12] The rebuilding of the church (before 1061),[13] and consequently the adjacent cloister, was also due to Albericus, as is suggested by an epigraph on a monk's tomb, which mentions him without mentioning the year: *Ossa sepultura patr(um)* [...] *Alberice facis capies meliora patratis* […].[14] The marble panel affixed to the north wall of the oratory is in archaeological continuity with the surrounding wall, which in turn shows a more primitive building technique than that employed in the great period of Romanesque Veronese architecture marked by *opus listatum*, which reached maturity in the building of San Fermo Maggiore (1065).[15]

It is highly probable, as will be seen, that the first bronze door was commissioned as a result of the renovation of the monastery, as is suggested by historical circumstances and cultural references to the Lower Saxon circle of founders.[16] It was certainly made be-

7 Arslan 1943, 72–73.
8 Gazzola 1965, 8–9.
9 Zuliani 1990, 410–418; Frugoni 1991, 165, 168; Gaudioso 1999, 226.
10 Coden 2014, xxviii–xxix.
11 Coden 2015a, 133–143.
12 For a critical discussion of this inscription, see Musetti 2015a, 145–149.
13 Da Lisca 1941, 29–33, 78–79, 216–217.
14 Musetti 2018, 149–150, 181–183.
15 Trevisan 2004, 174–175.
16 Polak 1989, 37, 75.

fore 1138,[17] when the basilica was enlarged, when the new façade housed stories from the Old and New Testament executed by the sculptor Nicholaus, his workshop, and Guillelmus, the most promising of his collaborators.[18] Numerous elements confirm that the work in metal ('First Master' and his workshop) and the one in marble on the monastery façade (Nicholaus and his workshop) were created at different times:

- the repetition of some biblical scenes between the stone bas-reliefs on either side of the main passage and the bronze panels;
- the different degrees of maturity of the lexicon of the stonework, which is classical and of Po Valley origin, and the harsh and impetuous bronzes, similar to those found of the German style;
- the lack of linguistic exchange between the two contexts, despite the monumentality, prestige and significant scenic effects of both;
- the ordering of the 'Nicholaus' programme when the bronze wings were reassembled.

Apart from these features, it is also worth drawing attention to the fact that numerous metal elements from this first phase are now missing. Only twelve frames survive, a number insufficient to even fix the still existing first workshop panels. Even if we assume that the empty spaces (currently 22/30)[19] were occupied in the latest arrangement by the frames from this first phase, they would still not meet the required quantity.[20] Similar considerations can also be made for the other parts of the door. The surviving studs from the first phase are sufficient to anchor only twelve plates; the borders with palm trees, originally arranged along the outer edges, are only enough for two rows; and there are only eight plates with the Elders of the Apocalypse instead of a plausible twenty-four.

Regarding the large panels, greater caution is required when counting the pieces. Perhaps the non-biblical scenes occupied the first row at the bottom and therefore two elements could be missing. Nevertheless, it cannot be ruled out that there were originally only these scenes relegated to the extreme corners. In this case, however, the thematic discontinuity must be explained. Undoubtedly, the two demonic masks were originally located on the two wings, but more significant problems of interpretation arise in relation to the division between the two doors of the Old and New Testament scenes.

A first hypothesis envisages a balanced distribution of the scenes, as in Hildesheim, with at least nineteen biblical panels per wing, to which must be added the two masks and at least two allegorical plates. The only plausible organisation of this variant is three elements per row in each door wing, which would result in two wings slightly smaller than the current ones.[21] In this case we would be in front of one of the most majestic bronze portals in the West, in the 11th century. A second hypothesis considers the possibility of a continuous narrative with a few Old Testament episodes and many from the Gospels. In this way, each wing could have accommodated two scenes per row, making the doors of smaller dimensions, perhaps more calibrated to the width of Albericus's basilica.

From a purely engineering point of view, it is worth emphasising that the technique used for attaching the bronze elements is of undeniable quality (fig. 4).[22]

Each piece is designed to be clamped to the wooden support in a way that guarantees an orderly final result, which is only modified in the next phase.[23] The correct spacing between the panels is guaranteed by the distinct section of the frames and the joints with the anchoring studs. These joint covers are organised as follows. At first, there is an element on each side of the

17 Aliberti Gaudioso, Pietropoli 1990, 423.
18 Calzona 1985, vol. 2, 441–489.
19 This number relies on the fact that the eight frames on the right-hand edge of the south door were perhaps never fitted, as they would have prevented the door from closing: at this point, the panels are very close to the jamb. It should be noted, however, that there are holes in the wood here that may derive from the use of modified frames.
20 If there were fourteen mouldings per door, organised into two columns and seven rows, then 74 frames and 48 studs would be required.
21 Mellini 1992, 32–33, 38.
22 Coden, Franco 2017, 16, 58–59, 61, 120–121.
23 Adami 1984, 10.

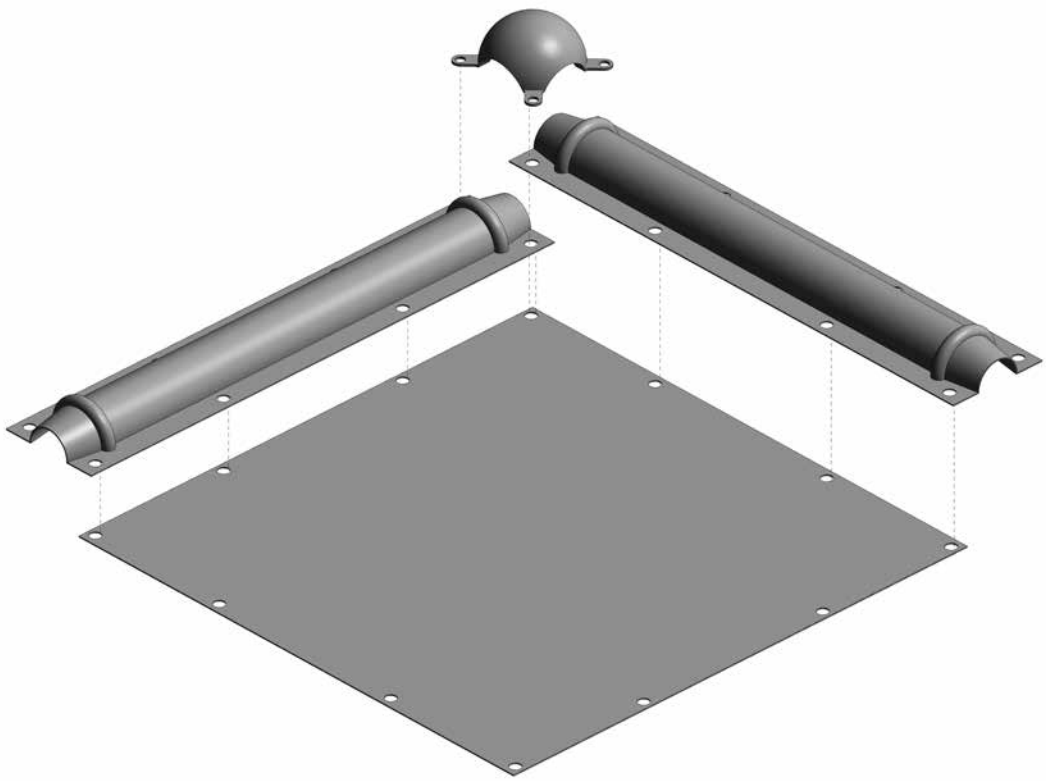

Fig. 4: Assembly diagram of the first portal (second half of the 11th century) (© Marco Fassetta, Aisatec Pordenone).

panel that is blocked by the flap at the sides. The central convex area is fretworked in many designs (geometric, vegetal, mixed), and at the ends an arched protruding tab is provided, which acts as a spacer. Beyond this element, the support, which remains rounded but unworked, opens up telescopically for a few centimetres. The studs thus act as a blocking system as the frames converge on all four sides. The demonic and anthropomorphic heads, which are much more rounded than the frames, house the terminal areas of the joint covers. The tongues are intended to remain visible, and so act as an anchoring and spacing boundary. The four fins arranged along the diagonals of each stud house the nail which fixes the entire structure (although it cannot be ruled out that anchors were provided in this phase along the edges of the frames and in the slabs, as we see today). Ultimately, it is an orderly system of self-adjusting joints, similar to the Klosterneuburg candelabra, although this is a manufact that shows a greater maturity, and mounting letters are also provided.[24]

It is no coincidence that this assembly system is very close to well-established practices in the German cultural sphere, such as on the doors of Augsburg Cathedral (for the small heads at the intersections of the frames), in St Maria im Kapitol in Cologne (with precise parallels for the iconography of the cornices, even though the doors in this case are made of wood), in Novgorod Cathedral (with the rounded shape of the cornices, which are highly decorated but not pierced, and for the system of bayonet joints), and in the late Nativity Cathedral in Suzdal. Some slight similarities can even be identified in the doors of Benevento Cathedral.[25]

Some stylistic features and working techniques of the Veronese panels also point to contexts north of the Alps. This will not be examined in depth here, but it is

24 Bloch 1961, 130–134; Bloch 1962, 163–173.

25 Winzinger 1958, 7; Mellini 1992, 22–23; Salomi 1990; Mende 1994.

worth mentioning, albeit briefly, some parallels which have already been widely discussed and are significant, namely: Hildesheim, Cologne, Klosterneuburg, and Novgorod, as the final phase in a very characteristic stylistic *topos*.[26] Evidence for similar styles and techniques can also be found in smaller objects, such as the Hamburg cassette and in various thuribles and other objects, which are not always easy to date.[27]

The good relations between Verona and the lands of the Holy Roman Empire in the 11th century can explain this penetration of German aesthetics and the use of craftsmen from the north, before the installation of the reformer Bernard on the episcopal seat in the first half of the 12th century (1117/19–1135), who maintained closer ties to the Italian peninsular.[28] This was the time when transalpine bishops firmly controlled the diocese, and various emperors visited and stayed in the town and its monastery, such as Otto III (996), Henry II (1014, 1021), Conrad II (1027) and Henry IV (1082, 1084).[29] Abbot Albericus himself, the renovator of the monastery, was able to obtain diplomas from Henry III confirming land holdings that were very important for the life of the monastery (1047, 1055), thanks also to intercession of the bishop.[30] In the 11th century the relationship between the Verona episcopate and the monastery was very close, and even as early as 1012, Bishop Ilprandus had his chair at San Zeno, as is noted at the bottom of three diplomas from Otto III.[31]

So there are numerous reasons that lead us to believe that the doors were cast by Lower Saxon craftsmen, quite possibly hailing from the region of Hildesheim, after the middle of the 11th century,[32] and certainly, in any case, before the events that dramatically affected the structures of the Zenonian complex at the beginning of the following century.[33] The patron of this extraordinary first bronze door at San Zeno should therefore be identified as Albericus, who completely renovated the monastery with significant expenditure of energy, or, alternatively, with one of his immediate successors, Turrisendo or Varnerio/Varemberio, of whom little is known, if one assumes that this substantial campaign of work took a long time.[34]

From earthquake to post-Nicholaus reassembly

In January 1117, a seismic event occurred in the Po Valley, which is attested by numerous sources and has been evaluated by scholars.[35] It seems to have caused some damage to the structures of the Zenonian complex, and as a result, work on the walls became necessary. This was completed in a few years, but its extent remains difficult to fully comprehend.[36] Undoubtedly, the bell tower was restored in 1120, as an epigraph inscribed on the south side of the church, near the façade, reminds us: […] *restaura|tio(n)e vero ip(s)ius ca(m) panil(is)* […].[37] In addition, the cloister was repaired in 1123 at the behest of the priest Gaudio, as we learn from two testimonies beside the entrance to the chapel of St Benedict: […] *restaurat pulchr(um) claustru(m)* […].[38] It cannot be excluded that the enlargement of the church, as recorded in an epigraph of 1178 on the southern wall, may also have some relationship to this tragic event, although the text is not as explicit as in the case of the bell tower: […] *renovatione aut(em) et eccl(esia)e augm(en)tatione* […].[39]

26 Gosebruch 1975, 97, 118, 124, 126; Bučarov 1990, 221–23, 227; Mende 1994, 62–67.
27 Boeckler 1931, 40; Mende 1981, *passim*, suggests around 1138 for the Verona examples. See also Mende 2013.
28 Miller 1998, 107–108, 115–116, 184–186, 217–223, 240, 241.
29 Valenzano 1993, 9–10.
30 Varanini 2015, 30–31.
31 Varanini 2015, 29.
32 Bode 1902, 10; Simeoni 1909, 59; Marignan 1911, 19–41; Arslan 1943, 72, 74–78; Fiocco 1951, 20–22; Gazzola 1965, 12–13; Polak 1989, 31–32; Zuliani 1990, 418–419.
33 Weinryb 2016, 112–113.
34 For a chronology of San Zeno abbots, see Biancolini 1749, vol. I, 50–52.
35 Guidoboni, Comastri 2005, 84–126.
36 Valenzano 1993, 20–24, 90, 103, 105.
37 Valenzano 1993, 214–219.
38 Musetti 2018, 186–193.
39 Valenzano 1993, 214–219.

Signs of an event of a traumatic nature are traceable on the surviving part of Albericus's basilica. Today they are visible, only partially, inside, between the access to the crypt and the eastern end of the church, and easily outside, in the cloister corridor adjoining the north wall of the church.[40] One can assess them, especially in the sector next to the side door near the sepulchral monument of Margherita Nalda and Nicola Schioppo (1566)[41] and by the immediately following ones of Donato Fiorio (1503)[42] and Farinata degli Uberti (1348).[43] In this section of the 11th-century building one can clearly see the points of contact of various types of masonry, where their coursing indicates precise events on the site. Although this is not the place to go into the details of specific archaeological analyses of the elevations, it is worthwhile to briefly dwell on this portion of the basilica, which may suggest there was a collapse of the façade or perhaps part of it, before the 12th-century extension was built.

This proto-Romanesque wall is composed of poorly squared blocks laid in a pseudo-isodomic pattern; flat pilasters regularly distributed up to the end of the corridor can also be seen. These marked the succession of bays within the building. The front portion, largely hidden by the Margherita and Nicola monument, shows large well-worked blocks at the base, which credibly formed the sector near the front edge of Albericus's building. In this regard, a recent georadar survey conducted in the building[44] has revealed the presence of a wall transversal to the aisles just beyond the free-standing column in front of the north side entrance, which was demolished following the 'Nicholaus phase'.[45] The position of this septum corresponds in elevation to the change in masonry technique in the perimeter of the minor aisle. At the front it is in large square ashlars, while from the left parapet of the door it is in *opus listatum* with a slightly diagonal course towards the west. In other words, these 12th-century

Fig. 5: North wall of San Zeno. Section of the masonry phases (© photo and adaptation Fabio Coden).

40 Coden 2012, 157, 163–164.
41 Musetti 2018, 169–170.
42 Musetti 2018, 172–173.
43 Musetti 2018, 173–175.
44 The survey was conducted by Marco Zandonà and Loris Turella from Veneta Engineering in Verona on 3 July 2013, under the guidance of Fabio Coden and Architect Flavio Pachera. The results are collected in report 89072 (this document resides in the personal archive of Fabio Coden).
45 This is the fifth column from the counter façade.

walls, which are very different from each other and rest one on top of the other, mark the precise point at which the development phases of the Romanesque basilica met. They were conditioned by what pre-existed, that is the ancient façade of the church commissioned by Albericus. Therefore, approximately in the middle of the present aisle there should be the opening that housed the original bronze door. It was later reassembled in the present façade, several metres further west.[46]

Let us now return to the signs of the probable trauma suffered by the 11th-century basilica, which

46 Frugoni 1991, 169.

are visible from the south ambulatory of the cloister (fig. 5).

The Albercian wall shows a very irregular course in the portion close to the ancient façade. The fracture running diagonally between the first buttress (which was probably originally the second) and the following one[47] cannot be seen beyond this due to the presence of a 1566 tomb. The wall above does not appear to have been carefully dismantled, as the entire top section has been, to make way for the new construction. However, it seems to have been quickly rearranged with the intention of exploiting as much spolia as possible that was still in good condition.[48] Just above the 1503 tomb it is possible to identify the point of contact between the phases of the 12th-century construction, which is marked by accurate masonry with *opus listatum* work, which adapts to the profile of the older wall to recompose the unity of the perimeter. Towards the front, it is of several courses and literally rests on the older one following the diagonal course. Towards the east, it is of a single row of ashlars, thin and limited to the top of the perimeter. In short, these seem to be signs of the collapse of the mid-11th century wall and of two distinct phases in the 1138 building: one coming from the east, which raised the entire perimeter and created the new level of the nave; and one coming from the west, which replaced the front sector of Albericus's basilica and determined the outline of the present basilica.[49]

Let us now turn to the bronze portal. It is credible, although not provable, that at the conclusion of the extension of the building (around 1138) the metal elements of the door were reassembled in the new central doorway (fig. 6).

However, it was necessary to wait until the front and the three aisles were completed and the building was covered with wooden trusses. In this regard, various scenarios can be envisaged.

The bronze door may have remained in place in the old façade until the completion of the new construction without any thought of reusing it in the new frontage. On the other hand, it cannot be excluded that the metal doors suffered some damage in the 1117 earthquake,[50] and were temporarily stored in some separate place in the monastery, only to be reassembled later. It can also not be ruled out that the recovery of the pieces only took place following the new campaign to transform the main façade (with the creation of the rose window and the widening of the doorway), with which the commissioning of the portal by the last two *ateliers* must be associated.

In fact, assuming a temporal pause between the phases of the bronze portals can help us to understand why the elements prepared by the First Master did not influence Nicholaus's iconographic choices regarding the decorative layout around the new door about 1138.[51] Only later in time, therefore, did these repetitions occur, although the citations describing the Zenonian miracles inserted in the band below the lunette remain to be explained. Finally, it cannot be excluded that it was the preciousness of the metal material and the recognised value of the representations that triggered the restoration of what remained of the ancient portal.

The monumentalisation of the façade and the new portal

It was only between the end of the 12th century and the beginning of the 13th that it became necessary to redesign the bronze doors following a new and substantial campaign of work on the church.[52] The premise was the new concept of light in the interior, which was increasingly characterising the religious architecture of the time. In the case of Verona, it was decided to copiously

47 A total of four buttresses survive, close to their original height.

48 This choice ensured the preservation of the cloister area, which existed to the north of the basilica.

49 Valenzano 1993, 25–37.

50 Adami 1984, 2, 12, 115; Mellini 1992, 28–29, 44; Weinryb 2016, 110–115; Mödlinger et al. 2024.

51 Zuliani 1990, 409–410.

52 Neumann 1979, 163–164, 179; Musetti 2013, 31–39; Coden 2015b, 359–378; Musetti 2015b, 391–394.

Fig. 6: Frame FN_09 with signs of repair on the left head, probably related to the 12th–13th century reassembly (© BamsPhoto Brescia).

illuminate the central nave by working on the façade and on the clerestory.[53] The opening of the great rose window by Brioloto de Balneo,[54] who dismantled and reassembled the top section of the façade in order to insert the great "Wheel of Fortune", must therefore be associated with the enlargement of the main opening below and with the redesigning of the doors.[55] Indeed, it is possible that the modification of both elements could be ascribed to Brioloto de Balneo. Only after the completion of these interventions was the tympanum adorned with the Last Judgement, the figures of which are traced with black outlines on the white stone to make the composition clear from every point in the large square in front of the monastery.[56]

The previous, slightly narrower doorway, perhaps with some timid hint of splaying, was dismantled and new jambs and the mighty monolithic architrave were fitted, which were only later painted.[57] The margins of the Nicholaus panels were thus reworked, and two bands with inhabited trefoil were inserted and surmounted by a telamon.[58] The new flat profile of the trilithic system was now able to accommodate the two wings flush with the wall of the façade, so that the redeeming message in the panels would be clearly visible from afar.

Therefore, the wings were redesigned at this time adopting the 11th-century system of organising the elements without reservation.[59] Starting with what remained of the previous wings, the *atelier* of the Second Master and the Master of St Zeno devised a new distribution of panels, with the stories from the Old Testament on the right and the New Testament on the left.[60] For the second time, the correct narrative order was not respected, so as not to create a discrepancy between the stone reliefs and the metal panels. It was decided to start with the display system present in the sculptures anchored in the masonry. The choice of the sculptors in Nicholaus's workshop was to give greater prominence to the gospel events, putting them at the beginning of the reading path, thus influencing the foundrymen of the late 12th and 13th centuries as well.[61] Rather than dismantling and refitting the complex system of marble bas-reliefs on the sides of the passage, they preferred to pander to the patrons of Nicholaus and Guillelmus.

However, several inconsistencies in the new bronze doors remain to be clarified, which are jarring given the conscious and timely mutation of the assembly system.[62] Many of these currently remain without a convincing explanation. Concerning the large panels,

53 Musetti 2015b, 391, 398–399.
54 Musetti 2013, 31–50.
55 Coden 2015b, 372–375; Musetti 2016, 231–238.
56 Gerola 1908, 470–473.
57 Calzona 1985, 446, 450, 453–454, 460–461, 464; Mende 1994, 57.
58 Simeoni 1909, 57; Musetti 2016, 232–233.
59 Bökler 1931, 48, 49; Arslan 1943, 73; Winzinger 1958, 8; Gazzola 1965, 5; Neumann 1979, 184–185; Mellini 1992, 41.
60 Coden, Franco 2017, 12.
61 Nothing can be said, however, about the order adopted in the previous phase in the 11th century.
62 Mellini 1992, 21.

some repetition of subjects is noticeable, which could have been avoided in a well-calibrated design. In addition to the duplication of episodes between the new casts and the Nicholaus marble panels, there is a further level of replication on the doors between the new panels and those of the first atelier: the Expulsion from Paradise (PN_13, PS_03); the Killing of Cain (PS_59, PS_04); the Sacrifice of Isaac (PS_22); and Noah's Ark (PS_23, PS_09) (see fig. 2).[63] It cannot be possible that the remnants of the previous portal were ignored in the final re-assembly, as its complex engineering was clearly borrowed. Certainly, the oldest bronzes were at the disposal of the new masters. It also seems implausible that the inability to comprehend some scenes could have led to their duplication, though it is undeniable that this applied, for instance, to the Elders of the Apocalypse, who were interpreted as regal figures seated on thrones.

Another issue concerns the narrative path that unfolds between the two door wings.[64] At a cursory glance it is clear that the panels were not always arranged in such a way so as to respect the correct succession of biblical and evangelical events.[65] This anomaly is even more pronounced if one considers that all the available spaces in the two wings are still occupied by panels, since only frames, studs and smaller plates were stolen. In other words, we are in the presence of all the scenes available to the masters who set up the last version of the portal.

A similar situation can also be seen in the part concerning the Zenonian miracles. In addition to repeating what had already been laid out just below the Nicholaus lunette during the first half of the 12th century, it is crucial to note that the panels were arranged in a manner that was not consequential with the hagiographic narrative. Of the many events available only two are shown, one of which unfolds in three separate metal panels.[66] Evidently the narrative that included the emperor continued to play a central political role even at the end of the 12th century.

Finally, two panels from the first phase, with allegorical and devotional content, and which were not easy to fit within the already complicated palimpsest, were placed in the lower outer corners, with no connection to what preceded and followed them.

A few brief remarks can also be made about construction technique. In the second version of the door, the design conceived in the previous century was respected because there was a clear intention to recover what remained of the 11th-century bronzes.[67] Each new metal element had approximately the same dimensions as the old ones, with any missing parts, such as frames, studs and palms, created and new subjects introduced.[68] Thus, the Elders of the Apocalypse became kings seated on thrones and allegories, and figures of saints and a sculptor under an archway were also included.[69] It is therefore evident that a partial iconographic rearrangement took place, which may also have had an effect on the arrangement of the works on the door wings.

From a strictly technical point of view, the respect given to the original system was not carried out with perfect precision, perhaps because it was not completely understood. The profile of the studs was standardised, although all the features for effective anchoring were retained. Regarding the frames, there was clearly a misunderstanding or misinterpretation of the purpose of the spacer tab emerging at the ends; it is sometimes missing in one of the heads or even in both, as one gets the impression that it may have been viewed as a decorative element. The domed top simply ends without openwork decoration and without providing the telescopic joint interlocking under the stud.

Considering the significant economic effort required for this new phase, it seems extremely unlikely

63 Biadego 1909, 38; Bökler 1931, 7; Aliberti Gaudioso, Pietropoli 1990, 428; Zuliani 1990, 408–409; Valenzano 2008, 129–130; Franco 2017, 34.

64 Von Sacken 1865, 137.

65 Coden, Franco 2017, 12, 22, 24, 42.

66 Coden, Franco 2017, 43–44.

67 Coden, Franco 2017, 16.

68 Frugoni 1991, 171; Mödlinger et al. 2024.

69 Coden, Franco 2017, 32, 36, 39, 40, 44, 126–127, 158–159.

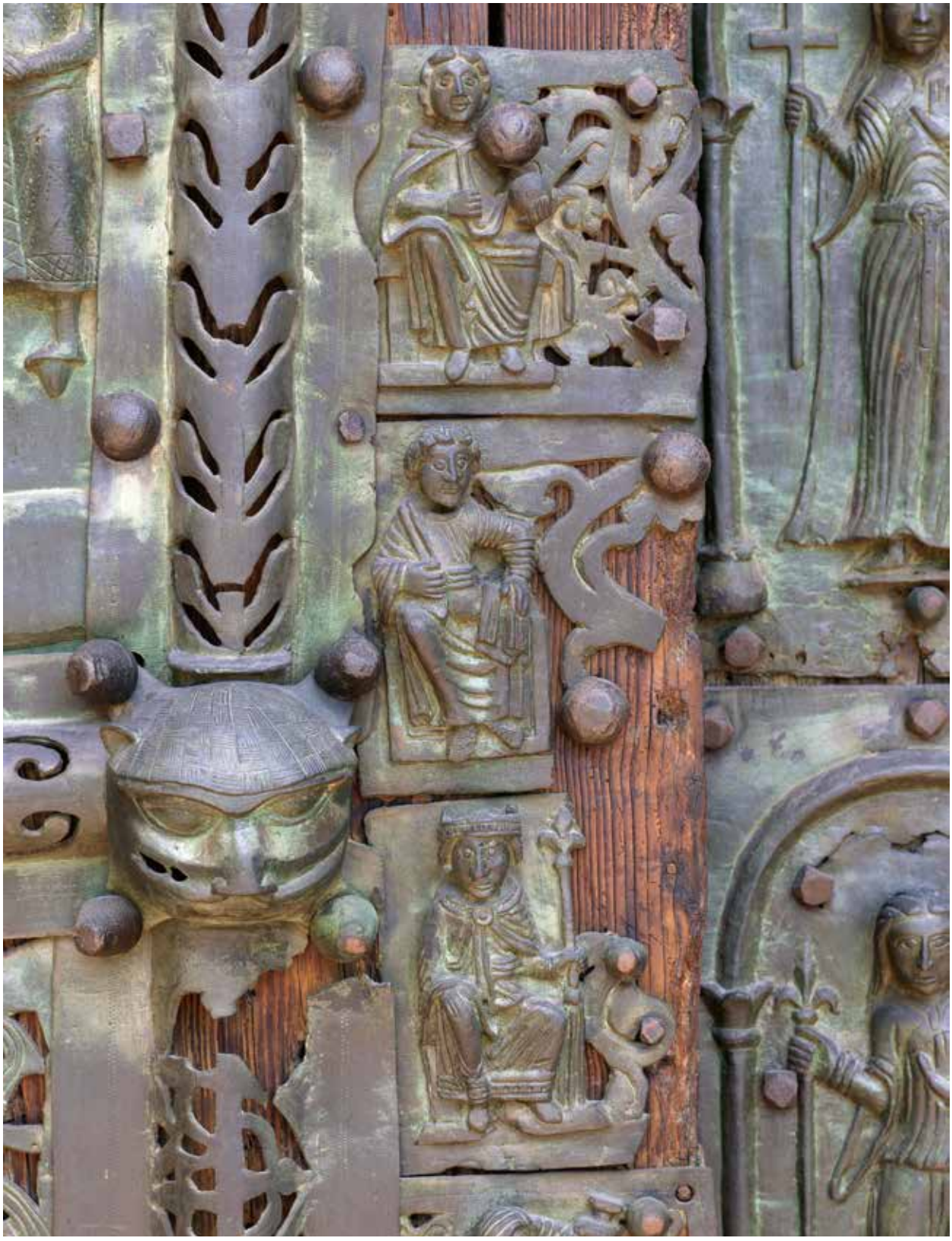

Fig. 7: The system of nails anchoring the bronzes in LN_14, LN_15, LN_16 (© BamsPhoto Brescia).

that the workshop of the Second Master and the Master of St Zeno lacked someone capable of correctly arranging the bronzes, despite the repetition of subjects and the simplification of the techniques. Moreover, it is hard to imagine that in such a sophisticated context, underlined by the inclusion of unusual biblical episodes,[70] there was no figure capable of guiding the proper arrangement of these episodes. Indeed, this was also a period in which some undeniably valuable works were conceived, such as the rose window, with its complex iconography of fortune and the striking double epigraph,[71] the Old Testament scenes under the small arches in the south wall, just beyond the corner of the façade,[72] the immense Last Judgement in the tympanum[73] and the lintels of the arches leading to the crypt and the paintings above.[74]

This raises the suspicion that a particularly serious event led to the complete dismantling of the bronze doors. Perhaps it was simply a desire to protect one of the monastery's most exposed and fragile masterpieces from ruin or theft. Such an event likely occurred after the 13th century, possibly after the period of the great abbots Ottonello de' Pasti (1364–1387), Jacopo de' Pasti (1387–1391), Pietro Paolo Cappelli (1391–1399), and Pietro Emilei (1399–1421), when the building was completed with the new choir, the grandiose wooden ceiling and extensive pictorial decorations.[75] Only after a return to normality the doors would be put back, but this time in haste and without the guidance of an authoritative figure. The period of great cultural stature of the 14th century was long gone, and these works were now mainly valued for their intrinsic worth rather than their artistic merit.[76] Only precise research, which we do not have the space for here, can examine the historical context that led to this final confusing rearrangement of the door. For now, it can be cautiously noted that in November 1439, the town found itself involved in military actions that saw Venice and Milan pitted against each other, and in 1509, during the Cambrai War, the town found itself at the centre of very bitter disputes.[77]

The large number of pins and their varied sizes, seem to suggest the work of inexperienced craftsmen, more focused on securing and stabilising the metal plates than adhering to the rigorous system of previous phases (fig. 7).[78]

Many anomalies are evident.[79] Nails were hammered along the edges of the plates, perhaps following earlier holes, but also inside them and in places that did not respect the figures. The frames were sometimes set touching the panels, while others overlapped them in an irregular manner, concealing specific details. It is possible that, on this occasion, the edges of some of the frames were cut out so as not to hide significant parts of the figures. The studs were sometimes attached without regard for the spacing system, and some frames were shortened and rearranged, and are generally misaligned. Most notably, the panels of the two wings are not aligned either, with those to the south being lower than those to the north (fig. 8).

It is plausible, therefore, that this work was carried out with the wings standing upright, still attached to the hinges, preventing the establishment of an orderly grid. Notably, no other European bronze door made of paired elements shows a similarly confused and disorderly arrangement.

Certainly, the currently missing bronze elements were only removed after this event.[80] Among the most recent losses it is worth mentioning the early 20th-century removal of two panels to Berlin, which were subsequently lost following the Second World War.[81] By comparing the measurements of these elements with

70 Franco 2016.
71 Musetti 2015a, 394–398.
72 Franco, Coden 2014, xxxiv–xxxv, 124.
73 Gerola 1908, 470–473.
74 Coden 2019, 417–469.
75 Franco, Coden 2014, xxxix–xlii.
76 Mellini 1992, 83.
77 Bertolini 1957–1958, 273–301; Varanini 2021, 25–46.
78 Caneva, Marabelli 1990, 438; Mellini 1992, 21, 28; Aliberti Gaudioso, Pietropoli 1990, 425, tav. CCCXCVI; Frugoni 1991, 168–169.
79 Da Lisca 1941, 204.
80 The thefts or acquisitions mostly occurred in the first half of the 19th century: Orti Manara 1839, tav. V; von Sacken 1865, 135; Simeoni 1909, 57; Trecca 1938, 49.
81 Bökler 1931, 6, 40, 69, Taf. III/98; Gazzola 1965, 51–52; Mellini 1992, 23, 26.

Fig. 8: FN_09 tile from the First atelier with the CN_20 frame on the left, extensively modified in the most recent door mounting (© BamsPhoto Brescia).

the spaces left empty[82] (especially in the lower, most easily accessible parts), it appears that the following are missing: 22/30 frames;[83] three small plates with a palm[84] on the left edge of the north door; four figures under arches on the left edge of the south door;[85] thirteen square plates with kings and allegories on the right edge of the north door;[86] and 24 studs. Reviewing the analysis proposed here, it is significant to note that even if we imagine all these elements existing on the door in the first phase, it would still not be possible to reconstruct the unity of the portal for Albericus's basilica.

82 The logic that guided those who last worked on the bronzes is clear, and might also explain the number of missing pieces. In the north door wing, they started with the palm plaques on the outer side; the 24 panels were fixed and then the small remaining space was occupied by the small plaques with the Elders of the Apocalypse, kings and allegories. On the south door wing, on the other hand, the larger size of the panels with the figures under the arches, made it impossible, after fixing the 24 panel scenes, to insert further elements.

83 As was argued above, it cannot be ruled out that the right edge of the south door was frameless.

84 The one currently below was mounted upside down simply to align the palm tree to the ones placed above.

85 The area in the middle is small, so it must be assumed that the sculpture has been considerably modified. See also footnote 86.

86 Orti Manara 1839, Table V shows two kings above the figure of the sculptor, therefore on the other wing. It is plausible, however, that these elements originally in the lower part to the north were mounted in this anomalous position at a later time to prevent them from being stolen or damaged.

Zusammenfassung

Die Bronzetür von San Zeno ist ein ausgesprochen komplexes Werk. Die wichtigsten Momente in der Geschichte der Tür können einerseits anhand unterschiedlicher Materialien und Technologien, andererseits aufgrund stilistischer Zuordnungen bis zu einem gewissen Grad rekonstruiert und zeitlich zugeordnet werden. Der ersten Phase werden die von Abt Alberic in der Mitte des 11. Jahrhunderts geförderten Arbeiten zugeordnet. Dem folgten weitere Überarbeitungen, möglicherweise als Folge des Erdbebens von 1117. Dies führte zu einer neuen Montage bzw. Anordnung der einzelnen Elemente der Tür an der Fassade aus nikolischer Zeit (ca. 1138). Die wesentlichste Veränderung muss jedoch dem 12. und 13. Jahrhundert mit der vollständigen Neugestaltung der Türflügel zugeschrieben werden. Zudem ist eine neuerliche Umordnung bzw. Neumontage der einzelnen metallenen Türelemente in nachmittelalterlicher Zeit wahrscheinlich, die zur Fehlinterpretation des ursprünglichen ikonografischen Programms führte.

Riassunto

La porta di bronzo di San Zeno è un palinsesto assai complicato da interpretare. Anche se non è facile comprendere i principali momenti di elaborazione che portarono alla versione attuale, alcune significative campagne di lavori al monastero suggeriscono cronologie precise. Oltre a ciò, la tecnologia adottata nei due principali cantieri delle ante è un indicatore prezioso. La prima fase sembra conseguenza delle opere promosse dall'abate Alberico a metà dell'XI secolo; seguirono altri interventi forse in conseguenza del terremoto del 1117, che portarono al rimontaggio dei bronzi nella facciata di epoca nicoliana (circa 1138); la modifica più consistente va però ascritta fra il XII e XIII secolo, con la integrale riprogettazione dei battenti; infine, è credibile un rimontaggio in epoca post-medievale, che portò al fraintendimento del percorso iconografico originario e a modifiche degli elementi metallici.

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The Bronze Doors of Gniezno Cathedral Church as a Text of Culture

A History of the Research and Some New Insights

Tomasz Węcławowicz

The bronze doors of Gniezno Cathedral Church in Poland are exceptional; they stand out from many others of the time. The eighteen bronze panels on them illustrate the most important episodes from the life of St Adalbert. On the left door, events unfold from his secular youth, to his taking up of the bishopric in Prague, and onto monastic seclusion in Rome. On the right door, his calling to embark on the journey to martyrdom amongst the Baltic pagans is shown, and end with his burial in Gniezno cathedral (fig. 1).

Because of their unique iconography, by the mid-19th century the doors had already attracted the attention of several historians and art enthusiasts.[1] However, in contrast to their high artistic value, the standard of literature on the Gniezno Doors in Polish, Czech and German literature is rather modest. The studies undertaken so far have not provided satisfactory answers to basic questions, and to this day there is no certainty as to their dating, the identity of their donor, or where they were made. The doors have been dated either to the mid-12th century or the late 1170s. This dating is not based on stylistic analysis because there are few 12th-century bronze doors surviving in Europe and it is difficult to undertake effective comparative analysis. Because it was difficult to determine the artistic provenance of the doors, so hagiographic precedents were also sought to interpret the content of the figural scenes.[2]

Subsequent claims as to their dating were rooted in historical speculation relating to potential patrons: either an Gniezno archbishop (Jacob, or Petrus, or perhaps Bogumił), or some Polish duke (Boleslaus the Wrymouth, or his son Mieszko the Old). Some fragments of barely visible inscriptions have also been interpreted as the names of artists, foundry masters, or even unknown patrons.[3] These albeit cautious and preliminary hypotheses have now become certainties after multiple repetitions, and, even though erroneous, have been frequently replicated in popular or even scholarly literature.[4]

The most interesting studies on the Gniezno Doors have come from cultural historians due to the motivation and uniqueness of the door's iconography, which stems from the fact that their aim was to portray the

1 E.g. Nesbitt 1852; Lelewel 1857.

2 The standard works on this are: Furmankiewiczówna 1921; Goldschmidt 1932; Morelowski 1935; Dobrzeniecki 1953; Morelowski 1956; Stiennon 1961; Daniec 1966; and later Skubiszewski 1981; Monhaupt 1993; Cerny 1993; Labuda 1997; Grzesik 1997; Daniec 1999; Labuda 1999; Starnawska 2002; Jarzewicz 2009; Sommer, Sláma 2009. Most of these scholars draw attention to the many similar but not quite identical ornamental motifs from Mosan art, e.g. the jambs of Samson's portal in Nivelles, and usually omit Italy. Suggestions of Italian patterns were given by Kalinowski 1959; Węcławowicz 1999; Węcławowicz 2020.

3 Ibidem. Recently Skwierczyński 2014 has focused again on the potential donors for the doors: either archbishops or Dukes. Łobodzińska 2022, 152 reports all the divergent hypotheses about the founders and the dating of the Gniezno Doors.

4 See e.g. Sommer, Sláma 2009, 246 where they stated, without quoting the source, that the Gniezno Doors were made by a master Petrus in Leodium. Polish researchers who discovered the name 'Petrus' on doors (e.g. Wiliński 1956; Budkowa et al. 1959) had believed that this hypothetical 'Petrus' could have been the donor for the door in Gniezno. He was thought to be a nobleman from Greater Poland, or one of the archbishops of Gniezno.

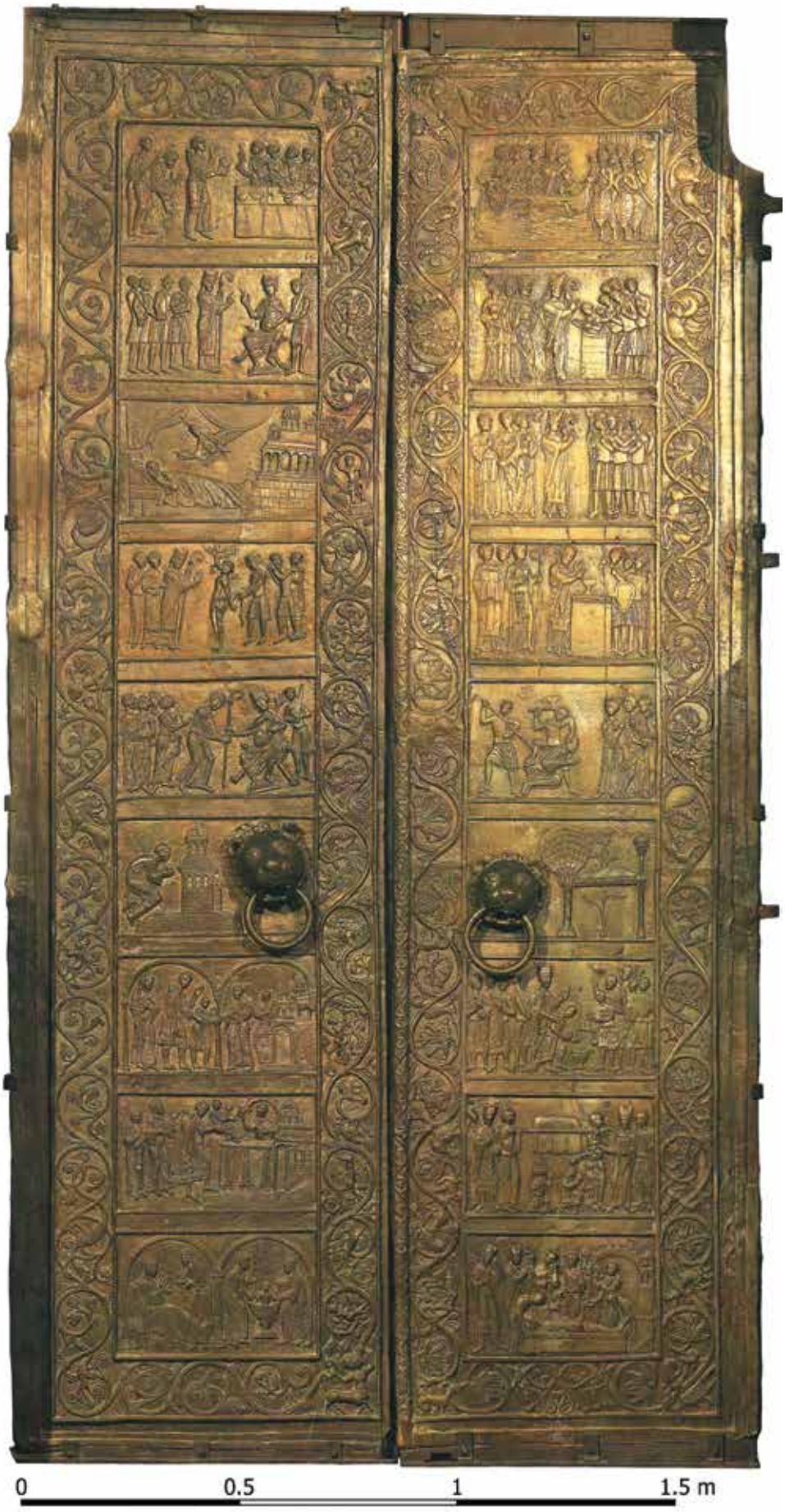

Fig. 1: Gniezno, the Cathedral church, the bronze doors (© Martin Fera/GAPAMET).

life of St Adalbert, a medieval patron of the Polish kingdom, in a continuous narrative. Yet, it was believed, wrongly, that no other doors were known with a similar, multi-scene, sequential narrative, other than the Hildesheim Doors.[5] Also, the important and exceptional framing of the narrative scenes of the Gniezno Doors, using a wide bordered edge (*bordière*) where 56 human and animal figures appear intertwined with vine scroll, was also considered unique at the time.[6] However, in Italy, the framing of scenes with floral ornamentation was common on church doors since as early as the Early Christian era.[7]

Studies produced so far have emphasised the relationship between the depictions on the Gniezno Doors and hagiographical texts on St Adalbert's life. The life-story of the holy patron of the Polish kingdom has been seen as an expression of national collective awareness, both in the composition of the scenes and their reception.[8] Against this background of literature from the fields of cultural and art history, a breakthrough came with the text published by Lech Kalinowski almost 70 years ago, and since then cited on multiple occasions as a classic.[9] Kalinowski analysed the Gniezno Doors as a complex cultural text which should be carefully read and interpreted. He did not enter into a polemic about dating based on uncertain premises, but instead broadened the comparative horizons, analysing multiple iconographic motifs and pointing to their origin in various 12th-century artistic centres. In a certain sense he introduced us into the world of the imagination of unknown medieval artists who illustrated the story of St Adalbert's life, in a composition complemented by glosses and comments concealed in the decorative border.

Kalinowski also suggested that the central idea of the hagiographical programme of the Gniezno Doors was the topos of the *imitatio Christi,* something a few scholars also later noted. He believed that for medieval spectators the scenes on the doors recalled the life of the Saviour to make the story easier to understand.[10] Indeed, by analysing the specific details of the iconography, it is clear that St Adalbert's birth is depicted in the same way as the birth of baby Jesus commonly was; equally, the presentation of the new-born Adalbert in the church of Libice relates to the Presentation of Jesus in the Temple. Also, Adalbert, as a bishop, admonishes the Bohemian King Boleslaus in the same way that Jesus reprimanded the Pharisees; Adalbert then subsequently teaches unbelievers and finally dies a martyr's death. The particulars of his martyrdom are based on hagiographical texts, but St Adalbert is accompanied on the Gniezno Door panels by three figures, while there are only two in the texts of his life: Gaudentius, the saint's brother, and Bogusza, a Benedictine monk. Even this slight change in detail shows a coherent *Christomorphism* as Jesus was always accompanied by three apostles: Peter, James, and John. In addition, Adalbert's companions acquired the Apostles' physiognomic characteristics, seen frequently in New Testament iconography, where, between bearded Peter and James, only the youngest, John, was distinguished by his shaven face.[11] It should also be noted that Adalbert in his martyrdom scene is naked, and his hips are bound with *perisonium* like Christ on the Cross. For

5 For the iconography of the doors from Hildesheim, see Butzkamm 2004. Formerly, Polish historians had regarded the Hildesheim Doors as a distant in time, but unique, narrative model for the Gniezno Doors. However, the custom of decorating church doors with figural scenes with didactic and pastoral content can be seen as far back as the late antique era: e.g. the 4th century doors now in the San Ambrogio Museum in Milan, and the 5th century doors of Santa Sabina in Rome. For new evidence for the dating of these wooden doors, see Poldi et al. 2009, 569–580.) It is also worth noting that ca. 990–992, St Adalbert, with his brother Gaudentius, lived in the neighbouring monastery on the Aventine Hill: See Rokosz 1999.

6 Kępiński 1959.

7 In total, four wooden doors of this date survive with such decoration, including San Ambrogio, Milan, and Santa Sabina, Rome (see n. 5 above), as well as the doors in Carsoli and Alba Fucens in Abruzzo (the latter now in the museum in Celano, Italy). See also Curzi 2021.

8 This topic was already raised in earlier Polish literature. See e.g.: Gieysztor 1956; Karwasińska 1956; Gieysztor 1967. Except Monhaupt 1993 of the more recent works, Figge 2000 seems to be a precursor one, as the author compares the hagiographic and iconographic topoi of venerated saint bishops, including martyr bishop St Adalbert. See: Figge 2000, 127–143, 151–161.

9 Kalinowski 1959, 7–160; See also Kalinowski 1989, 227–387.

10 Kalinowski 1959, 115.

11 See Węcławowicz 1999, 276–277.

each person engaged in the creation and reception of the doors – the artist, the theologian responsible for the iconographic programme, and for the lay faithful coming to the cathedral – it had a different meaning.

The *Christomorphism*, that is the imitation of Christ is, however, only one of the layers of meaning which need to be considered. In line with the medieval practice of a four-way *exegesis* of the Scripture, as described in a well-known Latin hexameter,[12] St Adalbert's legend needs to be read by peeling away these successive layers: the historical, allegorical, tropological, and anagogical. In the historical sense, his life can be interpreted literally from birth to death, while the allegorical reading presents it as a parallel to Christ's life. The tropological sense reveals the moral rules and instructions (*tropos*) for one's life; the many years of his life depicted on the left door are contrasted with only a few days devoted to the saint's pagan mission and glorious martyrdom. The last, the anagogical meaning, shows the hope for eternal life; following his martyrdom Adalbert's body becomes a revered relic.[13] It is therefore clear that, for any theologian, the paths of Adalbert's life shown on the doors represented a form of *glossa* to the New Testament. For the lay audience they were, in their own way, a type of medieval encyclopaedia. They depicted the divine and human aspects of existence, Christian and pagan, good and evil, all in the surroundings of nature: people, animals, birds and plants.[14]

The formal arrangement of the individual scenes of Adalbert's life bear witness to their creator's intimate familiarity with western art of the 12th century.[15] Possible iconographic inspiration can be found in places such as Poitiers,[16] but can be seen most frequently in Italy, in Modena and Ferrara.[17] The motifs in the borders and their floral ornamentation were especially common in Italy, famously in the stone panels of the façade of the church of San Zeno in Verona,[18] but many more Italian parallels could be cited. Hypotheses about formal and workshop influences could also be put forward, although unless written sources can be found in the future to support such ideas these will remain merely conjecture. The only significant circumstantial evidence for direct Italian influence is the presence of master mason Villigelmo of Modena and his workshop in the monastery of Czerwińsk in the Gniezno archdiocese in the mid-12th century.[19]

As such, although the fundamental historical data relating to the Gniezno Doors, such as their dating and how they were funded, have not been clearly evidenced, some scholars have attempted to find more concrete answers by exploring methodologies beyond the borders of the traditional historical-empirical approaches. Thus, in order to provide a broader research spectrum, effective iconographic insights and iconological analysis, and the methodologies of cultural anthropology, were the natural tools. However, in a sense, this is an elegant evasion of the fundamental research questions such as the identification of the author of the composition and the manufacturing workshop.

So, in order to provide answers to these essential questions the first metallurgical analysis on the doors was undertaken almost 70 years ago.[20] To a degree this contributed to a closer definition of the metallurgical and technical characteristics of the work. Yet, the results, although clarifying many of the technical details of the doors, can still not be accepted as absolute and final.

It is interesting that the cast elements were fixed into the thick oak wings with bronze thick pins, like

12 *Littera gesta docet, quid credas allegoria; Moralis quid agas, quo tendas anagogia.* See: de Lubac 1959 and 1998; and also a few new papers in: Staudinger Lane et al. 2009.

13 See Węcławowicz 1999, 275–278.

14 This is what was suggested by Kalinowski 1959, 115.

15 Kalinowski 1959, cited many examples from Western Europe, including one from the Emilia region in Italy.

16 A calyx-shaped baptismal font with a scene of the Nativity on its western elevation, from the Notre Dame la Grande church in Poitiers. See Węcławowicz 1999, 275–276, figs. 13, 14; See also Miziołek 2000, 42–43.

17 Modena Cathedral Church, south portal: funeral of St Geminianus; Ferrara Cathedral Church, south portal: scene of Epiphany divided by arcades, see Węcławowicz 2020, 263–266

18 See above n. 7, and Węcławowicz 2020, figs 20.2–20.9.

19 Mroczko 1971; Mroczko 1972, 26–30. On Villigelmo, see also: Salvini 1987; Frugoni 1996.

20 Dziekoński, Wesołowski 1956, 124–223.

dowels, which were cast together with the door plates. Next, this analysis confirmed a small amount of contamination in the metal used for the doors, which led to the conclusion that 'refined copper' was used for the casting. This would testify to a high level of technical proficiency for that period. The results of the spectrum analysis revealed no traces of gilding on the surface of the bronze. However, in written sources, these doors are called *Porta Aurea*. They must therefore have been systematically polished and given the impression of being gold. Also, the analysis of the welding confirmed that the right door was cast all in once. The left door, on the other hand, was cast in one piece, or is at least composed of elements much larger than its counterpart, although the analysis at the time could not identify the location of potential joints. The left door may have been cast as a block from several crucibles, the contents of which varied only slightly.

The knockers are important elements not only functionally but above all symbolically of every church door. In general, they have the shape of lions due to the words of the Psalm: *Salva me ex ore leonis* (save me from the lion's jaws).[21] The knockers of the Gniezno Doors were cast together with the doors. The right knocker survived intact, but the left one must have been slightly damaged. It is clearly seen that during repairs the original inscriptions visible around it were partially obscured.[22] Therefore, some art historians have previously suggested that the knockers are stylistically earlier or later, perhaps even of the 14th century,[23] and were added after the doors were damaged probably in 1331. However, current metal research (of 2023) definitely confirmed that the composition of the metal of the knockers is identical to the metal of the door's wings.[24] Therefore, probably only the left knocker fell off when the doors were damaged and was welded on again.

The research carried out 70 years ago concluded that each door differs in its level of casting technique. The right one comprises medium-size panels whose forming and casting would not have caused much difficulty even in the early Middle Ages; there was only a small possibility of damaging the contours of the negatives during shaping. The left door, as we have said, was probably cast in one piece, or pieces larger than those of its counterpart, but the relief is also deeper here, the treatment of the figures much more of a raised-relief. Their casting demanded a significantly more advanced technique than that used for the figures on the right door.[25]

Once the metallurgical analysis had been concluded, the sequence of the most important technological work and repairs on the Gniezno Doors was reconstructed as follows. The narrow rim into which the hinges were melted was cast in one piece, similar to the bottom and upper edges. The elements for the borders were welded onto the central part of the door and attached to the oak wing with iron nails. [26]

As we know, the left door was cast as a single block or using much larger elements than the right, thus the level of technological expertise and manufacture was much higher here. It can be said then that the foundry workers drew on the experience acquired during the manufacture of the right door. What is similar here though, in the left door, is that bronze dowels were also used and affixed onto the timber underlayer.

Thus, these differences in the technology and the artistic quality of the two wings could be explained by the sequence of manufacture and the development of experience, as the researchers concluded 70 years ago. However, it could also have been the result of using two separate groups of welders, albeit working at a similar time.[27]

Although these observations and simple metallographic analyses were, for that time, arduous and thorough, so many questions remained unanswered.[28] The problem in determining the artistic provenance of

21 Ps. 22, 21.

22 Dziekoński, Wesołowski 1956, 125–126, 138.

23 Furmankiewiczówna 1921, passim, referring to 19th c. scholars; Morelowski 1956, 66–68.

24 See below research by doc. Mödlinger's team on 'Gates to Paradise' project.

25 Dziekoński, Wesołowski 1956, 139.

26 Dziekoński, Wesołowski 1956,136–156 passim.

27 Dziekoński, Wesołowski 1956, 156–158.

28 Only general analyses of the chemical composition of the casting metals were made.

the doors was the impossibility of comparative analysis, a serious problem for Polish scholars in the political realities of the 1950s. At that time a comparative analysis of the casting process for the doors could only have been done with the descriptions of 12th-century technology included in the work of Theophilus Presbyter.[29]

In this light, the modern in-depth analysis of the chemical composition of bronze church doors was carried out in 2023 as a part of the project *Gates to Paradise*. It seems to be a huge step forward, changing our knowledge of these Romanesque examples. Such research on other doors will enable us to compare the techniques and work of various casting workshops and, in the future, may lead to the discovery of the artistic provenance of these masterpieces.

Zusammenfassung

Die Bronzetüren der Kathedralkirche in Gniezno (Gnesen) sind außergewöhnlich, da sie sich von vielen anderen Türen der damaligen Zeit abheben. Die achtzehn Bronzetafeln stellen Episoden aus dem Leben des Heiligen Adalbert dar. Auf der linken Seite werden die Ereignisse von seiner weltlichen Jugend über die Übernahme des Bischofsamtes in Prag und die klösterliche Abgeschiedenheit in Rom bis hin zu seinem Märtyrertod unter den Heiden des Baltikums und seiner Bestattung in der Kathedrale von Gniezno dargestellt.

Die bisher durchgeführten Studien haben keine zufriedenstellenden Antworten auf grundlegende Fragen geben können. Bis heute gibt es keine Gewissheit über die Datierung des Objektes, die Identität des Stifters, oder den Ort der Herstellung der Tür. Sie wurde bisher entweder in die Mitte des 12. Jahrhunderts oder in die späten 1170er Jahre datiert.

Die ersten chemischen Analysen wurden vor nun schon fast 70 Jahren durchgeführt. Obwohl die damals gemachten Beobachtungen interessant waren, blieben weiterhin viele Fragen unbeantwortet. Um ein breiteres Spektrum an Forschungsergebnissen zu erzielen, werden hier im Folgenden auch Methoden aus der Kulturanthropologie genutzt.

Riassunto

Le porte di bronzo della cattedrale di Gniezno sono eccezionali, in quanto si distinguono da molte altre dell'epoca. I diciotto pannelli di bronzo illustrano gli episodi della vita di Sant'Adalberto: sul lato sinistro, gli eventi si susseguono dalla giovinezza secolare, all'assunzione del vescovato a Praga e alla clausura monastica a Roma; sul lato destro sono esposti pannelli che esplicano i fatti a partire dalla chiamata a intraprendere il viaggio verso il martirio tra i pagani del Baltico fino alla sepoltura nella cattedrale di Gniezno.

Gli studi condotti finora non hanno fornito risposte a domande fondamentali. Ad oggi non vi sono certezze sulla datazione, sull'identità del fondatore o sul luogo di realizzazione. Le porte sono state datate metà del XII secolo/fine del 1170. Per fornire uno spettro di ricerca più ampio, le metodologie dell'antropologia culturale si erano rivelate lo strumento naturale. Tuttavia, in un certo senso, si tratta di un'elegante elusione alle domande di ricerca fondamentali. Infatti, la prima analisi metallurgica è stata intrapresa quasi 70 anni fa. Sebbene queste osservazioni fossero, per l'epoca, interessanti, molte domande rimasero senza risposta.

29 Theophilus Presbyter (1125) passim.

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The Bronze Door of San Clemente a Casauria and its Monumental and Environmental Context

Gaetano Curzi

The bronze door of San Clemente a Casauria (Pescara) was made shortly after 1182, during the final phase of the reconstruction of the monastic complex after the devastating sack perpetrated by the Norman Ugo Malmozzetto in 1079. The work consists of two wings almost four metres high, divided into twelve horizontal registers and four vertical rows, for a total of 72 panels, set in a regular grid of flat frames. The only figures are to be found in the first register, where St Clement, Emperor Ludwig II, who founded the monastery, King William II, and Abbot Giole, the patron of the door, appear. The other panels contain symbolic motifs and a series of castles, representing the possessions of the abbey. Analysis of the decorative apparatus, unique in the panorama of mediaeval bronze doors, reveals how it is an integral part of the sculptural programme of the façade and portico, where the myth of the institution's origins and the predestination of the place are celebrated. The door of San Clemente a Casauria is the culmination of an extremely cohesive construction site, dense with references to the tangible and symbolic image of the building and its monumental and environmental context.[1]

The abbey is located in the valley of the Pescara river in an area crossed by the *Via Tiburtina Valeria* that connected ancient Rome to the Adriatic. Over time, the natural environment and the surrounding territory[2] became the protagonists of the monastic community's self-representation and the building's decorative programme. In 1079, the Norman Ugo Malmozzetto destroyed the monastery,[3] which had recently been rebuilt after the 10th century, when first the Saracens, in 915, and then an earthquake, in 990, had devastated the complex founded by Emperor Louis II (855–875) in 871.[4]

The year 1079 is therefore *year zero* for us. With the possible exception of the crypt, which is of controversial date,[5] no remains can be found prior to the Romanesque phase. In the Romanesque period, first the presbytery area was built until the construction works reached their climax in the last quarter of the 12th century with the raising of the façade, which displays the ideological manifesto of the community[6] that also produced the *Chronicon Casauriense* in the same years.[7]

In this we read that Abbot Leonate had the front elevation of the building built in 1176, and that in 1182, on his death, the leadership of the project passed to a Joel, who finished the construction, adorning it with the monumental bronze door.[8]

1 Bloch 1990; Curzi 2012a; Curzi 2012b; Iacobini 2021; Curzi (in press).
2 Tedeschi 2019.
3 Paciocco 1995.
4 Pratesi, Cherubini 2017–2019, I, 766–801.
5 Staffa, Mattoscio 2017.
6 Bradford Smith 2002; Bradford Smith 2003; Späth 2007; Curzi 2012a; Curzi (in press).
7 Pratesi, Cherubini 2017–2019.
8 Aceto 2003; Gandolfo 2003; Pratesi, Cherubini 2017–2019, I, 1177–1180.

Despite the succession of abbots, the building project followed a unified design logic, confirmed by the connections between the various parts. The characterising element is undoubtedly the monumental portico with three arches, which evokes a triumphal arch, but also had the function of welcoming pilgrims attracted by the indulgence granted in 1170 to those who visited the abbey on the anniversary of the transfer of the titular relics,[9] authenticated by the story on the architrave of the main portal (fig. 1). According to the tradition, Clement was drowned in the Black Sea, which from then on began to recede once a year to allow the faithful to visit the underwater martyrium, which prodigiously appeared in the place where his body rested. In 868, however, Cyril and Methodius brought his remains to Rome and entrusted them to Pope Adrian II (687–872).[10]

At Casauria, the lintel therefore opens with a representation of the *urbe* and the pope handing the urn with the relics to the Emperor Louis II (850–875), who, after loading them onto a donkey, sets off.

Having arrived near an island enclosed by the waters of the river Pescara, the occurrence of several prodigies reveals the saint's wish to be venerated there. Louis therefore founds the building, dedicated to the Trinity, and appoints the first abbot, Romanus. The investiture is represented by the handing over of a lily sceptre that symbolised imperial protection, which is reproduced several times as an insignia on the façade and in the portraits of the abbots in the *Chronicon Casauriense* (see fig. 9). Here the crosier is held first by Grimoaldo (1097–1110), to whom it is handed over directly by the pontiff, while Trasmondus (1074–1079) and John III (1086–1094) are accompanied by both as they were bishops of Valva and also abbots of San Clemente.[11] The story of the foundation ends with Emperor Louis receiving the area from the hands of the landowner and the Bishop of Penne.

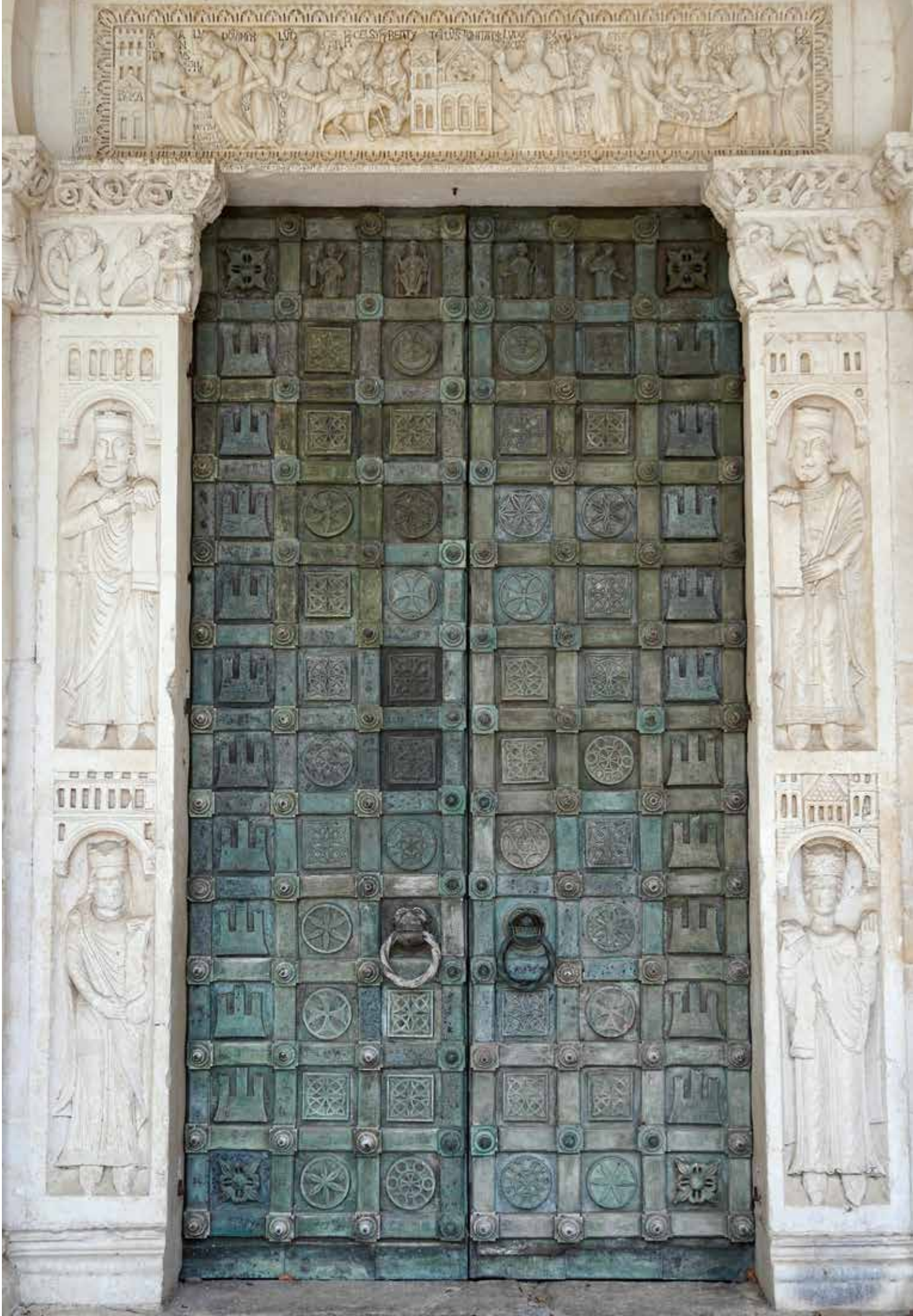
The depiction of the abbey on the architrave in a median position thus marks the two elements of the story: on the left the cultic dimension and the manifestation of the supernatural will; on the right the legal prerequisites to the autonomy of the institution. The church is thus placed in the centre of the island formed by the Pescara river,[12] which today includes it within a bend. Even if geographers confirm this landscape indication, anticipated in the *Chronicon Vulturnense*[13] and in numerous passages of the *Chronicon Casauriense*, the island is obviously a metaphor for monastic life, and the waters surrounding Casauria offered an allusion to the story of St Clement, who found death and his first burial in the Black Sea. Also, in Rome, the site of the basilica of St Clement reaffirms the cultic link with water, through the presence of a spring and an underground sewer, the course of which can still be heard by those who visit the Roman and early mediaeval remains there.

This transposition of the land into a symbolic place, which recalls the categories of the *locus amoenus* and the *hortus conclusus*, is also evident from the central segment of the inscription on the architrave which, just below the image of the abbey, reads: "*insula Piscarie Paradisi floridus ortus*".[14] The *Chronicon Casauriense* also illustrates the beauty of the landscape, the richness of the vegetation and the abundance of wildlife, stating that these aspects were decisive in the emperor's decision to build the abbey exactly there.[15]

The theme of a kind of predestination of the place is revived by the sculptures adorning the central arch of the portico. At the bottom we find David and Solomon, surmounted by Joel and St Clement, followed by two angels and finally on the right side by the *agnus dei*. The first four figures hold scrolls with passages alluding to the symbolism of water, the sacredness of the natural environment, and its importance for the prosperity of the community, suggesting a link between the

9 Ghisetti Giavarina 2001, 39.
10 Scorza Barcellona 2000.
11 Paris, Bibliothèque Nationale de France, lat. 5411, cc. 233v, 236v, 238r; Pratesi, Cherubini 2017–2019, I, 67–68.
12 Pratesi, Cherubini 2017–2019, I, 148–155.
13 Oldoni 2010, 148.
14 Curzi 2012a; Tedeschi 2019, 79–80.
15 Curzi 2012a; Curzi (in press).

► Fig. 1: San Clemente a Casauria, abbey, façade, main portal (© Gaetano Curzi).



biblical passages and the island on the river Pescara.[16] The choice of characters is also significant: there are two kings, David and Solomon, the titular saint and the prophet Joel whose mediaeval-style clothing[17] and homonymity allude to the abbot Joel who completed the building in 1182.

The portico then becomes the place where the prehistory of the institution is celebrated, introducing the historical narrative of the main doorway,[18] where on the jambs are portraits of the four sovereigns (fig. 1) who favoured the rebirth of the monastery after the sacking by the Saracens. They display cartouches, perhaps originally containing painted inscriptions relating to donations made.

This complex apparatus constitutes the material and symbolic framework within which the bronze door (see fig. 1) is placed, consisting of two wings almost four metres high, divided into twelve registers for a total of 72 square panels contained in a regular frame of flat laths fixed by 104 studs.[19] The door must have still been substantially intact in the second half of the 18th century, as a survey carried out in 1776 recorded only the absence of secondary parts.[20] The inscriptions were accurately transcribed by Allegranza in 1754[21] and by Di Pietro in 1804,[22] who also restored the layout, confirming the reliability of a drawing from the Seroux D'Agincourt collection, recently studied by Antonio Iacobini, who dated it to around 1780.[23] At the beginning of the 19th century, however, the door was moved to nearby Castiglione following the spoliation carried out by French troops in 1799, to which the local population also seems to have contributed. The missing parts were later replaced with painted wooden additions.[24]

In this partially tampered condition, the door was examined in 1838 by Schulz,[25] who had a drawing made, from which the published engraving was taken a few years later.[26] This shows significant inaccuracies, perhaps due to the clumsy recomposition of some parts, although several inaccuracies also characterise the copy of the wooden door of St Peter's in Alba Fucens, made on the same occasion.[27]

This began the most degraded phase of the monumental complex, which also risked demolition.[28] After the restorations carried out at the end of the 19th century, 37 panels were still affixed to the door, while eleven were in storage; four of them were later dispersed. In 1902, Henry Walters bought two panels on the Roman market that are now in Baltimore,[29] while two others entered the Bode Museum in 1905. At least one of these must have been still in place in 1894.[30]

The current appearance of the artefact (see fig. 1), however, is the result of a restoration carried out in 1933, when the 44 surviving panels were arranged according to the seemingly unreliable scheme of the engraving published by Schulz, and supplemented on the basis of this testimony with elements carved in wood and patinated with a greenish tint (fig. 2), which reflected the colour caused by metal oxidation. Hence, this betrayed the original effect[31] that Ughelli described in the 17th century, as having pure gold incrustations. He probably intended to reproduce the original effect of the door with the preserved bronze lustre and damascened inserts,[32] common in bronze doors in central and southern Italy, however the Abruzzo door differs markedly from these in its iconographic programme.

In the first register we find the only four figures on the door, representing the patron, Abbot Gioele

16 Tedeschi 2019, 70–75.
17 Tedeschi 2019, 69.
18 Tedeschi 2019, 68–75.
19 Curzi 2012b.
20 Iacobini 2021, 523; Varrasso 2017, 55–71.
21 Bianchi 1781, 188–192.
22 Di Pietro 1804, 140–142.
23 Iacobini 2021; Città del Vaticano, Biblioteca Apostolica Vaticana, Vat. lat. 9846, c. 49r.
24 Iacobini 2021, 524; Varrasso 2017; Iacobini et al. 2024.
25 Schulz 1860, Tab. LV.
26 Bloch 1990, 584.
27 Curzi 2007, 15–45.
28 Calore 1891; Calore 1994; Ciglia 2009; Pio 2012.
29 The Walters Art Museum: Richardson 2009–2011.
30 Bloch 1990. These were probably destroyed during the Second World War.
31 Able to be reconstructed thanks to the restoration of the panel with the *Castrum Fare D'Abrile*, preserved in The Walters Art Museum: Richardson 2009–2011.
32 Ughelli 1649, 838.

Fig. 2: San Clemente a Casauria, abbey, portico, central arch (© Gaetano Curzi).

Fig. 3: San Clemente a Casauria, abbey, bronze door, detail with Giole (© Gaetano Curzi).

Fig. 4: San Clemente a Casauria, abbey, bronze door, detail with St Clement (© Gaetano Curzi).

Fig. 5: San Clemente a Casauria, abbey, bronze door, detail with William II (© Gaetano Curzi).

(fig. 3), with a deferential attitude, today incongruously reserved for the corner fleuron but in the original setting addressed to St Clement enthroned with mitre and *baculum* (fig. 4).

This is followed by William II (1166–1189), the reigning ruler, standing and holding the fleur-de-lis sceptre (fig. 5), and Louis II (fig. 6), holding the sceptre and the deed of foundation of the monastery complex. In the current arrangement the sequence is different, but Seroux D'Agincourt's drawing of 1780,[33] Di Pietro's publication of 1804,[34] and studies by Bloch[35] and Iacobini,[36] sanction this reconstruction, which finds an indirect precedent in a scene with a similar setting in the wooden door of San Pietro at Alba Fucens (now in Celano, Museo d'arte sacra della Marsica.[37] (fig. 7).

The quartet (figs. 1, 3–6) at the ridge of the bronze door also suggests – in a historicising way, i.e. by referring to the events of the abbey – the atemporal representation of the central arch of the portico (fig. 2) examined above, with Joel, prophet and abbot, confronted with St Clement and the two biblical kings Solomon and David. In the four corners of the door, on the other hand, *florons* are inserted (figs. 1, 3), a decorative element typical of Abruzzi ornamental sculpture, as also attested by the lunette above and the pulpit inside.[38]

With the exception of the two door handles, inserted as usual into the jaws of lion protomes,[39] all the other panels can be divided into two groups. The larger group, according to Seroux D'Agincourt's drawing, consisted of 40 pieces with geometric elements, half of which showed variations on the theme of the cross and the flower inscribed within circumferences and crescents surmounted by a cross and flower, also inscribed. This is a repertoire repeated on the frames as well, and is also found in ornamental sculpture in the region, from Santa Maria a Vico in Sant'Omero to Santa Maria del Lago in Moscufo and San Pelino in Corfinio.[40]

33 Iacobini 2021.
34 Bianchi 1781; Di Pietro 1804.
35 Bloch 1990.
36 Iacobini 2021.
37 Curzi 2007, 15–45.
38 Gandolfo 2003.
39 Mende 1981.
40 Gandolfo 2003, 284.

Fig. 6: San Clemente a Casauria, abbey, bronze door, detail with Louis II (© Gaetano Curzi).

The other twenty panels exhibited a weave motif of early mediaeval origin, attested in Abruzzo for example by a fragment from the ancient cathedral of Teramo (Teramo, Museo Archeologico 'F. Savini').[41] One could see in the adoption of this icon an allusion to the foundation of the abbey in the 9th century, thus assuming a significance analogous to the reuse of early mediaeval fragments in the open portal on the northern side of San Giovanni in Venere or at S. Pietro ad Oratorium, where it has also been hypothesised that some of these pieces constitute an imitation 'in style' of the Romanesque period.[42] This repertoire is distributed haphazardly on the two wings, supplemented with wooden panels according to the arrangement indicated by Schulz's engraving.[43] The 1780 drawing,[44] on the other hand, renders the regular pattern, with the Carolingian-style interlacing above and below the pickets, and the others, with the cross and flower motifs, arranged in pairs along the middle axes of the two wings.

The most relevant group, at least from a semantic point of view, is undoubtedly the two rows of vertically-aligned panels at the outer sides of the door, which, by means of a stylised fortification (fig. 1), represent by synecdoche the feudal possessions of the abbey.[45] Their arrangement near the jambs seems to suggest an ideal relationship with the kings displaying the privileges promulgated in favour of the abbey *Casauriense*, anticipating a solution later adopted by the portrait of Pope Innocent III (1198–1216) in the Sacro Speco of Subiaco,[46] and that of the pontiffs in the portico of Santa Maria di Propezzano.[47]

Today, there are twenty tiles with castles, again placed along the lines of the engraving published by Schultz,[48] who, however, indicated two more in the text, in agreement with previous graphic and textual sources that recorded four in the second row.[49] It could be hypothesised that the overflowing of these representations of possessions in the second column of each wing was a prelude to the possibility of continuing the iteration of the castles horizontally or vertically in the event of an increase in land holdings, gradually replacing the geometric panels with those with the new possessions, without disrupting the compositional logic and symbolic apparatus of the door.

The views of the castles are all the same – a scarp base, three crenelated towers with the central one soaring and curtain walls (fig. 8) – and we can assume that they were made in series using a single mould. The only thing that distinguishes them is a damascened inscription with the names of the places, sometimes preceded by the appellation *castrum, castellum, roccam* or *podium*, or accompanied by indications such as *in Marchia, in Camerino* that facilitate contextualisation.[50] This reveals a shrewdness with regard to geographical notation that can be also found in the *Chronicon Casa-*

41 Gandolfo 2006.
42 Antonelli 2010.
43 Schulz 1860, Tab. LV.
44 Iacobini 2021.
45 Richardson 2009–2011.
46 Caramico 2020.
47 Aceto 1986; Curzi (in press).
48 Schulz 1860, Tab. LV.
49 Bianchi 1781; Di Pietro 1804; Iacobini 2021.
50 Bloch 1986, 571–574; Späth 2007, 249–253.

Fig. 7: Celano, Museo d'arte sacra della Marsica, wooden door (from San Pietro ad Alba Fucens), detail with holy abbot and pious person (© Rocco D'Errico).

uriense where some of the scarce notes in the margins clarify precisely the location and etymology of certain place names.[51] It is interesting, however, that the image of the *castle* was chosen to visualise the landed estate, whereas in the *Chronicon's* text it takes on a negative connotation, so much so that when describing the surrounding landscape, the author laments the presence of an excessive number of fortresses, believing them to

51 Pratesi 1982, 11, cc. 6r, 31v, 32r, 54r, 66r.

52 Curzi 2012a; Curzi (in press).

53 BAV, Vat. Lat 1202, c. 2r.

54 Paris, Bibliothèque Nationale de France, lat. 10136: e.g. c. 3v, 7r.

be the consequence of a violent era, thus rhetorically contrasting the anthropisation of the territory with the Arcadian amenity of the natural environment that characterised the area at the time of its foundation.[52]

With these 22 panels, therefore, the surrounding territory enters the space of the door, which appears as an open codex. In fact, the solution adopted to depict the properties seems inspired by book production, as suggested by the famous page of Desiderio's lectionary,[53] populated with landscapes and buildings to represent the *Terra sancti Benedicti*; but drawings of castles and villages are also found in numerous civic manuscripts, for example Caffaro's *Annales ianuenses*.[54]

The documentary rather than evocative value of the bronze door of San Clemente a Casauria, however, leads us back to Montecassino, where abbot Oderisius II (1123–1126) transformed the bronze gate commissioned by Desiderius (1058–1086) just over half a century earlier[55] into a possession gate by 1126, turning around the panels and having the list of possessions and churches dependent on the monastery written on them.This was a solution probably inspired by the doors of the atrium of the Vatican basilica, on which the goods of the *Patrimonium Petri* were listed in the time of Pope Leo III (795–816).[56] In the apse of San Liberatore alla Majella, a gallery of characters was painted with a similar purpose, starting with Charlemagne and portraying the sovereigns who had benefited from the monastic complex, interspersed with cartouches publishing the relative acts promulgated. This decoration, dated to the end of the 13th century, was renewed in the middle of the 16th century, updating it stylistically but safeguarding it semantically, in order to reaffirm the legitimacy of the properties.[57]

The long-lasting testimonial value of these works that publicised the heritage of institutions, is also confirmed by the gate of San Clemente a Casauria, reproduced for the first time in 1774 in a summary drawing that, being attached alongside the acts of a trial that was to settle a land dispute, only details the panels

Fig. 8: San Clemente a Casauria, abbey, bronze door, detail with castle (© Gaetano Curzi).

Fig. 9: *Chronicon Casauriense*, Paris, Bibliothèque Nationale de France, lat. 5411, c. 131r (source BnF/Gallica).

55 Moretti 2009.

56 Richardson 2009–2011, 39.

57 Ghisetti Giavarina, Maselli Campagna 1998; Carlettini 2001.

with the castles.[58] The purely documentary character of these works, however, is diluted in Casauria, compared to the Cassinese model, in the figurative component of the castle, which is represented in the entrance arch and in the atrium of the abbey of Tre Fontane near Rome, where the possessions of the abbey and the events that determined their acquisition, were depicted, and,[59] in different metonymic forms, in the bronze door of Benevento, with the parade of the 24 bishops that depended on the archdiocese.[60] Monastic institutions, on the other hand, were large landowners and their efforts were directed towards safeguarding the integrity of this patrimony by asserting the legitimacy of ownership, even in different media. For this reason, during the 12th century, the major monasteries of central and southern Italy promoted historical and diplomatic compilations.[61] In some ways this seems to have been a European phenomenon, as the cases of Saint-Martin-des-Champs or Vezelay also suggest.[62]

By the fateful year 1182, the year of Joel's succession to Leonate, the *Chronicon Casauriense* – composed of the history of the abbey and the collection of documents – was compiled, which continues the same aims as the decorative apparatus of the façade with historical-philological instruments. Its illustrative set is in fact made up of drawings that reflect the instrumental character of the manuscript – alternating portraits with scenes of the publication of privileges – according to an extremely clear compositional structure that reminds us, in the images of sovereigns and abbots, the portrait modalities of the four figures placed at the top of the bronze door (Figs 3–6).[63] Although the comparison of works executed with different techniques is always a risky exercise, I would like to conclude by pointing out that both the illuminated and the sculpted figures share a decorative insistence that is resolved in stone and bronze in sharp profiles, almost in high relief, and in a calligraphic carving of the surface (Figs 1–6), transposed into the manuscript through marked contour lines and exaggerated drapery.[64]

At this point, the hypothesis that a common language was developed at Casauria, gains strength from the design coherence and contemporaneity of the portal, the codex and the bronze door, which, beyond the inextricable question of its authors, thus truly appears to be a site-specific work.

Zusammenfassung

Die Bronzetür von San Clemente a Casauria (Pescara) entstand kurz nach 1182, in der letzten Phase des Wiederaufbaus des Klosterkomplexes nach der verheerenden Plünderung durch den Normannen Ugo Malmozzetto im Jahr 1079. Die Tür besteht aus zwei fast vier Meter hohen Flügeln, die in zwölf horizontale Register und vier vertikale Reihen unterteilt sind, was insgesamt zweiundsiebzig Tafeln ergibt, die in ein regelmäßiges Gitter aus flachen Rahmen eingefasst sind. Die einzigen Figuren befinden sich im ersten Register, wo der Heilige Clemens, Kaiser Ludwig II. – der Gründer des Klosters –, König Wilhelm II. und Abt Giole – der Schutzpatron der Tür – erscheinen. Die anderen Tafeln enthalten symbolische Motive und eine Reihe von Burgen, die die Besitztümer der Abtei darstellen. Die Analyse der Dekorationen, die im Kontext der mittelalterlichen Bronzetüren einzigartig ist, zeigt, dass sie ein integraler Bestandteil des bildhauerischen Programms der Fassade und des Portikus sind, in denen der Mythos des Ursprungs des Klosters und die Prädestination des Ortes gefeiert werden.

58 Varrasso 2017, 124.
59 Waetzoldt 1964, 1136–1137; Späth 2007, 244.
60 Bloch 1990, 318; see Milone in this volume.
61 Leonardis 1999, 133; Späth 2007, 249–251; Haug 2011; Curzi 2012a; Curzi (in press).
62 London, British Library, Add. MS 11662; Huygens 1976.
63 Leonardis 1999, 133; Späth 2007; Curzi 2012a.
64 Curzi 2012a.

Riassunto

La porta bronzea di San Clemente a Casauria (Pescara) venne realizzata poco dopo il 1182, durante la fase conclusiva dei lavori di ricostruzione del complesso monastico dopo il devastante saccheggio perpetrato dal normanno Ugo Malmozzetto nel 1079. L'opera è costituita da due battenti alti quasi quattro metri, scanditi in dodici registri orizzontali e quattro file verticali, per un totale di settantadue formelle, inserite in una griglia regolare di cornici piatte. Le uniche figure si trovano nel primo registro dove compaiono San Clemente, l'imperatore Ludovico II che fondò il cenobio, re Guglielmo II e l'abate Giole, il committente della porta. Le altre formelle contengono motivi simbolici e una serie di castelli che rappresentano i possedimenti dell'abbazia. L'analisi dell'apparato decorativo, unico nel panorama delle porte bronzee medievali, rivela come questo sia parte integrante del programma scultoreo della facciata e del portico dove viene celebrato il mito delle origini dell'istituzione e la predestinazione del luogo.

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Art and History of the Bronze Door of Benevento Cathedral

Antonio Milone

Benevento has a central position between the two southern Italian shores of the Tyrrhenian Sea and the Adriatic Sea, separated by the Apennine chain, and is located on the Appian Way, the unifying route of the entire south. This condition of the city is reflected in its artistic production, particularly between the 12th and 13th centuries. Thus, for example, the architectural forms of the façade of its cathedral have similarities with contemporary monuments in Puglia, and, at the same time, the sculptural production present in the capitals of the cloister of Santa Sofia, has significant parallels in similar contexts in Campania, between Irpinia and Terra di Lavoro.[1]

Benevento is also at a crossroads for the art of casting in southern Italy. If Constantinopolitan production is apparent mostly on the coasts of Campania and Puglia, from Amalfi to the Gargano, most of the bronze doors made during the 12th century, from Canosa to Troia, appear along the Appian Way and its vicinity, from Capua to Benevento, from Bari to Trani.

One of the protagonists of this important era in the art of casting in the European Middle Ages comes from Benevento: Oderisio., He executed four doors during the first half of the 12th century. They are those of Troia (1119 and 1127), one in Capua (1122), and one in Benevento (1150–1151), There are also the door handles preserved in the church of Santa Cristina in Sepino, a Molise city once part of the vast Benevento archdiocese. In this context, the bronze door of Benevento Cathedral played a leading role (fig. 1).

Considered by scholars to be a work dating back to the first decades of the 13th century, it has been seen as the apogee of the exceptional series of bronze doors created in southern Italy between the 12th and 13th centuries.[2] Since the date is not given on the doors, much less the signature of the artist, its execution was associated with Ruggero, whose name appears on the right hand portal of the façade.[3] It is not thought to refer to a sculptor, as is clear from the epigraph on the architrave, but rather Archbishop Ruggero, on the Benevento seat between 1179 and 1221. Consequently, the door is dated within this period.

A restoration, which led to the recovery of the surviving panels of the door after its destruction when bombs hit the cathedral in 1943, allowed for a notable discovery, which overturned earlier judgments on the door and its dating. One panel showing the Bishop of Lesina (fig. 2), now examined more carefully, revealed a reworking.[4] It was now possible to understand that, originally, the prelate depicted there was in fact Enrico, Archbishop of Benevento between 1156 and 1170/1171. Only later was the original inscription ("*Henricus / beneven/tanus // archie/piscop[us]*") abraded, transforming it, leaving only the original fragment "…*piscop(us)*", and then becoming "*Episcop(us)/ Lesene*".[5]

The title of the metropolitan is the same that we find on contemporary seals that accompanied the

1 Gandolfo 1999, 41–47; Aceto 2000.

2 Mende 1983, 179–184; Angelucci, Marinelli 1988a; Pollio, Pace 2003, 477–478.

3 Dietl 2009, II, 625–626.

4 Angelucci, Marinelli 1988b, 45.

5 Andenna 2005, 370–371.

Fig. 2: Bishop of Lesina (formerly Henry archbishop of Benevento), plate of the Bronze Door, 1156–1171, Benevento, Cathedral (© Martin Fera/Novetus/GAPAMET).

◄ Fig. 1: Bronze Door, 1156–1171, Benevento, Cathedral (© Martin Fera/Novetus/GAPAMET).

documents issued by the city curia, as can be seen in a surviving example linked to a document from December 1158. Here, on the *recto*, we find the heads of Mary and Bartholomew, while on the *verso*, the image of the bishop stands out with the epigraph "*Henricus beneventanus archiepiscopus*".[6] The analogy in the wording between the inscription on the door and that on the seal is further proof of the authorship of this bishop and his entourage in initiating the bronze door project.

This discovery revolutionised our knowledge of the door, significantly anticipating its dating, and allowed the work to be placed in a different historical and artistic context. It thus posed new questions as to the original intent of the door's iconographic programme, the time in which the modification was made, and the meaning to be attributed to these changes.

The creation and modifications made to the bronze panels take place between two illustrious deaths that occurred in Benevento: the assassination of the city's bishop, Peter II, in 1156, and the disappearance of King Manfred in the battle lost against Charles of Anjou, fought in 1266 in the city under papal rule.

In the first half of the 12th century, the clash between the factions in Benevento was intense, divided between the pressures exerted by the Normans – who in those decades dominated the entire south and were soon to establish (with the Altavilla dynasty) the Kingdom of Sicily – and that by the pope, also attempting to control the city, at a time when two popes often sat on the Petrine throne. Around 1130, the conflict between the city *communitas* and Archbishop Landulf III, elected by Anacletus II, an ally of King Roger II, worsened, and the city appeared divided as a reflection of the conflict within the Roman Curia, of the politics of the Norman sovereigns, and of the autonomist demands of the population.[7]

Archbishop Peter II, elected in 1146, established a positive relationship with Rome by receiving a privilege from Anastasius IV in 1153, which granted him 22 suffragan seats and the use of the *pallium*. With the death of Anastasius IV and King Roger II, and the election of Hadrian IV and the succession of William I, a war began between the papacy and the Normans, for which the archbishop paid the price first hand, killed by his citizens because he was accused of being pro-Norman. The war ended with a peace treaty between the king and Hadrian IV, who, before leaving Benevento, where he had lived for some time, elected Henry as the new archbishop. Shortly afterwards, a new confirmation arrived from the pope of his metropolitan powers over the dioceses, something already recognised by Anastasius IV.

Henry, the archbishop represented in the original version of the row of bishops depicted on the bronze door of the cathedral, was probably part of the Roman entourage, and was particularly linked to the successor of Hadrian IV, Alexander III, the Sienese Rolando Bandinelli, who had negotiated the peace with the Normans in Benevento.[8] The Archbishop of Benevento had various assignments from the pope, for example he was papal legate in Constantinople in 1161. Present in Benevento in April 1163, he immediately left for the Byzantine capital, where he was still in 1165, returning only in the spring of 1166. Henry ruled the Benevento church until 1170 or the first months of 1171 when, between April and August, a Cardinal Lombardo, a disciple of Thomas Becket, was elected as the new prelate.[9]

Henry's years in office brought some tranquillity to the city, which maintained excellent relations with the Roman Curia. In the years of the conflict between Alexander III and Emperor Frederick Barbarossa, Benevento was on the pontiff's side, hosting him after his expulsion from Rome, from August 1167 to February 1170. In this climate, John IV, the abbot of Santa Sofia, who built its monastery cloister after 1139, was elected cardinal priest by Alexander III in 1168, and his brother, Alberto de Morra, chancellor of the Roman Curia, was also elected pope, with the name Gregory VIII, in 1187, but only lasted two months in office.[10]

6 Andenna 2005, 361.
7 Aceto 2000, 248.
8 Palmieri 1993.
9 Panarelli 2005.
10 di Carpegna Falconieri 2000.

From this brief biographical *excursus* we can deduce that only two windows of time are feasible to date the execution of the door, assuming Henry's explicit desire to have the precious doors of his cathedral decorated: 1156–1161 or 1166–1170/1171, as in every other year the prelate was involved in delicate embassies to the imperial court in Constantinople.[11] In favour of the earlier dates, there may have been a desire by the newly-appointed bishop, with the support of the pontiff, to show in a work of great prestige, such as a bronze door, the new condition of the city, of its clergy and the new climate of harmony after the difficult conflicts between the city and the local curia, and between the Normans and the papacy. The second, later, time window seems less likely because, although it was a time when the pontiff was in Benevento, it also represents a period of renewed tensions between the papacy and the empire, and thus a period unfavourable for undertaking new and demanding artistic projects promoting the bishopric.

From my point of view, what also strengthens the hypothesis that it was during the first years of Henry's bishopric that the execution of the cathedral door took place, is the fact that, immediately before his election, the last documented bronze door of Oderisio da Benevento was created. This was executed in two phases, between 1150 and 1151, and placed at the entrance to the building that housed the body of the apostle Bartholomew. For that work, the inscriptions on the portal and on the bronze door recorded the participation of the city ("*auxilio populi*"), which had financed the project with collective offerings ("*de fidelium oblationibus*") and, probably, of the members of a family ("*Gimundus de Palata cum uxore et filiis*"), and the will of a parish priest, John ("*voto studioque Ioannis presbiteri*"), and of Pagano ("*cura studioque Pagani*") perhaps another ecclesiastic.[12] What was missing, however, was even the slightest mention of the participation of the bishop *pro tempore*, the controversial Peter II, who was shortly thereafter assassinated by the citizens of the city.

We must assume that precisely the appearance of a bronze door desired by the citizens for the church, which housed the most important relic of the city – a pilgrimage destination but above all a memory of the euergetism of the Lombard princes (who, with Sicardo in 838, had brought the remains of the apostle from the island of Lipari) – prompted Henry to take action. In the aftermath of the newfound *pax* established in the city, Henry, in a climate of harmony between Benevento, Rome, and the Normans, sought to underscore the important role that the city clergy was assuming in local politics. As a result, he initiated a similar work for the seat of the bishop, the cathedral dedicated to the Virgin. Thus, the door financed by the citizens for the body of the apostle was matched, a few years later, by the new door commissioned by the archbishop for his cathedral.

The door completed the renovation work on the façade of the ancient cathedral, facing west like the early Christian basilicas, which began with the acquisition, in 1136, of the churchyard located in front of the building. It was known as the *Paradisum*, the area with the tombs of the Lombard princes, located near the façade, oriented in a NE direction, which was then incorporated into the perimeter of the cathedral.[13]

The door of the cathedral, from a figurative point of view, represents a *unicum* among similar artefacts created for the churches of southern Italy, where two different features merge: the religious, with the evangelical scenes; and the political, with bishops preceded by the representation of the investiture of a prelate by the pontiff. These themes had almost always been presented separately before though. For example, in Montecassino, in Troia, or in San Clemente a Casauria, the message of ecclesiastical power predominates, expressed in the series of representations of dominions or bishops; while other creations, such as the doors of San Paolo Fuori le Mura in Rome or those of the Gargano sanctuary, contain solely religious figures. Never had these two features appeared together before in the same artefact and to such a significant extent, as in Benevento.

11 Andenna 2005, 363–365.

12 Dietl 2009, II, 622–625.

13 Andenna 2005, 356.

These two sources of power find several significant points of contact in the door commissioned by Archbishop Enrico for his cathedral, starting from the *Annunciation* (fig. 3) and the *Consecration of the Bishop* (fig. 4) scenes. In fact, both are presented according to a similar ternary composition enclosed by the same structure: the Virgin, unusually enthroned and at the centre of the scene, is flanked, on the left, by the announcing angel and, on the right, by a maid, while the interior is depicted as gabled architecture. In the same way, the pontiff, under a building of the same design, sits on a chair, flanked on the right and left by acolytes, while he receives the bishop at the act of investiture. Thus, the pontiff, the head of the Church, appears in the same way as Mary, *Sedes Sapientiae* who carries in her womb the one who will give life to the Church. The same architectural composition appears in the scene of the *Adoration of the Magi* (fig. 5), but also in the panels of the bishops, from Enrico of Benevento to all his suffragans (see fig. 2). They find themselves in a standing pose, framed by the same gabled structure, according to a principle of assimilation, in a descending scale of importance from: the Virgin Mother of God, the pope, the Archbishop of Benevento, and then the prelates of the subject dioceses to the metropolitan see.

The references to Mary also find indisputable comparisons in the epigraphs that run along the architrave of the central portal that frames the bronze doors, and with the one in the image that was contained in the lunette above it (fig. 6).

The image of the Virgin placed on the lunette was accompanied by two inscriptions, which underlined Mary's role in the upholding of Trinitarian values, as the parent of Christ, mother of the Creator and of the Father: "*Mater Factoris Mater Patris*" ("Mother of the Creator, Mother of the Father"), where she was invoked as "*aula pudoris, aula pudica, Dei loca*" ("embodiment of modesty, modest body, place of God") so that she would give peace to men ("*nobis dare quiei*"). Even more significant is the other epigraph which praises the "*Virgo parens Chr(ist)i*" ("Virgin who gave birth to Christ"), who is asked to listen to the prayers of the faithful in the name of the Christ she had generated.

The role of the Virgin revealed in the portal is reflected in the iconographic programme contained on the bronze door. This represents the best *viaticum* for understanding the message contained on the bronze panels, where the initial examples, placed in direct correspondence with the marble architrave, focus on the origin of Jesus, with eight scenes, arranged on the first register, dedicated to his conception and birth, with the *Annunciation*, the *Nativity* and the *Announcement to the Shepherds*, followed, on the right, by the cycle of the Magi, which culminates in the *Adoration*, with the three kings kneeling before the Virgin on the throne with the child on her lap, always under a temple-like structure. She is in the pose of the *Sedes Sapientiae* which, starting from the 12th century, established itself as a statuary archetype in the churches of Christian Europe. The figure of the Virgin marks all the evangelical scenes, from the infancy of Christ to the *post-mortem* episodes, up to the *Ascension*, with Mary the mother at the centre of the group with the apostles, in a straight line with her son, who ascends to heaven in the mandorla raised by the angels.

When examining bronze doors, therefore, we must never overlook the context in which they exist. Very often there is a strong correspondence between the message contained on the panels and the contents expressed through the inscriptions that surrounded these works, corroborating their meaning. We see the same pattern, for example, with the bronze door that Oderisio created between 1150 and 1151 for the entrance to the basilica of San Bartolomeo in Benevento, which housed the relics of the apostle.[14] In the lunette there stood the mosaic image of the saint surrounded by the inscription which recalled the construction of the church and the portals "*auxilio populi voto studioque Ioannis presbiteri*" ("With the collaboration of the people and thanks to the will and commitment of the priest John"), and on the architrave we see an invocation to Bartholomew with the faithful, offering their prayers to God under the guidance of the apostle.

14 Dietl 2009, I, 622–625.

Fig. 3: Annunciation, plate of the Bronze Door, 1156–1171, Benevento, Cathedral (© Martin Fera/Novetus/GAPAMET).

Fig. 4: Consecration of the bishop, plate of the Bronze Door, 1156–1171, Benevento, Cathedral (© Martin Fera/Novetus/GAPAMET).

Fig. 5: Adoration of the Magi, plate of the Bronze Door, 1156–1171, Benevento, Cathedral (© Martin Fera/Novetus/GAPAMET).

Fig. 6: Central Portal of Façade, marble, 12th century, Benevento, Cathedral (© Antonio Milone).

We also see the inscription "*Domus pacis et requiei*" ("House of peace and rest"), alluding to the conditions of the city at the time as well as the church itself.

The series of panels with bishops of the suffragan sees presented in the original version of the door of Benevento, is repeated in the order, as well as the names, of the dioceses listed in two papal bulls of 1153 and 1156. Only the addition of the bishopric of Limosano is novel on the door. This diocese, whose centre was called *Musanum*, appears as a suffragan of Benevento in the *Provincial* of Albino, the cardinal bishop of Albano (1189–1196), where there are 24 seats (Morcone also appears),[15] and in the contemporary *Liber censuum* of Cencio Camerario of 1192 (which records 22).[16] As Andenna supposes, Henry included the see of Limosano because it had recently been reinstated to Benevento's archdiocese by Anacletus II, as evidenced by a papal letter dating back to 1130–1132.[17] Therefore, for Enrico, the bronze door had to constitute testimonial evidence of this change, and ensure the future subjection of this Molise centre to the Benevento archbishop.

The bronze doors of medieval churches have often held the same significance as a document. For in-

15 Fabre, Duchesne 1910–1952, II, 103.

16 Fabre, Duchesne 1910–1952, I, 34–39.

17 Andenna 2005, 373.

stance, Pope Hadrian I (772–795) reused an ancient bronze door, transported from Perugia, in the Vatican, on which he had engraved the *Patrimonium Sancti Petri*. Similarly, the second door of Montecassino, engraved by Abbot Oderisio II (1123–1126), depicted the territories and monasteries linked to the mother house of the Benedictines. Additionally, Oderisio da Benevento designed two doors at Troy (1119 and 1127) displaying the historical succession of all the bishops of this "*nova civitas*" founded in the 11th century on the ruins of *Aecae*.

The documentary value of Benevento's cathedral door was confirmed during a trial which took place at the time of Archbishop Monaldo (1303–1333). The trial concerned the community of Limosano's request to regain the diocesan seat by merging it with that of Fiorentino, an almost uninhabited place at the time. The existence of a bishopric in Limosano was thus called into question, and the door of the cathedral played a central role in the trial. The witnesses at the trial confirmed, because they had been there several times, that the Benevento cathedral doors featured many sculpted images of prelates, and that within the left hand door there was that of the Bishop of Limosano, as attested by Abbot Ruggero di Simone among others:

> "*Vidit in portis maioris ecclesie beneventane ymagines omnium episcoporum provincie beneventane, scultas cum subscriptionibus civitatis episcoporum, inter quas vidit sculturam ymaginis episcopi Limosani prope ymaginem seu sculturam episcopi Alesine et ymaginem seu sculturam episcopi Alifij et subscriptio talis erat "Episcopus Limosani"*
> ("He saw in the doors of the greater church of Benevento the images of all the bishops of the province of Benevento, sculptured with the names of the bishops of the city, among which he saw a sculpture of the image of the Bishop of Limosano near the image or sculpture of the Bishop of Lesina and the image or sculpture of the Bishop of Alife and the name was "Bishop of Limosano").[18]

This testimony also seems to confirm that the position of the panels with the bishops has not undergone any radical changes since the various restorations that took place in the modern period; in fact, before the war, the panel with the prelate of Limosano, the second on the third to last register, was placed above those showing the bishops of Lesina and Alife, respectively first and second on the penultimate row of the left hand door.

The removal of the name of the Benevento archbishop and its replacement with that of an anonymous Bishop of Lesina remains unexplained. During the 13th century, one of Henry's successors sacrificed the figure of the former to introduce that of a new prelate, representing a recently established or reconstituted bishopric.[19] Unfortunately, there is very little evidence for the foundation of this diocese. While we have records of a Bishop Felice (1232–1235), a donation to a Bishop of Lesina in 1179 is only handed down to us in a dubious document from the 15th century.[20] It does not appear in the *Liber Censuum*, nor in the records of Albino, but the diocese is mentioned in a letter from Gregory IX of 1237.[21]

The alteration on the door is probably attributable to political factors. With the advent of the Swabian dynasty, relations between Benevento, the papal city, and the Kingdom of Sicily, changed radically. Between 1229 and 1230, there were several clashes between the people of Benevento, assisted by papal troops, and the imperial army. Later, in 1240, Frederick II besieged the city and, after its surrender in 1241, ordered the destruction of its walls, which was only partially carried out. The city that had been, "*lapis offensionis et petra scandali regni nostri*" ("a beacon of misfortune and a scandal on our reign")[22] for the Swabian monarch, was thus brought under royal dominion.[23] Between 1241 and 1252 the archiepiscopal see was vacant, and a rebellion by the citizens against Frederick led to more

18 Bozza 2017, 120.
19 Kamp 1973–1982, I, 271–273.
20 Kamp 1973–1982, I, 271.
21 Andenna 2005, 374.
22 Carbonetti Vendittelli 2002, 441, no. 460.
23 Martin 2005.

destruction in 1250. From 1252, the Benevento citizen Capoferro became archbishop, who ruled the diocese until 1280[24]. When the city briefly returned to papal power, he concentrated on the reconstruction and reorganisation of the ecclesiastical province. He then fled to Rome when Benevento was occupied by King Conrad IV, but returned in 1254. Then, with the resumption of Swabian control of the city under Manfredi (1258), Capoferro had to navigate between the wishes of the pope and the king, but showed a strong bias in favour of the new sovereign, above all to safeguard the autonomy of the city and its diocese, but which led to his excommunication.

In the government of the large territory under his jurisdiction, he appointed numerous holders of suffragan seats. Between 1254 and 1255 he elected bishops, receiving disapproval from Alexander IV as a result. The evidence for the appointment of a canon from Benevento, Nicolaus, as bishop of Lesina, dates to 1255.[25] All these events suggest that Capoferro's time in office saw the inclusion of the new diocese of Lesina among the suffragan seats of Benevento. This decision, which led to the removal of the depiction of the Archbishop of Benevento among the prelates engraved on the bronze doors at the entrance to the cathedral, aimed to defend archiepiscopal prerogatives, despite the conflict with pontifical power, and to reaffirm the prestige of the Benevento see, which, with Lesina, had gained a new diocese.

The figure of Archbishop Enrico could well have been removed to confirm the establishment of this new suffragan bishopric, located at the end of the Gargano peninsula, and, with this, demonstrate the expansion of the geographical area placed under the jurisdiction of the curia of the ancient capital of the Lombard duchy. Therefore, the renewed push for autonomy by the city and local clergy, together with the new status of Benevento as a royal city, led to an artistic manifestation of these prerogatives through the replacement of the figure of the city archbishop from the time the door was created, with the representative of a recently acquired episcopal see.

As Giancarlo Andenna writes, when discussing the first version of the door (the one commissioned at the time of Archbishop Enrico), the message appeared to be very clear: "*Benevento apparteneva al papa, vicario di Cristo, e l'arcivescovo, nominato e consacrato dal pontefice, desiderava essere visto e pensato come un vicario del vicario di Cristo*" ("Benevento belonged to the pope, vicar of Christ, and the archbishop, appointed and consecrated by the pontiff, wished to be seen and thought of as a vicar of the vicar of Christ").[26] With the changes made in the Swabian period, the perception of the entire political programme on the bronze door of the cathedral changed; the scene of the *Papal Investiture* was now interpreted as an act of consecration by the Benevento archbishop on a suffragan bishop. This was, therefore, the reading of the episode over the following centuries, as confirmed, for example, by the image contained in the reliquary containing the remains of Saint Bartholomew, commissioned at the time of Archbishop Arnaldo de Brussac, around 1338. Here a prelate wears a headdress very similar to that of the pontiff on the bronze door.[27] This interpretation, reiterated in the city's modern historiography, was amplified in studies until recent years, until a careful restoration completed in 1999 made it possible to restore the iconographic truth to the Benevento monument.

Not all scholars, however, subscribed to this explanation of the subject of the panel placed as the *incipit* of the series of prelates from the diocese of Benevento. Their focus instead was on identifying the pontiff depicted in the central character of the scene.[28] The observation that this individual was in fact a pope not an archbishop, derived from a comparison between the shape of the papal tiara with the headdress worn by the archbishop of Benevento in works of art created between the 11th and 12th centuries. Indeed, the character present in the panel (fig. 4) wears the pontifical tiara

24 Kamp 1975.
25 Kamp 1973–1982, I, 272–273.
26 Andenna 2005, 362.
27 Schimmelpfennig 1991, 365–368.
28 Sirch 1973, 96, 104.

Fig. 7: Saint Alexis' Stories, detail, fresco, 1078–1084, Roma, Saint Clement's Basilica (after Romano 2006, 146 fig. 3).

as we see it, for example, on the tombstone of Pope Lucius III (1181–1185), preserved in the cathedral of Verona.[29] Older depictions, such as the scenes of the *Translation of the Body of San Clemente* and the *Saint Alexis' Stories* (fig. 7), present in the ancient basilica of San Clemente in Rome (1078–1084) also show the tiara in this way.[30] However, the archbishop of Benevento at this time wore a headdress distinct from the mitre, the *camelaucum*, a round flat byssus hat, which can be seen on the *Exultet Casanatense*, a work of the first half of the 12th century of Benevento production, likely commissioned by an archbishop (fig. 8).[31]

29 Paravicini Bagliani 1998, 71.

30 Romano 2006, 145–147.

31 Rome, Biblioteca Casanatense, ms. Cas. 724/III. Cavallo 1994; Aceto 2000.

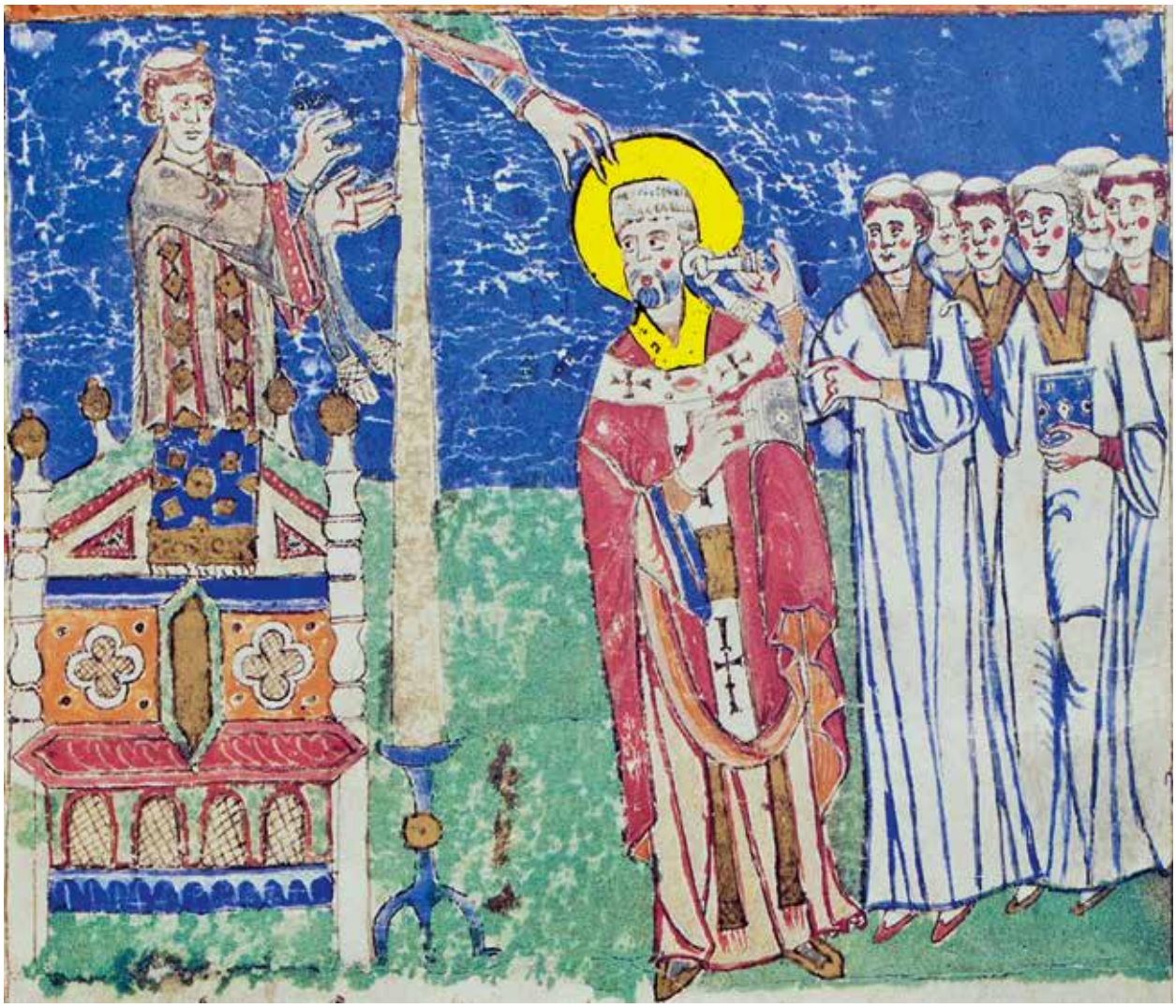

Fig. 8: Fratres karissimi (detail of Exultet Casanatense), parchment, 12th century, Benevento (Roma, Biblioteca Casanatense, ms. 724/III c. 1RD2) (after Cavallo 1994, Facsimile).

The earliest testimony for the presence of this headdress, distinct from the mitre, among the liturgical vestments of Benevento Cathedral, dates to the time of Archbishop Capoferro (1252–1280). He had initiated new works on the cathedral, which had already undergone interventions on its façade and churchyard at the beginning of the century. This is evidenced by a diploma from Archbishop Roger from 1217, which states that one-third of funds were to be assigned "*operi maioris ecclesiae nostrae, vel refectioni ipsius*" ("for the building or the repair of our main church").[32] Damaged during the battle of 1266, in which Manfred died and Charles of Anjou conquered the kingdom, Capodiferro initiated restoration work and, in 1279, began work on the bell tower, erected "*de oblationibus fidelium et cleri*" ("thanks to the offerings of the faith-

32 Meomartini 1889, 420; Glass 1991, 147–148.

ful and the clergy"), as stated in the epigraph on the monument. Restoration works also took place on the basilica of San Bartolomeo, which then stood next to the cathedral on its left side, near the transept.

These interventions resulted in huge debts for the bishop's coffers, leading to a necessity to resort to loans in exchange for precious objects from the treasury. After the death of the archbishop, his successor, Giovanni di Castrocielo, in 1284 was able to honour the debts caused "*in fabrica maioris ecclesie beati Bartholomei apostoli de Benevento*" ("in the construction of the main church of Saint Bartholomew in Benevento"), regaining the pledged treasury items, including the "*coronam domini archiepiscopi*" ("archbishop's headdress"), commonly known as the "*calamauca*", and the mitre adorned with enamel, gold and pearls.[33] This seems to confirm therefore that the tiara, of a similar shape to that of the pontiffs, was never the prerogative of the archbishops of Benevento until the end of the 13th century, and only later did this desire for assimilation assert itself between the archbishops of Benevento and the popes. This desire manifested itself not only in the formulas of the acts issued by the curia and in the leaden bulls placed at the bottom of archiepiscopal privileges, but also openly and visibly in the main liturgical ceremonies, when the prelate adopted a headdress, still called the *camauro*, but in every other way very similar to the pontifical tiara.[34] To put an end to this practice, which had become a custom during the 14th century, Pope Paul II had to intervene with a *motu proprio* in 1466.[35]

If the Benevento archbishops were able to transform their round byssus *camauro* headdress, which they had used until the 12th century, into a tiara, a *triregnum* which they still subtly defined as *camauro*, the modifications they made to the bronze cathedral door in the mid-13th century would have played an important role in this power game. Once again, these bronze panels represented in the eyes of the clergy and contemporary Benevento people, not only a prestigious work of art that enriched their cathedral, but a true document of history, an act on which to found prerogatives and privileges, asserting that they had the strength to raise Benevento to the rank of a *Roma secunda*.

The dating of the bronze door of the cathedral of Benevento to the second half of the 12th century, during Henry's episcopate (1156–1170/1171), finds further confirmation in the city's artistic panorama. The realisation of the two doors of the church which housed the remains of Bartholomew, commissioned by the citizens and the local clergy and carried out by Oderisio between 1150 and 1151, served as a significant precedent. These doors became a benchmark for the cathedral, which could not be without an equally impressive door of the same precious material. Henry did not fail to seize the opportunity to elevate his church to the rank of the nearby apostolic *martyrium*.

Other references to contemporary artistic production can be seen in the decoration of the cloister of the Benedictine monastery of Santa Sofia, a religious institution of Lombard foundation located in the city centre, a few steps from the cathedral.[36] This complex cloister features a rich set of illustrated and historiated crutch capitals, one of which contains an inscription in capital letters which recalls Abbot John IV, documented between 1142 and 1176. As mentioned before, he was elected cardinal priest in 1168, and was the brother of Alberto de Morra, Pope Gregory VIII (1187).[37] The epigraph in leonine hexameter reads "*Perpetuis annis stat quarti fame Iohannis / per quem pastorem domus hunc habet ista decorem*" ("May the fame of Abbot John IV last forever, thanks to whom this building received this ornament"). It celebrates John's role in the monastery's decoration, with the hope that his fame will last forever. We can therefore hypothesise that it is a eulogy engraved *post-mortem* to remember the work of a great abbot of the monastery.

33 Andenna 2005, 367–368.
34 Andenna 2005, 352–354.
35 Schimmelpfennig 1991; 2005.
36 Naldi 1990; Glass 1991, 37–40; Gandolfo 1999, 41–47.
37 Zazo 1937.

Fig. 9: Visitation, plate of the Bronze Door, 1156–1171, Benevento, Cathedral (© Martin Fera/Novetus/GAPAMET).

The dating of the capitals, especially those depicting the cycle of the months and scenes from the Old and New Testaments, can be fixed to the decades around the middle of the century, and therefore a time very close to the execution of the bronze door of the cathedral. These writings visible on the sculptures of the cloister bear possible similarities to the *tituli* engraved on the door panels. The names of the figures of the months on the capitals present a *ductus* rich in uncials, comparable with that of the suffragan bishops present on the panels of the door, among which we also find some captions with capital letters. This is reflected in the praise for Abbot John, engraved on one of the capitals of the cloister.

Upon examining the formal solutions adopted in the construction of the figures, in the pose of the heads, in the expression of the faces, as well as in the engravings of the hair, we can observe a certain correspondence between the marble sculptures of the cloister of Santa Sofia and the characters depicted on the panels of the cathedral door. We can examine two comparisons that I think are significant. First, *Mary of the Visitation* (fig. 9) is comparable in the pose, the cut of the face, and in the construction of the figure, with a character present in the capital *Samson Slaughtering the Lion* in the cloister (fig. 10). Similarly, Simeon in the *Presentation in the Temple* (fig. 11) reveals strong similarities, in the execution of the hair and beard with its thick and parallel striations, and the raised contour of the eyes, with the figure present in the capital with the Tetramorph (fig. 12).

Even the marble portal of the cathedral that frames the bronze doors, with its inscriptions praising the Virgin, has a raceme decoration in the architrave (with the *Agnus Dei* in the centre) (fig. 6), which reveals characteristics similar to the formulas adopted on the faces of the crutch capitals of the cloister, just as the animals that inhabit the racemes of the door jambs reveal formal and stylistic forms comparable to those present in Santa Sofia.

Another work that shows similarities with the bronze door and the sculptures of the cloister of Santa Sofia, is the candlestick that was located next to the pulpit, inside the cathedral. Now severely damaged, only the fragmentary base and part of the stem remain. Here too, comparable forms can still be revealed between the drapery and posing of the figures as well as in the workmanship of the animals with the images on the cathedral door and those on the capitals of the cloister, confirming the common artistic milieu in which all these works were created.

Fig. 10: Detail of a capital, marble, 12th century, Benevento, Santa Sofia, Cloister (© Antonio Milone)

All this seems to confirm, therefore, a dating of the third-quarter of the 12th century for the bronze doors commissioned by Henry, and that the forms adopted on the imposts bear a significant resemblance to contemporary sculptural production from Benevento. These similarities are apparent on the cathedral façade, its interior, and in the nearby cloister of Santa Sofia.

All this raises questions about the relationship between the caster and the moulder of the plates of the

Fig. 11: Presentation to the Temple, plate of the Bronze Door, 1156–1171, Benevento, Cathedral (© Martin Fera/ Novetus/GAPAMET).

Fig. 12: Detail of a capital, marble, 12th century, Benevento, Santa Sofia, Cloister (© Antonio Milone).

bronze door panels. We know from various testimonies that the execution of a complex project such as a bronze door required teamwork, where a manager was entrusted with the final task of casting the lost wax models and the finishing of the cast products. It was he who ultimately signed off, and took responsibility for, the creation of the artefact. However, the person who signed off on the work was not always the same person who moulded the figures that would then be transformed into metal alloy. It is likely that for the Benevento Cathedral doors, the anonymous foundryman, tasked with giving form to the evangelical episodes and creating figures of the suffragan bishops, had to turn to the sculptors working in the active construction sites in the city, while he would have lent his expertise to the casting of the two doors.

Finally, this observation raises a more general theme that warrants careful consideration in future studies on medieval bronze doors: namely the relationship between those who have the task of modelling forms by offering stylistic and formal solutions for artistic representation, and the man in the foundry. He was not always the same individual who took care of the artistic forms, but he was involved in the most delicate and precious phase, that of the final realisation. In the eyes of contemporaries, the foundryman was the real person responsible for the work, regardless of who actually conceived the artistic form of the doors. However, today, we primarily appreciate and examine these artefacts for their expressive qualities and forms, often overlooking the value and expertise involved in their technical execution.

Zusammenfassung

Benevent ist ein Knotenpunkt der Gießereikunst in Süditalien. In diesem Zusammenhang spielte die Bronzetür der Kathedrale von Benevent eine herausragende Rolle. Die Entdeckung des Namens des Erzbischofs von Benevent, Enrico (1156–1170/1171), auf der Tür führte zu einer deutlich früheren Datierung der Tür, ermöglichte die Einordnung des Werkes in einen neuen historischen und künstlerischen Kontext und warf darüber hinaus neue Fragen zur ursprünglichen Absicht des ikonographischen Programms der Tür auf. Fraglich sind nach wie vor die Zeit, in der spätere Änderungen durchgeführt wurden, sowie die Bedeutung, die diesen Veränderungen zuzuschreiben ist. Die Herstellung und die Überarbeitungen an den beiden Flügeln erfolgten zwischen zwei berühmten Todesfällen in Benevent: der Ermordung des Stadtbischofs Peter II. im Jahr 1156 und dem Verschwinden von König Manfred in der verlorenen Schlacht gegen Karl von Anjou im Jahr 1266, als die Stadt unter päpstlicher Herrschaft stand.

Riassunto

Benevento è un crocevia dell'arte fusoria in Italia meridionale. In questo contesto, la porta bronzea della cattedrale di Benevento ha giocato un ruolo di primo piano. La scoperta del nome dell'arcivescovo di Benevento Enrico (1156–1170/1171) sulla porta ne ha rivoluzionato le conoscenze, anticipandone significativamente la sua datazione e permettendo di collocare l'opera in un diverso contesto storico e artistico e ponendo nuovi interrogativi sull'intento originario del programma iconografico della porta della cattedrale di Benevento, sul tempo in cui fu eseguita la modifica e sul significato da attribuire a questi mutamenti. La realizzazione e le modifiche apportate alle imposte bronzee si collocano, quindi, tra due morti illustri avvenute a Benevento: l'assassinio del vescovo cittadino Pietro II nel 1156 e la scomparsa di re Manfredi nella battaglia persa contro Carlo d'Angiò, combattuta nel 1266 presso la città sotto il dominio pontificio.

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Medieval Bronze Doors as *Figura* of Heavenly Jerusalem's Gates

The Materiality of the Virtual in the Iconologies of Matter, Technique, and Object

Heike Schlie

In research on the bronze doors of the 11th and 12th century, such objects have often been referred to as "Gates of Paradise", as with the project from which the present volume emerged. In this study, material, technique, and object iconological approaches are used to describe more precisely and systematically the status of these bronze doors as material *figura* and virtual counterparts or substitutes of the heavenly doors. The church door does not symbolise the gate of paradise, but rather embodies it in a carnal–material, performative and functional way. The Paradise gates or the doors of the Heavenly Jerusalem themselves have a transcendental status. The present study aims to show how, and for what purposes, their earthly absence gained virtual presence within the materialised church doors,[1] emphasising the role of the bronze material. The church door cannot materialise the Paradise gate, and it would not suffice to say that it it is a medium refering to the latter either. The most precise way to define them would be to say that the church door materialises the virtual presence of the Gates to the Heavenly Jerusalem.

This investigation into the materiality of the virtual, is situated in the context of art history as *Objektwissenschaft*,[2] what cannot be translated in a satisfactory way. Art history as 'object studies' is not to be understood as opposed to or a substitute for *Bildwissenschaft*[3] ('visual studies'), but as a complement to the latter.[4] Although *Bildwissenschaft* of the last 30 years has contributed a great deal to our understanding of historical imagery and the theories associated with visual media, it has often ignored both the objecthood and the materiality of artworks. Sometimes it is not just about seeing or visuality, but about being corporeally confronted by the object, sharing the same space, about touching, the haptic experience, even hearing and smelling and handling the object in whatever way. Furthermore, there is the primary thesis that medieval art works very often reflect not only the material and techniques used, but also their own object status, in order to inscribe themselves and the activity of the artist into the cosmos of the plan of salvation. In other words, the artists also take into account the semantics of the material and the techniques used for the constitution of the meaning

1 In some research contexts, virtuality is taken as a synonym for transcendence, which seems to be a general problem for research on medieval virtuality. Virtuality does not exist without a sort of material carrier; the virtual world of computer games, for instance, is depending on the 'materiality' of hard– and software. - I would like to take this opportunity to thank Isabella Nicka, who had the idea for a research focus on "Materiality and Virtuality" and with whom I developed a corresponding concept in 2021. Since the end of 2021, the Institute for Medieval and Early Modern Material Culture (IMAREAL) has been working on the research focus "Sensing Materiality and Virtuality", from which this article also benefits.

2 Since *Objektwissenschaft* as well as *Bildwissenschaft* cannot be translated well into English, and *Bildwissenschaft* is used as a term in the English language, I propose the same use for *Objektwissenschaft*.

3 *Bildwissenschaft* is a methodology that was introduced into the disciplines of art history and visual studies by Hans Belting, Horst Bredekamp, and Gottfried Boehm in the 1990s.

4 Schlie 2022a, 10–14.

of the artwork, or even attribute theological values to them through certain reference formations, ultimately in order to manifest their own relevance as artists within the history of salvation.[5]

In the following, I will discuss those cases in which the artwork explicitly refers to its own material, its technique, or its significance as an object, in its pictures or inscriptions. The iconology of the material and the technique concerns the question as to how the material of the artwork (emphasised as such in the artwork) and the techniques used contribute to the meaning, status, and impact of the artwork. The relevance of an iconology of technique becomes clear, for example, in depictions of the *Deus Artifex*, in which God draws the circle of the earth with a compass.[6] Both aspects are crucial for the broader notion of what I mean by object iconology. Into which horizon of meaning does the work of art inscribe itself as an object that consists of certain materials and was made by special techniques?

Bronze: iconology of material, technique and the object

For art history, a disregard for the material and technique of a work of art is closely linked to the history of art criticism and art theory. In one of the earliest explicit contributions to material iconology, Bandmann writes: "As long as the essence of art was seen as being founded in the idea, in the *disegno* and the *concetto*, the material used only signified the medium required by the idea that urged for visualisation."[7] Bandmann even sees a negation of the material in the 15th and 16th centuries, insofar as it is sublimated as far as possible and 'muted' in its sensual manifestation, so that the idea can emerge in its pure form. However, it remains open whether this is really due to an overall endeavour of early modern art itself, or a modern art historical projection or one–sided concentration on the written art theory of the early modern era.[8] The dualisation of matter and idea was thus a given for art history until the end of the 20th century.[9] Later on, as already mentioned, the development of art history into visual studies – as important as this was for the subject of art history – has led to a continuation of a disregard for object status and the material conditionality of artworks.

In research literature, material iconology is often understood as describing what a certain material generally means or can mean. However, the semantics can vary greatly depending solely on the genre or medium, and the context. For example, bronze baptismal fonts refer to the typological prefiguration of baptism, the Brazen Sea of the Old Testament, which then applies only to that genre. But even within the genre of baptismal fonts, a wide variety of material meanings of bronze were activated differently. In fact the bronze's semantics can be highlighted as such in the pictorial and scriptural programmes, in which the flowing of the river Jordan, the flowing of the water of baptism, the flowing of liquid bronze into form, and the flowing of the grace of God, are explicitly associated with each other, as is the case in the example in Lüttich in St Barthélemy,[10] but this does not automatically apply to every baptismal font made of bronze.

Mediaeval bronze doors can always be related to ancient Roman bronze doors, and often the significance of the material is thus more implicit and applies to bronze doors in general. On the other hand, mediaeval bronze doors which show picture narratives in a frame system, are successors of both ancient panelled, imageless bronze doors as well as wooden Christian doors with pictural programmes. They mark the entrance to the church building as a threshold to the salvation space as the former wooden doors did, and at the same time adopt the eternity and power *topos* of Roman bronze doors. But they also relate in the sense

5 Schlie 2022a, 15–17. This is explicitly formulated in the prologues of the *Schedula Diversarum Artium*, see https://schedula.uni-koeln.de [last access: 13.03.2025].

6 Wiener Bible Moralisée, around 1220: Wien, Österreichische Nationalbibliothek, Cod. 2554, fol. 1.

7 Bandmann 1969, 75, translation by the author.

8 Bandmann 1969, 75. I hold that it is more likely to be a projection of 19th century art historiography onto the early modern period, as completely different approaches to the material can also be found for the latter period, for example in the context of the *Kunstkammer*.

9 Lehmann 2012, 10–11; Kühtreiber, Schlie 2017.

10 Schlie 2023.

of the '*translatio imperii*' which may be the main reason why Charlemagne had the doors of Aachen cathedral cast from one solid bronze piece.[11] The use of lions' heads are also adaptions based on the ancient Roman model. From there, bronze could become the material *de rigeur* of Christendom. According to Weinryb, the Christian pictorial programme of the Hildesheim bronze door is only of secondary importance; more important to him is Bishop Bernward's strategy of using the single-cast bronze door leaves, and the Christ Column, similarly cast, to create technological symbols of triumph and remembrance in Hildesheim, in the context of the conversion of the pagan Slavs on the periphery of north-eastern Germany.[12]

Bronze doors of the 11th and 12th centuries consist of copper alloys of different compositions, for which there were no differentiated and defined terms in the Middle Ages. This applies not only to the contemporary theological allegorisations of bronze, but also to the Old Testament in the *Vulgata*. Ore alloys were not differentiated according to their exact composition, and our concept of bronze (copper and tin) and brass (copper and zinc) cannot be related to the variety of ore alloys in pre–modern times. The important bronze cult objects of the Temple of Solomon, for example, which are discussed in various books of the Old Testament, are referred to simply as 'ore artefacts'. In Latin, there is only one term that can be used to describe copper, copper alloys, or ores: *aes* as the noun and *aeneus* or *aereus* as the adjective:

> "Columnas autem aereas, quae erant in templo Domini, et bases, et mare aereum, quod erat in domo Domini, confregerunt Chaldaei, et transtulerunt aes omne in Babylonem. Ollas quoque aereas, et trullas, et tridentes, et scyphos, et mortariola, et omnia vasa aerea, in quibus ministrabant, tulerunt."[13]

Thus, a word for our modern understanding of bronze (an alloy of copper and tin), in contrast to brass (an alloy of copper and zinc), did not really exist, while brass was also called *aurichalcum* because of its golden colour. In addition, many ancient and mediaeval alloys contained both tin and zinc, and their proportions in the overall alloy also varied. Weinryb states that it is not clear to what extent the foundrymen realised the difference.[14] However, even if the terms that are used simply mean 'an alloy of different ores', the foundrymen must have been aware of the relevance of their composition, as the different alloys, including their additions of iron, nickel, lead, arsenic, etc., behaved differently during casting, and produced different results after cooling.[15] The respective solidified materials had different properties in terms of hardness, surface, colour and resonance, the latter being very important for the casting of bells. Brass is more gold–coloured than tin bronze or lead bronze, and this may have played a role in the Liège baptismal font and the chromatic doors of Byzantine origin, for example. A material's colour and surface properties also provide different conditions for the reflection of light. Pliny was already familiar with brass alloys, but the term *aurichalcum* used by him seems to refer to an ore (calamine?), and not the alloy of copper and calamine.[16] However, the anonymous author of the *Schedula diversarium artium*

11 The so called *Wolfstür*, the door of the *Karlskapelle*, the door of the *Hubertuskapelle*, and the door of the *Annakapelle*, the latter two being cast from the same model. See Mende 1994, 21–24, 131–133; Weinryb 2016, 16–23.

12 Weinryb 2018.

13 Biblia Sacra Vulgata, King James Bible, 2 Kings 25, 13–14: "And the pillars of brass that were in the house of the LORD, and the bases, and the brazen sea that was in the house of the LORD, did the Chaldees break in pieces, and carried the brass of them to Babylon. And the pots, and the shovels, and the snuffers, and the spoons, and all the vessels of brass wherewith they ministered, took they away." The translator of the Anglican King James bible (first published 1611) chose to translate '*aes*' as 'brass' (copper–zinc–alloy), whereas Luther chose the more neutral German term '*ehern*' which means 'made from ores', which is nowadays a very old-fashioned term.

14 Weinryb 2016, 4.

15 I thank Marianne Mödlinger for her support in technical material matters. Without her project initiative, the GAPAMET team's collaboration and the discussions in front of the doors, the present article could not have been written.

16 Pliny, Naturalis Historia, Book XXXIV, 2.

17 *Schedula diversarium artium*, Book 3, chapter LXVI. The processing of calamine, consisting of zinc carbonate, zinc silicate, and lead, was necessary for zinc extraction because metallic zinc does not exist in nature.

calls a copper–calamine alloy "*aes*",[17] when the copper is not cleared of lead, but he also uses the term "*aurichalcum*" for copper-calamine-alloys.[18] Thus the term *aes* has been used for completely different copper alloys, and cannot precisely define the material in terms of its substantial composition.

While material has come more into focus in recent years, this only applies to a limited extent to technical aspects or techniques. But with bronze in particular, it is not possible to separate material from techniques, because the material does not exist without the technique of smelting, for example. Like glass, bronze is one of the early artificial materials, that is to say even its production requires expertise, namely: mining, smelting, furnace construction, a knowledge of relative melting points and the flow behaviour of the alloy in the mould, a knowledge of the properties of alloy variants, etc. The artist or the foundryman always makes decisions for the properties of the 'bronze' (copper-alloy) by creating a variant from the indefinite palette of possible alloys for a specific requirement, producing a substance which only comes into existence from the moment of casting. To explain this difference compared to other available and worked materials in more detail, we can use the analogy of using a piece of wood, a block of marble or an elephant tusk, which changes the shape but not the substance of the material. Generating an alloy was always seen as a sort of alchemical process;[19] even if a caster used recipes, he could not be completely sure of the actual outcome, as the casting process itself includes several more variables influencing the process of a successful cast. Furthermore, the artist may have understood his activity as generating a material like God had created stone, wood, and all the other materials used in art. In the 16th century, it was widely debated whether God had actually created all metals and minerals at the beginning of the earth's existence, or whether he had merely implemented the potential means to create various alloys,[20] leaving the creation of a specific metal to humans. Ǧābir ibn Ḥayyān (latinised as Geber), the so called 'father of alchemy', wrote on the subject of metals in the second half of the 8th century, saying that: "Metallum est corpus mixibile, fusibile et sub malleo ex omni dimensioni extensibile".[21] Man-made metals, therefore, had properties that distinguished them from other (natural) materials at a fundamental level. The fact that there were neither fixed definitions nor clear categorisations for such materials must have imbued the perception of the material itself, and the expertise of its producer, with a notion of extraordinary creative power.

There is a further factor to consider: we can never rule out the possibility that a mediaeval bronze object was cast from the material of an older object. The decision is then based less on a choice in favour of a conceived alloy/mixture for a particular object, but rather the idea that the former object is still inscribed or incorporated in some form in the new work.[22] In the case of the baptismal font in Liège that is shaped like the Brazen Sea of the Old Testament, for example, the now melted ancient objects it was made from,[23] still inherent in the font, would be physically (in the sense of 'materially') connected to the form of the cult device from the Temple of Solomon. Since antiquity was roughly considered to be the time when Christ was on earth, the concept would have been that materials created during Christ's lifetime, the beginning of the New Covenant period, would merge with an Old Covenant form that was modified in a Christological way by the artist.[24] At least at the time when these artefacts made from reused bronze were created, such reuse would have been known to local viewers, even if it was not visible on the newly cast objects themselves. The metaphors of bronze casting used for various ab-

18 *Schedula diversarium artium*, Book 3, chapter LXVII. For this work, and information on it, see: https://schedula.uni-koeln.de [last access: 13.03.2025].

19 Weinryb 2016, 34–35

20 Haug 2016, 116.

21 Cited after Beck 1884, not paginated. Metals that were not expandable, such as antimony, were only discovered much later.

22 On the significance of this "recasting" for bronze objects, see Weinryb 2016, 3. "In the intrinsic particles of the bronze object lies what we might term its hereditary code".

23 Martinot holds that the material of these baptismal fonts' stems from ancient objects because of the composition of the copper-zinc alloy: Martinot 2003–04, 111.

24 Schlie 2023.

stract theological concepts, highlight an awareness of the material taking on a form. The transition from melted down to a solidified or cooled artefact becomes clear, as we will see here below. Since antique artefacts were generally associated with the lifetime of Christ, we must assume that such an impregnation was also generally taken for granted for new artefacts. Bronze could appear as a shape–shifter in several senses: after melting down and recasting, the material transforms into a different shape; in the lost wax process, the same shape transforms into a different material. The latter transformation, specifically the evocative idea of what happens inside the mould, can be traced in the much–quoted inscription on a door ring from Trier Cathedral: QUOD FORE CERA DEDIT TULIT IGNIS ES TIBI REGDIT (What the wax gave, the fire took; and it is returned to you by the bronze / ("ES")).[25] This inscription (referring to the shape or form of the artefact) is treated by Bushart and Haug as evidence for the special actor status or agency of bronze, but in fact this poetic formulation ascribes agency not only to the bronze, but also to the wax and fire, although wax, unlike bronze, takes on form directly due to the artist's tools and not as a result of its own agency and movement. Even if I have no doubt in principle about the special actor status of bronze, I see in the verse mentioned above more the poetisation of an inversion in a particular moment of the work process: the solid form (wax) becomes liquid; the formless liquid (bronze) that appears in the same place then itself becomes a form. In contrast to copper, which exists 'naturally' in the ore, bronze, as an artificially generated material, is always destined to become a form; Haug speaks of it as a 'teleological material'.[26]

In fact, in the case of bronze doors, a specific reference to the material as an ore alloy is almost always automatically linked to a reference to the techniques of bronze casting into form. This can be explained by the fact that the bronze raw material to be processed is essentially a fundamentally artificial material that has no existence outside of its moulded or forged forms; the ores are only components of the material. This is also different to natural materials of plant or animal provenance, or with marble extracted from a quarry, which is processed directly as that material. The reliquary of St Aemilian in San Millan de la Cogolla, Spain, which is adorned with panels of ivory, is a good example here. On this object, the saint blows into an olifant made from a (rather small) elephant tusk, and at the same time the transport of ivory, in the form of a giant tusk, was thematised on another, now lost panel.[27] Thus, the material used for the reliquary is visually referred to several times, but the techniques used to process it are not.

In the following section I will describe bronze doors made of different alloys and with different techniques (solid casts or panels on wood). Bronze doors open up two different aesthetics, both of which already played a role in late antique doors. While doors such as the door of the Roman Curia, which Borromini used as the main entrance to the Basilica San Giovanni in Laterano, Rome, have a sculptural character that works with a changing play of light and shadow, the effect of Byzantine flat panel doors, which work with inlay and niello, is more stable in terms of light effects; they are chromatic and pictorial, as opposed to sculptural.[28] One aspect that we do not have the space to discuss in detail here is the framing of the panels. While in solid cast doors they have a purely structural and aesthetic function, in wooden doors with bronze fittings they have a tectonic one. There they hold the panels, which they overlap, to the door and conceal the gaps, but they also can be designed to provide aesthetic structure. Matthiae points out that Byzantine doors are axis-accentuated because their vertical frame pieces are continuous, unlike the vertical ones.[29] There is also another feature that should not be underestimated: a door made of wood

25 For example Bushart, Haug 2016, 8.

26 Haug 2016, 111.

27 It was once kept in the Berlin Museum, but its whereabouts have been unknown since the Second World War. See Salem 2004, 124.

28 Matthiae 1971, 19; Frazer 1990, 273.

29 Matthiae 1971, 25.

and mounted with metal panels is more than just a wooden door, also in respect of the impenetrability of the closed door. There is evidence that the mounting of metal panels on wooden structures was understood as a kind of fortification of a tectonical structure, at least in a metonymical sense.[30] All these features are crucial for the perception and aesthetic impact of these doors, also in terms of the virtual sense of the doors as gates to Heavenly Jerusalem.

San Zeno I: the liquefied Christ in the crucible

In this section I will present a case that not only showcases bronze–specific techniques and tools used to make the doors, but also connect the semantics of the images on the door to the real door as the threshold to redemption. On the bronze Door of San Zeno in Verona, we are confronted with a *Deposition of the Cross*, which looks like a crucifixion at first glance (fig. 1).[31] Mary and John are pushed to the edge and seem almost to make contact with the adjacent scenes, while Joseph of Arimathia embraces Christ's body as if it could already be taken down (fig. 2). However, Christ's hands are still attached to the cross with the nails, while Nicodemus is standing ready with large tongs to pull them out. If we look at the latter more closely, we can see that the nails in Christ's hands are not only depicted as tools within the pictorial logic of the narration, but actually serve a technical function, fixing the bronze panel to the wooden door. These nails are literally used to attach the separately cast bronze figure of Christ to the bronze panel, and at the same time to nail the bronze panel to the wooden support of the door, while at the same time being the nails for the pictorial representation.[32] These multiple levels of meaning and purpose for the nails is the reason why Christ has been cast as a fully three-dimensional, separate figure. The representation of the tongs, in turn, which, within the logic of the image, are for pulling out the crucifixion nails (or to show the tool of a carpenter, which Jesus Christ was, after all), are, rather, shaped like the fire tongs of a blacksmith or the crucible tongs of a bronze caster, who thus inserts himself here in a kind of 'crypto-portrait'.

In the door in Novgorod (1152–1156, formerly in Płock), the bronze casters Riquin and Waismuth are both represented with crucible tongs that are perfectly recognisable as such (fig. 3). Riquin is obviously the older man with a beard, the master of the workshop, while Waismuth has younger features and long hair. The difference in hierarchy can also be seen in the attributes and written signatures. While Riquin holds a pair of tongs and a pair of scales in front of his body, with which the individual components of the alloy are weighed,[33] Waismuth is securing a crucible with his tongs, and thus stands more for the craftsman's work. The scale stands for the correct measure of the ores in the alloy, which the bronze caster was able to master due to his *scientia*. His knowledge goes beyond the *artes mechanicae* because he also has to deal with measurements and mathematics. Perhaps the casters were also assumed to have a fundamental knowledge of natural or divine metallogenesis, which they virtually imitated. Riquin holds the tongs less like a tool than like a royal sceptre, the head of the tongs directly relating to the important "*fecit*" of the signature RIQVIN(us) ME FEC(it). Waismuth is only referred to by his name

30 Schlie 2022b, 227–228.

31 For the reconstruction of the history of the portal and the object biography of the door, see the detailed investigation in Neumann 1979. Both the *Descent from the Cross* and the *Carrying of the Cross* mentioned later are from the first workshop (around 1045–1061 after Coden 2017, 29). See also Mödlinger et al. 2024, 12–15. Mende dates the first workshop later (shortly before 1138): Mende 1994, 63–65. This study does not include illustrations of the entire doors, and only shows the details of the doors discussed. Image files of the entire doors or further details and their terms of use, can be accessed via the following links: https://gapamet.imareal.sbg.ac.at/en [last access: 13.03.2025] https://gapamet.imareal.sbg.ac.at/en/usage-information/ [last access: 13.03.2025]. The colouring of the panel originates at the earliest from the second workshop (around 1138): Mödlinger et al. 2024, 12–15.

32 Boeckler believes that the nails are no longer the original ones but, based on material findings, they are still in their original positions: Boeckler 1931, 9.

33 See for example Bocarov 1990, 224.

Fig. 1: Deposition of the Cross, ca. 1100, Bronze door of San Zeno, Verona (© M. Fera/Novetus/GAPAMET).

Fig. 2: Deposition of the Cross (detail), ca. 1100, Bronze door of San Zeno, Verona (© M. Fera/Novetus/GAPAMET).

in his signature and emphasises the "making" with the tongs, not with the learned sense of the written signature, but with the material itself. His tongs carry a piece of metal which could be a crucible, protruding from the bottom of the panel, however as a crucible it is not depicted as realistically as the tongs touching it. Rather, it looks like a piece of bare material from the plate itself, which may have come into contact with the

real tongs of Waismuth. Either way, the depiction and the production of the entire door intertwine also here in a surprising way.

In the *Deposition of the Cross* in San Zeno, we should imagine that the separately casted figure of Christ has also been embraced on various levels with the arms of the bronze caster's fire tongs. First of all, in the process of production, the bronze figure of Christ would be the liquid material in the crucible of the bronze caster. This is linked to the metaphor of 'Christ in the crucible', which is actually utilised as an allegorical argument by Beda Venerabilis in his exegetical interpretation of the brazen sea in his *De templo*: "The sea is cast, as it was said, and is cast therefore, I say, because Christ truly, being melted down (*conflatus*) and liquefied (*liquefactus)* by the great fire of love, has poured out this grace to us." [34] *Conflatus* is usually translated as 'inflamed',[35] but here I think *conflatus et liquefatus* is a phrase that refers to the nature of an alloy becoming liquid. 'Inflammation' in connection to 'liquefaction' makes no sense, and it must be taken into account here that *conflatus* is also a *terminus technicus* for casting, since the foundryman's crucible itself is called a *conflatorium*.

Secondly, the hardened, but still hot, bronze figure of Christ in the *Deposition* scene must have been taken out of the mould with tongs for further processing, just as Joseph of Arimathea embraces Christ's body with both arms similar to the 'arms' of tongs. Here the motive for handling the cast figure of Christ is repeated in the inner logic of the image as the handling of Christ's dead body with a similar tong structure.

It is also noteworthy that the autonomous figure of Christ is literally nailed to the cross with the same nails that fix the bronze panel to the wooden door. Significantly, the tools of hammer and nails are also explicitly depicted in the pictorial programme, namely on the panel of Christ carrying the cross. Although the depiction here is stylistically reduced, and is without a detailed and accessory–rich description, the hammer and nails needed to assemble and install the door are clearly marked, and make references to the visible, real

Fig. 3: The casters Riquin and Weissmuth, 1162, St. Sophia Cathedral, Nowgorod (after Goldschmidt, Hamann 1932, II 30,36).

nails of the door. Similarly, the historical cross was made of wood, as is the wooden support of the real door, to which the whole pictorial structure of body and cross is nailed. Christ here virtually stands for the bronze 'body' of the whole real door as the gateway to salvation. That is to say, this technique of mounting is referencing the logic of salvation history.

The work of the second workshop on the door reinforced all these meanings by choosing the Brazen Serpent as the Old Testament counterpart to the *Descent from the Cross* for the renovated door (fig. 4). The cross here is depicted frontally and centrally; the bronze serpent coils around the (wooden) cross at the same length as the body of Christ on the left–hand door leaf. Moses, the maker of the serpent, stands in the same place as

34 "Mare ergo est, et fusile, inquit, fusile, inquam, quia profecto grandi charitatis igne conflatus et liquefactus Christus, istam nobis gratiam effudit": PL 160, 1167.

35 Raff 2008, 103; Olchawa 2016, 31.

Fig. 4: The Brazen Serpent, ca. 1138, Bronze door of San Zeno, Verona (© M. Fera/Novetus/GAPAMET).

Nicodemus with the crucible tongs, who represents the caster on a second level of meaning. In depictions of the brazen serpent it does not always seem important whether the snake is made of metal or not, but in this case, its materiality is clear from the overall meaning of the door. The formal similarities between the two panels and the typological tradition of the brazen serpent as a prefiguration of the crucifixion, could be a reminder that the figure of Christ was made of bronze by the artist, whereas the brazen serpent was 'brazen' not only on the door but also in the biblical narrative.[36] The real door is not just a symbol of something virtual or transcendent, but embodies it via its own execution, in its own materiality and form of existence.

36 Weinryb also investigates the emphasis on the Brazen Serpent as a bronze artifact on the door of San Zeno, and discusses the serpent as a bronze artifact in a wider context, but does not relate it to the *Descent from the Cross*: Weinryb 2016, 115–121.

Fig. 5: Ark of Noe, ca. 1100, Bronze door of San Zeno, Verona (© M. Fera/Novetus/GAPAMET).

San Zeno II: the Door of Noah's Ark

There is a further Old Testament panel on the door from the first Veronese workshop (around 1100), which depicts another striking tool (fig. 5). It shows Noah and his ark; in front of the ark on the left, Noah is working on the planks of the ship with a hatchet.[37] On the right, he is seen again pulling a reluctant ox by its horns up the ramp towards the open door of the ark,[38] where other animals were probably originally depicted. The bronze door of San Zeno (as the antitype for its prefiguration in the ark) is thematised in this

37 For the interpretation of this figure as Noah, see Neumann 1979, 47.

38 There must have been another figure in front of the door in its original state, as the nail holes show, see Boeckler 1931, 19.

way as the entrance to salvation. Noah was considered an artist and architect of the Old Testament; the ark, as a structure for salvation, was considered a prefiguration of the church building, as Hugo of Saint Victor, for example, has described it. The measurements for the ark mentioned in the Bible were even taken up and applied to medieval church architecture.[39] It is no coincidence that the hatchet was also the tool of the carpenter who made the wooden beams of the door itself, that also had to be smoothed and worked. On the door, perhaps not by chance either, the hatchet, as a woodworking tool, is assigned to the Old Testament, whereas the one that works the nobler material, bronze, is associated with the New Testament. Also, the 'softer' wood is worked by the stronger metal of the hatchet's head. Whether the partial visibility of the wood on the door, resulting from the style of the panels, also plays a role here is possible as well. What is also striking about this ark is that its outer skin is entirely composed of layers of undulations of water, and perhaps here there is an attempt to reflect the moment where the bronze flows, as it did here, before it solidified. This possibility is made more plausible if we look at other monumental bronze objects, such as the aforementioned baptismal fonts, in which, among other things, the 'flow' of the waves of the River Jordan could also refer to the flow of liquid bronze into the mould. Thus, in Verona, the iconology of the materials of wood and bronze, of the production techniques on one side and the meaning of the door as a door, on the other, are intertwined. It is a complex system. The appearance of the strikingly realistic tools (in an art form that is usually very stylised), links Noah's ark and the descent from the cross not only with the techniques of the artists, but one with the other. The (wooden) ark had saved people from the Flood, the (wooden) cross saves people from original sin. The ark (with its open door) and the cross are thus themselves the door to salvation.

San Zeno III: the doors of the two covenants

In my opinion, this visibility of the wood in the artfully openworked bronze panels also plays a role in a panel of the second Veronese workshop. One of the panels on the right leaf connects the announcement of Isaac's birth to Abraham by the three angels, in the upper register, with the expulsion of Hagar in the lower (fig. 6). Hagar is standing in front of an open door and embraces the door ring with her left hand.[40] As Hahnloser has proven with numerous sources, in the Middle Ages the grasping of a door ring could seal contracts and oaths, or bring about protection from legal or criminal prosecution or protection in the asylum system, i.e. from banishment. Thus this image refers both to the real door and one of its functions.[41] However, this choice of motif must also have been intended to emphasise that not everyone can be granted asylum through this ritual, because Hagar as a "bondwoman", as opposed to a "freewoman", ultimately has to leave. The reason why this rarely depicted scene appears lies in St Paul's Mariological–Christological allegory in his letter to the Galatians:

> "For it is written that Abraham had two sons, the one by a bondmaid, the other by a freewoman. But he who was of the bondwoman was born after the flesh; but he of the freewoman was by promise. Which things are an allegory: for these are the two covenants; the one from the mount Sinai, which gendereth to bondage, which is Agar. For this Agar is mount Sinai in Arabia, and answereth to Jerusalem which now is, and is in bondage with her children. But Jerusalem which is above is free, which is the mother of us all." (Galat. 4: 22–26).

Accordingly, the door which Hagar stands in front of can be understood as the door in front of the earthly

39 Rorem 2009, 129–152; Boblitz 1972; Bezzel 2023, 97.

40 The identification of the women in the lower register is controversial. Neumann identifies the young woman standing at the door as Hagar (Neumann 1979, 38), but Frugoni interprets the figure as Sara (Frugoni 1991, 189). One of her arguments is the differentiated, precious garment; however, it is precisely this elaborate clothing, with its possibly negative connotations, that points more to Hagar.

41 Hahnloser 1959.

Fig. 6: Abraham and the Three Angels/Expulsion of Hagar, ca. 1138, Bronze door of San Zeno, Verona (© M. Fera/Novetus/GAPAMET).

Jerusalem, while the real door of San Zeno leads into the church, which in turn is the Christological earthly representative of the heavenly Jerusalem. The scene might be a prefigurative complement to the scene of the Annunciation on the left door leaf made by the first workshop. As in the illustration with the play of light and shadow (fig. 7), the scene with Gabriel, who approaches energetically to deliver the message to Mary, can only be seen when the door is open and the light is coming in from the west in the evening. The role of light is often neglected in our analyses, but in this scenario the plasticity of the characters and the dynamics of the narrative are emphasised by their full illumination and shadowing. Here, the angel comes from

Fig. 7: Annunciation, ca. 1100, Bronze door of San Zeno, Verona (© Heike Schlie).

outside to the threshold of the real door, as it were, to approach Mary. The real, actual light comes with Gabriel and falls on the figure of the Virgin Mary, as if the conception were happening at that moment. The Annunciation to Mary is prefigured in the three angels' delivery of the announcement of Isaac's birth to Abraham. There again, the angels come from the outside when the door is open. The son, Isaac, born through a promise to Abraham from Sara – in Paul's formulation – prefigures Christ, whose birth is announced through a revelation to Mary. And again, the wood of the church door is thematised, to be seen through the

Fig. 8: Expulsion from Paradise, 1015, Bronze Door of the Cathedral, Hildesheim (© Heike Schlie).

(bronze) door of the earthly Jerusalem of the Old Testament, as enunciated or prefigured. The closed door behind Mary in the Annunciation scene may also be an allusion to the virgin birth, but, read with Paul, it is rather the door to Heavenly Jerusalem. Both interpretations stress the role of Mary as *Ecclesia*.

Hildesheim: out of Paradise's door and back in one turn

With its numerous depictions of doors, the bronze door in St Zeno is not unique within the corpus. In general, it can be said that within the pictorial scenes on bronze doors of the 11th and 12th centuries, doors are a feature that are mostly depicted not because they appear in the biblical narrative, but rather to describe liminal threshold situations, and thus to refer to the function and semantics of the object on which they are depicted: the real church door. This is especially true for Hildesheim, the door commissioned by Bishop Bernward, with perhaps the most stringently composed pictorial programme (1015). There, on sixteen picture fields, six doors are set into the images, even where this does not necessarily correspond to the iconographic tradition. On the bronze door in Hildesheim, the self–thematisation is programmatic. The typological structuring of the two door panels of the fall of humanity, on the left, and the ascent from salvation, on the right, is also structured by the doors. As is well known, the narrative on the left is from top to bottom, in the sense of a fall, and on the right from bottom to top, in the sense of an ascent and the overcoming of original sin. In the chronological sequence, the first door that is depicted is the one through which Adam and Eve are banned from paradise (fig. 8), and the last one, at the very top right, is the one through which Christ – within the logic of the depiction – will apparently enter paradise directly after the encounter with Mary Magdalene (fig. 9); the Ascension is pictorially anticipated here, so to speak. The garden of *noli me tangere*, in which Mary Magdalene meets Christ, includes the door to paradise on the right, characterised not only by the context, but also by the imaginative, impressively differentiated birds of paradise. So the narrative goes from one side of the paradise door

Fig. 9: Noli me tangere, 1015, Bronze Door of the Cathedral, Hildesheim (© M. Fera/Novetus/GAPAMET).

to the other, a whole circle is closed within the logic of the history of salvation, and both are represented on the real door, which is the passage from the profane space into the sacred space, i.e. into the church as the earthly representative of the Heavenly Jerusalem. The four remaining doors can also be found on the right–hand leaf; they are a preliminary stage in the salvation–historical process of regaining access to paradise, which is also how the Hildesheim door can be understood. Gallistl interpreted three of the four remaining doors on the right wing in ecclesiological terms.[42] The *porta clausa* in the Annunciation is the gate through which, according to Ezekiel 44, only the king has access, which is linked to the understanding of Mary as the *Ecclesia* (fig. 10). In the *Presentation in the Temple*, the door is the incarnate *Logos*, which is offered in the temple and through which man can enter salvation (fig. 11).[43] It is no coincidence that the *Expulsion from Paradise* on the left leaf, and the depiction in the temple with the unusual door next to the open passageway with the curtain drawn back, are shown in the same register, i.e. at the same height. The *Presentation in the Temple* is the announcement of the sacrifice with which Christ will abolish original sin, and thus make it possible for man to enter paradise again. The open door[44] next to the temple passageway is possibly depicted to refer to the latter as a door, and thus to the typological relationship to the Gates of Paradise. Gallistl has pointed out that the Gate of Paradise and the Temple of Solomon were referred to by the term "House of the Father" (John 2:16). Thus, all buildings with doors are obvious analogies for the *Ecclesia*, with the exception of the Palace of Pilate, whose door Gallistl does not mention (fig. 12). Within the rather

42 Gallistl 1990, 162–168.

43 "Having therefore, brethren, boldness to enter into the holiest by the blood of Jesus, by a new and living way, which he hath consecrated for us, through the veil, that is to say, his flesh". (Hebr. 10:10–20).

44 Butzkamm is of the opinion that an open door is meant: Butzkamm 2004, 114. This is supported by the fact that, unlike the other doors, which are all closed, there is no top and side frame system.

Fig. 10: Annunciation, 1015, Bronze Door of the Cathedral, Hildesheim (© M. Fera/Novetus/GAPAMET).

Fig. 11: Presentation in the Temple, 1015, Bronze Door of the Cathedral, Hildesheim (© M. Fera/Novetus/GAPAMET).

Fig. 12: The Judgement of Pilate, 1015, Bronze Door of the Cathedral, Hildesheim (© M. Fera/Novetus/GAPAMET).

simply represented architecture, the door is located between the soldiers with Christ, on one side, and Pilate, on the other. The handing over of Christ, who is being presented for judgement, is located exactly above the door with the corresponding hand gesture of the right–hand soldier, emphasising a liminal moment; with his right hand he holds Christ's wrist, the handing over left hand is exactly above the upper framing of the door. This door is thus marked as a further threshold to the sacrifice of salvation, which is why Pilate's palace, like the Temple of the *Presentation* and the Holy Sepulchre, is also decorated with crosses on the roof ridge. The Holy Sepulchre, with the meeting of the angel and the three Marys, in turn shows the façade of the second era Jerusalem Temple (520–515 BC), as does the *Presentation in the Temple* (fig. 13).[45] The curtain is not wrapped around the pillars here, but is tied in a knot in the middle, and the door is closed, presumably to indicate that Christ has risen from the closed tomb. However, another reason for a door here is even more obvious: Christ's tomb is amalgamated with the Jerusalem (Solomonic) temple, and provided with a door because here too the depicted door has an ecclesiological referential character and announces or predicts the real church door in the pictorial narrative. Accordingly, the Hildesheim door embodies the door to paradise, as a surpassing of the door of the temple and Pilate's palace. So, there are various doors in front of which the viewer stands until he arrives with Christ and Mary Magdalene again at the door to paradise, where everything culminates. The door in Hildesheim captures this meaning in a 'door loop' that closes/culminates at the end in the uppermost image of the right door leaf. The Christian narrative of salvation begins with the door of paradise closed to humanity, and culminates in its reopening by means of Christ's sacrifice and resurrection. The door of paradise is, as it were, the first and last door of the salvation narrative, with all the other doors in between (between profane and sacred space) as its post- and pre-figurations. The latter applies to

45 Butzkamm 2004, 133.

Fig. 13: Three Maries at the Tomb, 1015, Bronze Door of the Cathedral, Hildesheim (© M. Fera/Novetus/GAPAMET).

the four other doors depicted on the Hildesheim door, but also to the Hildesheim door itself. Although this is not a typology negotiated between the Old and New Testaments in the narrower sense, it is nevertheless a typological principle. In this way, the Hildesheim door inscribes itself as an object in the history of salvation by embodying the door of paradise on earth and assuming corresponding functions as a church entrance as well as a feature in the liturgy.

Only a few authors have investigated the function and effect of the Hildesheim door in terms of its design and material. One source from 1473 provides evidence of a penitential ritual linked to it, although this cannot be proven to be from an earlier period, although it is plausible due to the pictorial programme.[46] Hofmann found that some of the figures are obviously designed for a close–up view when passing through the door.[47] The enthroned Mary in the *Adoration of the Magi*, depicted at the viewer's eye level on the left side of the image field, does not turn towards the three kings when the door is opened, but rather towards the viewer; one is welcomed by *Maria–Ecclesia* as one enters the earthly church. This effect is only possible thanks to the art of the caster, who cast the figure in full relief with it projecting far away from the surface of the panel. Although this would be technically possible in a wooden relief, it would not be practical or sustainable for reasons of durability.

As already indicated above, artefacts, such as the impressively large cast Christian column and the doors, for which tens of tonnes of ore had to be processed and the finest bell founders had to be brought in, were also intended to materialise the superiority of Christian culture over the colonised Slavic culture, as material and technological signs of triumph. Charlemagne had massive bronze doors cast for Aachen cathedral in

46 Olchawa 2013.

47 Hofmann 2018, 54–56. However, Hofmann is more concerned here with visual references and less with an analogy between the kings' entry into the 'ecclesiological space' and the viewer's entry into the church building.

imitation of Rome in order to materialise the concept of *translatio imperii*. Then Bishop Willigis (975–1011), with reference to Charlemagne's doors within the inscription on his door in Mainz, transferred this claim to the power of the episcopal seat there:

> POSTQVA(M) MAGNV(S) IMP(ERATOR) KAROLVS/ SVV(M) ESSE IURI DEDIT NATURAE/ WILLIGISVS ARCHIEP(ISCOPV)S EX METALLI SPECIE/ VALVAS EFFECERAT PRIMVS/ BERENGERVS HVIUS OPERIS ARTIFEX LECTOR VT P(RO) EO D(EV)M ROGES POSTVLAT DUPLEX[48]

Willigis emphasises that he is 'the first after the first' to have bronze doors made from 'a substance of metal' (*ex metalli specie*) according to the ancient tradition. Weinryb has pointed out that the central part of the inscription (*Willigisus Archiepicopus ex metalli specie valvas effecerat primus*) is clearly legible on the central crossbar of the door, while the name of Charlemagne is situated at the top, and as illegible as the artist's signature just above the floor. The self–reference of the door does not emphasise that it is '*ex metallo*', but rather '*ex metallo specie*', which further emphasises the special material status of bronze.

Both Charlemagne and Willigis manage without an image programme to demonstrate this political power game, while Bernward emphasises the triumph of Christ (with the column) and the entrance of Christians into salvation (with the door) by their pictorial programmes and not only by the material they are made from.

The engraved inscription on the Hildesheim door is located on the central crossbar and reads:

> AN(NO) DOM(INICE) INC(ARNATIONIS) M XV B(ERNVADVS) EP(ISCOPVS) DIVE MEM(ORIE) HAS VALVAS FVSILES IN FACIE(M) ANGELICI TE(M)PLI OB MONIM(EN) T(VM) SVI FEC(IT) SVSPENDI[49]

Similar to Willigis, the inscription emphasises the metalwork, here with a reference to the technique (*fvsiles*). As in Mainz, the door is also named according to its form (*valvas*), but in Hildesheim this could also be a reference to the doors depicted on the door, which in a broader sense were also cast, or are the result of, the complex casting process. In addition, as we have seen, there are actually "angel doors" and "doors of the temple" in the image programme.[50]

Pictorial and scriptural doors on bronze doors and elsewhere

The most meaningful and explicit inscription for understanding the metal church door, was perhaps the example on the now lost main portal for Saint Denis of the time of Abbot Suger:

> "Portarum quisquis attollere quaeris honorem
> Aurum nec sumptus, operis mirare laborem
> Nobile claret opus, sed opus quod nobile claret
> Clarificet mentes, ut eant per lumina vera
> Ad verum lumen, ubi Christus janua vera
> Quale sit intus in his determinat aurea porta
> Mens hebes ad verum per materialia surgit
> Et demersa prius hac visa luce resurgit."[51]

48 "After the great Emperor Charles granted his life back to nature, Archbishop Willigis has been the first who had the doors made of a substance of metal. Berengar, the artist of this work, asks you, reader, to pray to God for him.", translation by the author.

49 "In the year of the Lord's Incarnation 1015, Bernard, Bishop of holy memory, had these bronze doors suspended in the facade of the angelic temple as a monument to himself", translation by the author.

50 For a long time, the door was thought to have been donated to St Michael's in Hildesheim, until archaeological investigations clarified that it was in fact created for the cathedral from the very beginning (Olchawa 2013, 57). The phrase "in faciem angelici templi" is therefore in need of explanation. The pictorial programme closely links the real door with the door of Solomon's temple and the gate of paradise guarded by the angel: could it be that the inscription is conceived accordingly in terms of this typology?

51 "Whoever you are, you may praise the doors, admire not the gold, the expense nor the craftsmanship. The work shines nobly, but the work that shines nobly clarifies minds, so that they may go by means of true lights to the true light, where Christ is the true door. What is within is determined by this golden door. The inert spirit rises

The inscription not only designates Christ himself as the entrance, or door (*janua*), and points to the radiant shine of the reflective metal door as a medium of insight and knowledge, but also programmatically formulates the liminality of its threshold and the function of the material to create a virtual presence, or the capture of an otherwise intangible *verum*.[52] Although Suger is always concerned with the crossing of thresholds, made possible by the material as a carrier of light, and less with the conditionalities of the creation of a cast material made possible by God and carried out by the caster; the experience of the virtually absent in the materially present is also thematised in his work. Unfortunately we do not know if doors were also depicted in the image programme of his door, with scenes from Christ's passion and ascension perhaps, that would have reinforced the "*Christus janua vera*" pictorially.

Although doors were depicted less frequently on doors after Hildesheim, the examples we do have where they appear confirm the finding that they are intentionally inserted into the narratives of images to define the real door as a liminal object in the system of spaces and salvation, as it were. In Monte Sant'Angelo, only biblical angel narratives are represented on the door (1076), with the only door depicted on it again on a panel showing the expulsion from paradise (fig. 14), with all other passages open or only partially covered with cloths. For the angels all doors are, as it were, permeable, the only door as a boundary, as a separation between outside and inside, is the door of paradise. The Archangel Michael is depicted in the centre and appears to be pushing the progenitors almost physically and forcefully to the right, away from the closed door of paradise, towards which Adam and Eve are looking back. The width of the frontally depicted door is completely blocked by a cherub. Its closed wings cross exactly over the caesura of the two coffered door wings of the Paradise Gate as if his body were part of the guarded door itself. The inscription reads: UBI ANGELVS DNI EXPVLIT PRIMVM HOMINEM DE PARADISO. In contrast to Hildesheim, the scene does not take place still within the garden but on the outside; Adam and Eve have already left paradise. This is made clear not only by the blocking cherub, but also by the trees and birds of paradise, which appear above the beams as if being beyond the door.[53] For the attribution of meaning to the church door, it is crucial that the door of paradise is shown from the outside and that the progenitors have already left paradise, which is rather

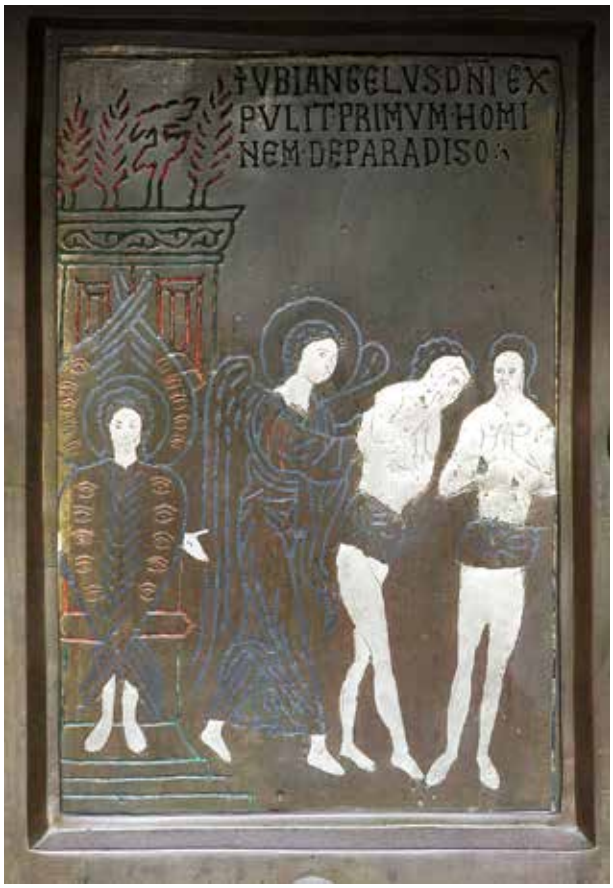

Fig. 14: Expulsion from Paradise, Bronze Door of St. Michael, Monte Sant'Angelo (© M. Fera/Novetus/GAPAMET).

to the truth through material things. And this view, having been submerged before, rises again to the light": cited in Panofsky 1979, 46–48, translation by the author.

52 I thank Elisabeth Sobieczky at this point for a discussion on the concept of virtuality in the writings of Suger.

53 Angelillis 1924, 43.

rare in the art and iconographic tradition of the time.[54] Through these pictorial strategies, the depicted and the real door to the Grotto Church are virtually merged: the viewer stands in front of both doors on the outside. Michael is thus implicitly addressed as the guardian of the church door itself. He is also addressed by one of the inscriptions on a panel on the right door leaf. In the first part of the inscription, the donor Pantaleone asks those entering the church to pray for him;[55] in the second part, the Archangel Michael is asked to answer the prayers.[56] Accordingly, the viewer stands in front of the closed door of paradise, which the guardian Michael is supposed to open for Pantaleone (and prospectively, of course, for himself).[57]

But not only closed doors are depicted. In Gniezno, on another door with a very special image programme, here dedicated to the *vita* of St Adalbert,[58] the door in his entry to the cathedral school of Magdeburg is defined as a liminal threshold between his secular and spiritual existence (fig. 15). This might have been applicable to those who entered and left the church building, for an awareness of their own 'spiritual existence' when partaking in the liturgy. The scene is divided into two parts by a double arch. On the left, from left to right, Adalbert's mother, his father, and the future saint himself, are depicted. On the right, two figures approach them from the right with the cathedral marked with a wide-open door. Adalbert's father is giving Adalbert's hand to the cathedral provost; the interlocked hands of the latter two are in the picture field right in front of the separating and connecting column.[59] The door pull of the real door is located directly above the depicted open door on the right side of the picture field, and it is certainly no coincidence that both doors (the one depicted and the real one) open to the left. Plus, the open door is rectangular like the real door leaf, though the entrance has an arched top.

On the Byzantine door of San Paolo Fuori le Mura in Rome (1070), the door theme appears throughout in both image and script. In the depiction of the so-called *Incredulity of St Thomas* on the left leaf, Christ stands in front of a coffered large door, while Thomas puts his finger in the side wound (fig. 16). The inscription on the panel reads: TωN ΘΥPωN KεKΛEIΣMεNωN (transl.: with closed doors); the closed door is thus emphasised by the image as well as by the inscription, and in the pictorial strategy, Christ is identified as the door behind him. All biblical passages in which Christ is metaphorically described as a door or entrance apply here: "I am the door: by me if any man enter in, he shall be saved" (John 10:9); "In my Father's house are many mansions [...] no man cometh unto the Father, but by me" (Joh. 14:1–6); "Having therefore, brethren, boldness to enter into the holiest by the blood of Jesus, by a new and living way, which he hath consecrated for us, through the veil, that is to say, his flesh". (Hebr. 10:10–20). Especially in the case of San Paolo, the door, which has the same width as the body of Christ, and is thus virtually identified with this body, does not merely contribute meaning to the scene itself but to the meaning of the actual door. There are other door references on it: the panel with Ezekiel, for example, has the Latin inscription INDVXIT ME PER VIAM PORTE BOREALIS (see Ez. 1:15). Attempts have been made to relate this panel either directly typologically to the scene of St Thomas or to the entry into Jerusalem;[60]

54 There is one interesting exception: within the mosaic cycle of the *Cappella Palatina*, the depiction of the *Expulsion from Paradise* is based exactly on the model from Monte Sant'Angelo (around 1140). It is interesting to note that the *cappella* was fitted with two bronze doors around the same time. It is possible that the mosaic image also in fact refers to the real doors here.

55 ROGO VOS OMNES QUI HIC VENITIS CAUSA ORATIONIS UT PRIUS INSPICIATIS TAM PULCHRUM LABOREM ET SIC INTRANTES PRECAMINI DOMINUM PRONI PRO ANIMA PANTALEONIS QUI FUIT AUCTOR HUIUS LABORIS.

56 O SUMME PRINCEPS MICHAEL NOS TE ROGAMUS QUI VENIMUS AD ORANDUM TUAM GRATIAM UT NOSTRIS PRECIBUS AUDIAS PRO AUCTORIS HUIUS ANIMA UT UNA NOBISCUM FRUATUR SEMPITERNA GAUDIA QUI TUI NOMINIS SANCTITAS FECIT DECORARE TALIA. A redrawing of the entire inscription can be found in in Angelucci 2009, 257. See also Bertelli, 1990, 301.

57 Bertelli 1990, 298, refers to apocryphal writings in which Michael is explicitly named as the "custode del Paradiso". See also Bertelli 2009, 257.

58 For the significance of the saint and the pictorial programme, see Węcławowicz 2020, who does not analyse the said motive.

59 Mende 1994, 161.

60 Bevilaqua 2009, 242.

Fig. 15: Entry of St. Adalbertus to the Cathedral School of Magdeburg, 1160–80, Bronze Door of the Cathedral, Gniezno (© Heike Schlie).

but in my opinion, all the doors mentioned in the image and script refer to that absent one of the Heavenly Jerusalem, which is prefigured in the church door. This analogy is referred to by the inscription with the plea of the founder Panataleone to St Paul that the foundation of these real doors shall grant entry through the transcendent doors of salvation.[61] A second inscription is addressed to the person entering, who is advised to take a close look at the door and its images in order to pray for the founder.[62] Here, the threshold to the sacred space defined by the door is explicitly emphasised, at which the prayers become effective.

61 On the right wing, right in the centre, there is a panel with the following inscription:
"+Paule beate preces/Domino ne fundere cesses/ consule Malfigeno/ Pantaleone rogando/ ductus amore tui/ qui portas has/ tibi struxit/ ergo sibi per te/ reseretur ianua vitae/ supplex ergo petit/ Domino qui semper adestis/ hic precibus vestris/ Dominus annuat esse quod estit."
(Paul, blessed one, do not cease to bring forth intercessions to the Lord for the Amalfitan Consul Pantaleone, who, led by your love, built these doors for you. Therefore, through you, may the gate of life be opened for him. Behold, he sends his supplication to you who serve the Lord, that through your prayer he may obtain from God what you are): after Josi 1967, 21, translation by the author.

62 The inscription can be found on the panel in the centre of the left door leaf.
"+Tu quoque qui sacri/ succedis limina temple/ has per quas intras/ studiosus inspice portas/ et sic ingressus, Domino/ fer cum prece fletus/ ut Deus huic requiem/ concedat habere perennem/ impetret hoc illi/ simul intercession Paulo/ quem quia dilexit/ decoravit munere tali"
(But you who tread the threshold of the holy temple, look closely at them, the gates through which you have come. And so offer your supplication here and your prayers, that the Almighty may grant

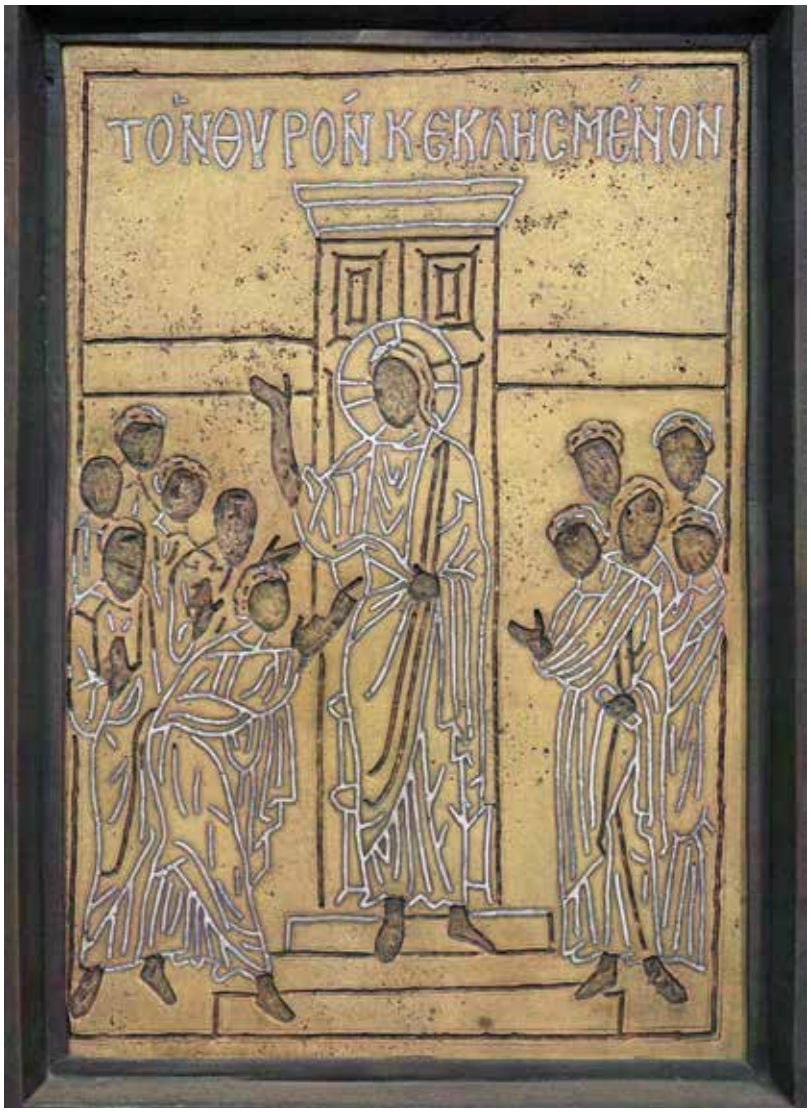

Fig. 16: St. Thomas putting his finger into Christ's side wound, 1070, Bronze Door of San Paolo Fuori le Mura, Rome (© Martin Fera/ Novetus/GAPAMET).

In Benevento, on its cathedral door, where we find one of the most varied iconographical cycles in the art of the Middle Ages, there is a focus on childhood, passion, and ascension.[63] A depiction of a closed door is placed below the scene of *St Thomas Touching Christ's Wound* on the left wing (fig. 17), executed by the second workshop,[64] but is still centrally located in an axis with the body of Christ. It is defining the space of Christ and the apostles as an enclosed structure with us on the outside, though the doors complicated lock system is to be seen from the inside. It is this locking system that is especially interesting; it consists of vari-

him eternal rest. And may Paul's prayer obtain the same for him, whom he so lovingly glorifies with this gift), after Josi 1967, 21, translation by the author.

There is a third inscription, written in Greek, in which the artist Teodoro asks for intercessions by Peter and Paul: Josi 1967, 21.

63 Mende 1994, 112, who points to the similarities with the iconography of the mosaics of Monreale, although she identifies the style as western Romanesque (ibid, 113). The door is dated between 1150 and 1200.

64 Mende 1994, 114. I prefer to not to call this image the *Incredulity of St Thomas* as I think this is not in keeping with the medieval attribution of the meaning of the scene.

Fig. 17: St. Thomas putting his finger into Christ's side wound, 1150–1200, Bronze Door of the Cathedral, Benevent (© Heike Schlie).

ous interlocking bolts and rods that reflect a historical locking system relatively accurately. This is a complex variant of a slide bolt lock, and works as follows: by turning the key in the keyhole of the box lock, a sliding bolt is moved, this sits in an eyelet of the upper horizontal bar, which is inserted in a slot in the hollow door leaf that is not visible here because it is covered by the bar. This allows the upper horizontal bar to be rotated by 90 degrees so that it is now at right angles to the door and horizontal to the front. This protruding rod is now used to pull out the vertical rod section, connected to it, upwards,[65] which unlocks the lower horizontal bar, which is loosely connected to the vertical bar with an eyelet. It is also folded out horizontally at a 90-degree angle, and the door can be opened. Due to the poor state of preservation, the caesura between the two door wings, above which the bolts sit, is now only visible below the lock. The consequence of such

65 I would like to thank Thomas Kühtreiber for advice on the locking mechanism. For the simple slide bolt lock see Pall 2005, 11–12.

Fig. 18: St. Thomas putting his finger into Christ's side wound, ca. 1100, Salerno, Museo Diocesano (© Enciclopedia dell'arte medievale, Volume X, Rom 1999. S. 257).

a mechanism is that even if there is a keyhole on the outside, the door can only be opened from the inside. If there is no keyhole on the inside, the door can only be opened by two people who must have an agreement to open the door at a certain time (on the inside to move the bars and on the outside with the key). This mechanism mirrors the relationship between Christ and Thomas. Interestingly, the alignment and insertion of the bars of the lock are also mirrored in the gestures and positions of the arms of Christ and Thomas, which are, not coincidentally, aligned at 90-degree angles. Thomas virtually unlocks the door with his finger (the key), opened by Christ himself on the inner side. This is made even more clear on an ivory panel of the 11th or 12th century, belonging to the Salerno Ivories, on which the same locking mechanism is also linked to the narrative (fig. 18). There, the inserts of the bars and the keyhole are shown more clearly, and are structurally aligned with the finger and the side wound. On the door in Benevento the arm of Thomas becomes the upper horizontal bolt whose end seems to push through the box of the lock, just as the contours of Thomas's hand push outwards through Christ's skin and robe. This complicated locking mechanism, which is a technological masterpiece executed in metal, thus takes on a theological message as a mechanism itself. It is no coincidence that we find two further doors in *Joseph's Dream* on the right wing, to indicate the transcendent, detached realm of the dream, on one side, and the threshold represented by the architecture and its closed doors, on the other.

Open a crack

I conclude my case studies with two representations of doors in depictions of the *Entry into Jerusalem* on medieval bronze church doors. In San Paolo Fuori le Mura, a two–winged door represents the Gate of Jerusalem (fig. 19), the right wing of which is open ajar: a realistic detail that is very unusual in view of the door's style. The depiction within the narrative is actually illogical: the inhabitants of the city are in fact approaching Christ through the open gate. Accordingly, in medieval art, an open gate is usually depicted without door wings,[66] or those door wings are wide open.[67] While Christ appears to be riding diagonally towards the gate from behind, the door is facing the viewer from the front. The way is still blocked by two figures, among others, but the viewer's path through the gate of the Heavenly Jerusalem is already prospectively opened ajar by the door of the depicted Jerusalem. Again, the viewer stands in front of the depicted and the real door, which in the interim embodies the virtual gate to the Heavenly Jerusalem. The gap stands for the potentiality and the hope of salvation.

In Novgorod, the image of the *Entry into Jerusalem* is carried across two panels (fig. 20). The gate, in which the Jerusalemites are standing, receiving Christ with palm fronds, occupies a separate picture field. Within the image, Christ must cross two thresholds here: the frame system of the real church door as well as the gate shown on the panel as part of its internal logic. We can transfer this to the situation of the viewer: he must cross the structural threshold of the real portal and, ideally, cross the threshold to transcendence. In the depicted gate, a door wing opens onto the outside left of the frame of the picture field, which does not seem to quite fit with the structure of the gate with the cloverleaf arch. This detail is also remarkable from a technical point of view. The gate, the figures, and the plant in the front left, were cast using the lost wax process, i.e. cut in the wax model; the door with the hinge, on the other hand, was engraved after the door had hardened, as were two additional leaves of the plant. They are thus flatter and more graphic, but still emphasised in a special way as immanent to the church door. Behind this outer door, a second door behind it in the city gate is indicated by a second hinge. This complex system, and the framing of the real church door between Christ and the gate, emphasises the liminal moment of the pictorial scene: the entrance marks the beginning of the passion story. At the same time, however, these pictorial strategies describe the liminal situation in which the viewer finds himself on the threshold of the church door, between the profane space and the sacred space; a sacred space that is connected to Heavenly Jerusalem.

Embodiments in virtuality: the bronze door as *figura*

In all of the above investigated bronze doors, their material, and their technical and pictorial strategies, which makes them an embodiment of the Gates of Paradise, are very complex and underlines the status of the door as a virtual presence of the transcendent, conceptual entrance to salvation. This virtual presence is dependent on the material and performative reality of the door. We might not see the church door as such, but for the medieval recipient, the opening of the door, after having been stood before its closed wings, was a kind of anticipation or prefiguration of the opening of Paradise's gates. Thus, in the medieval understanding, it was a *figura*,[68] and not an allegory, symbol or abstract concept in any way.

66 See, for example, the fresco on the south wall of the central nave in Sant'Angelo in Formis (1072–1087).

67 As in the monastery of Daphni, which is 11th century.

68 The term *figura* is borrowed from Erich Auerbach and his famous article (Auerbach 2016) where he discusses the *figura* as a 'plastic' figure in a broader sense, in which a *veritas* appears or is announced, in principle, as something substantial, generally and decidedly 'carnal'. The prefigurations of the Old Testament to the antitypes in the New Testaments events are, in his view, not allegorical signs, but – following Tertullian in this respect – corporeal entities with their own reality (Auerbach 2016, 143). Though he discusses the artwork as *figura* (Auerbach 2016, 174–175), he does not take in account its specific materiality, which can nevertheless be added to the concept. For more on this, see Schlie 2023.

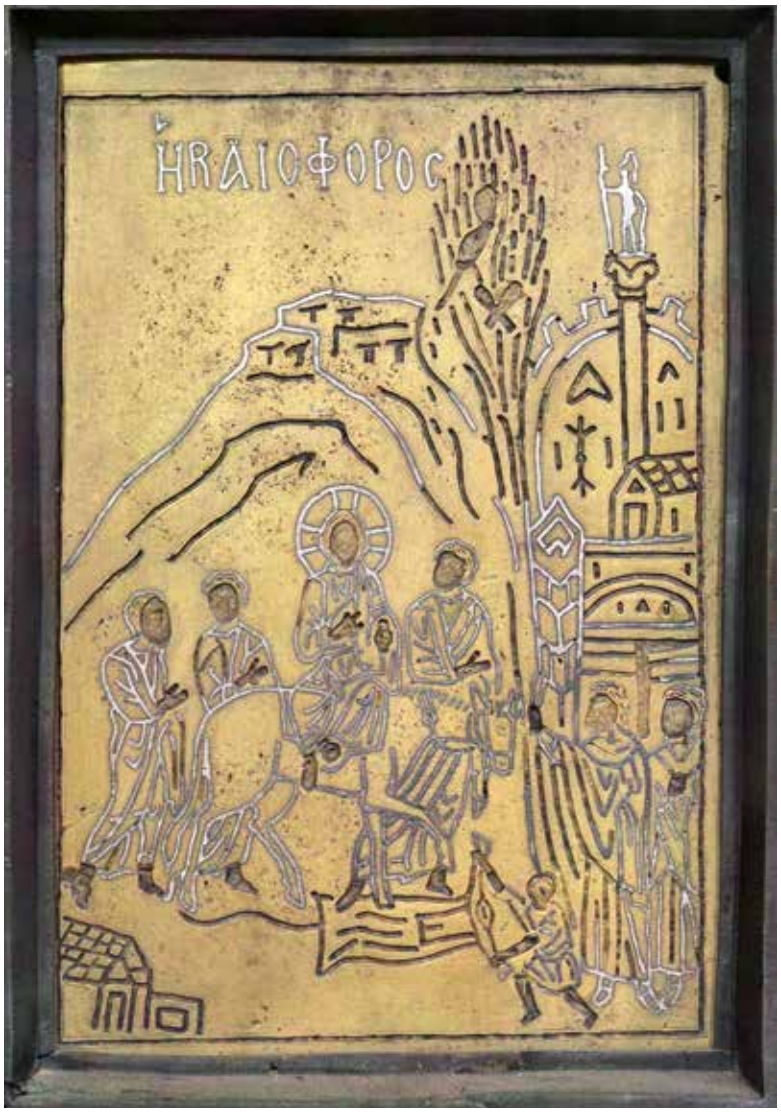

Fig. 19: Entry into Jerusalem, 1070, Bronze Door of San Paolo Fuori le Mura, Rome (© Martin Fera/ Novetus/GAPAMET).

We have seen that bronze as a material (in combination with wood or on its own) can contribute to a typological understanding of the door. Apart from the diverse pictorial strategies in the examples presented, the durability of bronze and the aspect of fortification itself might also have been decisive in embodying and imagining it as the door of paradise. Plus, its artificial character – the fact that 'bronze' could be seen nowhere apart from with bronze artifacts – could have played a role here. The surviving evidence does not allow us to make a broad confident statement that bronze doors themselves were more frequently and explicitly thematised and referenced as doors of paradise than wooden doors, but in the latter, the material, technical, pictorial and scriptural strategies would be different from their bronze counterparts.

The term *figura*, combining a typological embodiment with the notion of the virtual presence of the transcendent doors, reinforces the idea that the bronze doors of a church are a materially bound, 'fleshy' entity, that is perceived and handled as such, and not merely a symbol. Bronze doors are the carnal–material *figura* of the gates of paradise.

Fig. 20: Entry into Jerusalem (detail), 1162, St. Sophia Cathedral, Nowgorod (after Goldschmidt, Hamann 1932, II 44).

Zusammenfassung

In der Forschung zu den Bronzetüren des 11. und 12. Jahrhunderts wurden diese häufig als ‚Paradiestore' bezeichnet, so auch in dem Projekt, aus dem der vorliegende Band hervorgegangen ist. In diesem Beitrag wird mit material-, technik- und objektikonologischen Ansätzen der Status der Bronzetüren als materielle Figura und virtuelles Pendant oder Substitut der Pforten des Himmlischen Jerusalems systematisch erfasst. Die Kirchentür symbolisiert nicht lediglich die imaginierten Türen der Transzendenz, sondern verkörpert sie auf eine fleischlich-materielle, performative und funktionale Weise. Es soll gezeigt werden, wie und zu welchen Zwecken die irdische Abwesenheit der transzendenten Paradiestore in den materialisierten Kirchentüren virtuelle Präsenz gewinnt, und welche Rolle das Material Bronze dabei spielt.

Riassunto

Nella ricerca sulle porte di bronzo dell'XI e XII secolo, queste sono state spesso indicate come "porte del paradiso", come è avvenuto anche nel progetto da cui è nato questo volume. Di seguito, lo status delle porte di

bronzo come figura materiale e controparte virtuale o sostitutiva delle porte della Gerusalemme celeste viene analizzato sistematicamente utilizzando approcci iconologici dei materiali, tecnici e degli oggetti. La porta della chiesa non si limita a simboleggiare la porta del paradiso, ma la incarna in modo carnale-materiale, performativo e funzionale. L'obiettivo è quello di mostrare come e per quali scopi l'assenza terrena delle porte trascendenti del paradiso acquista una presenza virtuale nelle porte della chiesa materializzate, e quale ruolo gioca il bronzo materiale in questo.

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Ad perpetuitatem monimentorum? Medieval Doors after the Middle Ages

Judith Utz

At an uncertain time between the 13th and 15th centuries, a metal door, dismantled into many individual parts (including 48 image panels, at least 56 frame elements and countless nails), travelled from Płock to Novgorod.[1] It is not clear whether the door was stolen during the looting of Płock in 1262 or whether it was only in the 15th century that personal connections led to the door being brought to Novgorod as a gift.[2] Around the midst of the 15th century, Cyrillic inscriptions were added to the image panels, possibly when the door was installed at St Sophia.[3] However, the door was not only adapted to its new context through inscriptions; a local bronze caster, who cast some parts in the 15th century to complement the medieval door dating from the mid-12th century, took the opportunity to immortalise himself alongside the self-portraits of the medieval casters Riquin and his assistant Waismuth. This Abraham appears in a very similar way to the medieval master; he is dressed in a richly decorated skirt, wearing his hair short and holding a long pair of tongs in his hands, with which he grasps a crucible (fig. 1).[4]

The adjustments in the script and the new installation of the door at St Sophia in Novgorod, could have indicated a possible trophy character of the object; however, Abraham's staging as its restorer clearly shows that artistic value was also attached to the door's reworking.

The fate of the Novgorod door is not an isolated case. The bronze doors that have survived to this day, which have adorned important cathedrals since the 11th and 12th centuries in particular, have been repeatedly added to, reworked, and renewed over the course of their "lives".[5] Damage was repaired and the semantic meaning of the doors was updated to reflect current – mostly political – contexts. All of this points to the great esteem in which the doors have been held in over the centuries, but also to the importance that these objects obviously had for their respective communities over a very long period of time. Accordingly, the majority of the surviving doors created in the Middle Ages can still be found today in the place for which they were made: mostly in the church portals of central and southern Europe. This fulfils a promise that seems to have been inherent in bronze since Antiquity: that of the durability of the material. Pliny the Elder, for example, wrote that "[t]he employment of bronze was a long time ago applied to securing the perpetuity of monuments, by means of bronze tablets on which records of official enactments are made."[6] He is referring to tablets of laws, such as the *Lex Vespasiani*, which were recorded

1 The door was created in the middle of the 12th century in Magdeburg for Płock Cathedral. The door thus had already travelled a long way before its 'migration' to Novgorod. See Mende 1994, 74, 160; Daniec 1999; Poppe 1999; Knapiński 2015; Olchawa 2019, 104–114; Makhortykh et al. 2023. For recent photographs, see Трифонова 2015.

2 Poppe 1999, 83–84.

3 The Russian inscriptions can be dated to between 1435 and 1460: Poppe 1999, 85. For a reproduction of the inscriptions see Makhortykh et al. 2023, 17–20.

4 Schlie 2025 (in this volume).

5 Kopytoff 1986, esp. 66–68; Hennig 2015.

6 "Usus aeris ad perpetuitatem monimentorum iam pridem tralatus est tabulis aereis, in quibus publicae constitutiones inciduntur", Naturalis Historia XXXIV, XXI, cited after Pliny 1942, 200–201.

Fig. 1: The foundrymen Riquin, Abraham and Waismuth, bronze door, mid-12th century, Magdeburg, St Sophia, Novgorod (after Анна Трифонова, Двери Новгородской Софии, Moskau 2015, 92).

in bronze and set up in public spaces.[7] Despite the material's claim to eternity, however, the majority of the bronze artefacts created in the past have not survived.[8] This is due to another material property of the alloy: it could be reused by melting it down. Many medieval bronze doors that we know about from sources were destroyed by natural disasters or melted down in the course of armed conflicts. They should also be part of this corpus, as they fill important gaps in the examination of a tradition of bronze doors.[9]

Restored

The majority of the doors analysed as part of the project *Gates to Paradise. Creating Metal Doors for 11th–12th Century Churches (GAPAMET)* were restored, reworked or 'updated' in the centuries following their completion. This was done through repairs, renewals or additions at the material level, but also in terms of their content and meaning.[10] This is particularly evident in Monreale and Troia. In the case of Monreale, Archbishop Giovanni da Roano (1673–1703) ordered the restoration of both the doors that have adorned the cathedral since it was built.[11] The door of the north portal comes from the workshop of Barisanus of Trani, that of the south portal from that of Bonannus of Pisa. In the latter case, an inscription names the artist and the year the door was completed: 1186;[12] it seems reasonable to posit that the Barisanus door is probably similar in date. It is likely that both doors were manufactured in Trani and Pisa respectively, and shipped to Monreale, where the panels and frame system were fixed to a wooden support. By the 17th century, the lower panels of both doors were likely in a severely deteriorated state due to prolonged exposure to the elements and the constant impact of visitors entering the church. This prompted the decision to undertake a restoration project. In the case of the Barisanus door, which adorns the much-used north portal, three of the lower panels were replaced; two can be clearly identified by the addition of the Roano coat of arms, while the third panel shows a Bacchus. The panels were obviously modelled on the medieval ones, as the seams of the four moulds that made up the models are clearly visible (fig. 2).[13]

7 On the significance and staging of the *Lex Vespasiani* since the early Middle Ages, see Herklotz 1985.

8 In this essay, the term "bronze doors" refers to all doors made of copper alloys, which today would be categorised as bronze (copper-tin) and brass (copper-zinc). In the Middle Ages, however, not much terminological distinction was made; the terms bronze, brass or aurichalcum and ore were used almost synonymously: Reuther, Capelle 1983, col. 713.

9 The extent to which such *lost* objects can be part of art history has been the subject of repeated interest in recent years: see Fricke, Kumler 2022; Gerry, Cleaver 2022.

10 I would like to take this opportunity to sincerely thank all the team members, namely Heike Schlie, Martin Fera, Jarno Bontadi, Marco Fellin and Martino Negri, and above all, of course, the project manager Marianne Mödlinger. It was only through the many discussions on site that many of my thoughts on the biographies of these monumental bronzes, intended for eternity, came about and were able to develop further.

11 Boeckler 1953, 27–28; Mende 1994, 170, 179.

12 "Anno domini MCLXXXVI indictione III Bonanus civis Pisanus me fecit" (In 1186, in the third year of the Indiction, Bonannus, citizen of Pisa, made me): Mende 1994, 174, translation by the author.

13 See Mödlinger et al. 2025a, 6; Mende 1994, 170.

Fig. 2: Bachus panel, late 17th century, bronze door, Santa Maria Nuova, Monreale (© Martin Fera).

On the Bonannus door the additions are less obvious. The fact that they were reworked can only be recognised by the stylistic differences in some of the frames, which are very similar to the renewed ones on the Barisanus door.[14]

The main portal of Troia, which was built in 1119 under the direction of the foundryman Oderisius of Benevento, also features several renovations. The first restoration of the door took place in 1573 under Bishop Prospero Rebiba (1560–1593), as evidenced by an inscription on the door itself, which describes the door as almost "collapsas".[15] The early modern reworking can also be recognised in the depictions on the door panels themselves. St Anastasius was only worked into the medieval panel at a later date: upon closer examination, it becomes evident that the panel where he features was not recast in the 16th century, but rather that a medieval inscription was chisseled away in order to incorporate the figure. It can be reasonably assumed that the reworking process involved a significant investment of time and technical expertise (fig. 3).[16]

Around a century later the door was restored again, a project which was also commemorated with an inscription on the door. The patron, Bishop Antonio Di Sangro, had his name and coat of arms engraved on one of the upper panels.[17]

In Monreale and Troia, the respective ecclesiastical dignitaries developed an interest in renewing, and thus honouring, their medieval doors at roughly the same time. The inscriptions on the doors themselves attest to their historical significance. In the case of Monreale, the doors were originally created at the time of the cathedral's foundation. In the case of Troia, the acquisition of urban privileges occurred simultaneously with the construction of the doors. This is evidenced by the side portal of the cathedral, which was constructed in close temporal proximity to the main portal. The door was commissioned in 1127 by Bishop William II (1106–1141) to testify to Troia's independence from the Normans and its affiliation to the papal see.[18] The early modern restorations demonstrate that the doors were able to function as guarantors of legitimacy for centuries, and never lost their significance for the local communities.

In the case of some doors, however, neither written sources mentioning post-medieval restorations, nor inscriptions or renewals visible on the bronze surface itself testifying to this, have survived. Nevertheless, in such instances, when the wooden support structure of the bronze panels is visible and can be examined, this can provide valuable insights into the history of the door in question. It can be reasonably assumed that the renewal of the wooden core was frequently undertaken in conjunction with the restoration of the bronze plates. Very often this was accompanied by a change in the arrangement of the bronze panels, so that in many cases the original layout of the doors can no longer be reconstructed with certainty. This is the case, for example, in Salerno where the wooden beam of the Byzantine door of the cathedral was last renewed in 1730/31;[19] the wooden planks on which the bronze panels of the Barisanus door from Trani (1170/80) were mounted date from around the same time, with the date '*1725*' clearly engraved on the back. The wooden beams of the two doors of San Marco in Venice analysed in the project (from the main portal and Porta

14 Boeckler 1953, 27–28.

15 See Mödlinger et al. 2025c, 8–13. The inscription on the third panel in the third row reads as follows: "PROSPER REBIBA / EP(ISCOPU)S TROIAN(US) PATRIARCHA / CO(N)STA(N) TINOP(OLITANU)S EIUS NEPOS / HAS PORTAS PENE COLLAPSAS / INSTAURAVIT MDLXXIII" (Prospero Rebiba, Bishop of Troia, Patriarch of Constantinople, his nephew, restored these almost ruined doors in 1573), ibid., 10. Milone here also refers to a written tradition, where it is recorded, among other things, that Rebiba "fé riconciare le porte di bronzo principali della cattedrale in alcun quadrello" (had the main bronze doors of the cathedral reconstructed into some squares). Cf. Iacobini 2018, 120–121; Mende 1994, 143.

16 I would like to take this opportunity to thank the restorers of the door, Carlo Usai and Vito Nicola Iacobellis, who drew our attention to these revisions. Cf. Mödlinger et al. 2025c.

17 An inscription on one of the panels itself (third row, first panel) also bears witness to this: "ANTONIUS DE SANGRO EX MARCHIO/NIB(US) S(ANCTI) LUCIDI AN(NO) PRIMO SUI PRAESUL(ATU)S / ECCLESIAM RESTAURAVIT IANUASQ(UE) / REFECIT ANNO SAL(UTIS) MDCLXXXXI" (Antonio Di Sangro, of the marchesi of San Lucido, in the first year of his episcopate, restored the church and remade the doors in 1691), Transcription and translation after A. Milone.

18 Mende 1994, 48–52.

19 Vaccaro 2025 (in this volume).

Fig. 3: Panel with St Anastasius, 1573, bronze door, main portal of the Cathedral of Santa Maria Assunta, Troia (© Martin Fera).

San Clemente) date from the 17th century,[20] and the doors in Pisa and Augsburg were renewed in the 16th and 17th centuries respectively.[21]

As doors were utilitarian objects and were used regularly, this contributed to their accelerated deterioration. In the case of many of the doors analysed in the project, however, environmental influences played an equally important role. Many of the medieval doors are located at cathedrals in cities in close proximity to the sea, probably due to the wealth generated by these cities engaged in maritime trade. The high salt content of the air significantly affected the bronze surfaces, resulting in the rapid corrosion of the material, which in turn led to extensive damage (fig. 4).

That "climate [is] shaping the arts of a region"[22] should receive greater consideration, not only in the field of conservation science, but also in art history. The concepts of materiality and ecology are inextricably linked, and as such, natural disasters must also be understood as part of the object biographies.[23]

Due to its complex biography, the Verona door still raises many questions today. Two workshops were involved in the creation of the bronze door at different times.[24] It is possible that an earthquake in 1117 may have caused the original door, which was probably built around 1100, to be partially destroyed. An inscription on the south side of the church indicates that the construction of San Zeno was restored and extended around 1138. This may be a reference to repairs carried out in the aftermath of the earthquake, alongside the possible damage to the bronze door.[25] Thus, a local workshop, possibly related to the sculptors who worked at the same time on the façades of San Zeno and the Cathedral of Santa Maria Assunta, completed the panels destroyed by this natural disaster around 1138. If one wing of the original door was reserved for the Old Testament and the other for the New Testament and the basilica collapsed only partially destroying mostly one wing of the door, this would also explain why the Old Testament scenes in particular come mostly from a second workshop.[26]

An earthquake also caused the initial destruction of the door of Benevento Cathedral, which was casted around 1200.[27] In 1688, the earth in the Sannio region shook so hard that the door of the main portal was destroyed in parts and another bronze door from the Oderisius workshop, which had adorned the church of San Bartolomeo in Benevento since 1150/51, was completely destroyed.[28] The restoration of the cathedral door was started immediately; Giovanni Ciampini documented that Cardinal Orsini had already started a restoration of the door in 1693.[29] The Oderisius door, on the other hand, seems to have been unsalvageable or was considered less important; legend has it that its remains were used to ensure the repair of the cathedral door.[30] The material analyses carried out by the project wanted to investigate this narrative, and examine whether different alloys could be found in the

20 The analyses of the project revealed the year 1695 to be the *terminus post quem* for the felling of the wood: Mödlinger et al. 2023, 19.

21 Mödlinger et al. 2025b, 2. There are detailed drawings by Gotthard Montgelas of the wooden beam of the door in Augsburg, which are kept in the archives of the Bayerisches Landesamt für Denkmalpflege in Munich. I would like to thank Mr Montgelas and Mrs Simone Kreuzeder from the archive for providing me with this information. The medieval wooden beam was probably replaced in 1593: Mach 2009, 200.

22 Patrizio 2019, 17.

23 Both from the point of view of the Anthropocene, see also Patrizio 2019, esp. 45–49, as well as, with an interest in disaster research, cf. Belmonte, Scirocco 2019; Juneja, Schenk 2014.

24 Boeckler 1931; Fasanari 1961; Neumann 1979; Mellini 1992; Coden, Franco 2017; Coden 2025 (in this volume).

25 Weinryb 2016, 112–113, Heginbotham 2016, 11–12.

26 The door in Hildesheim, for example, is structured in this way and was presumably known to the Verona workshop. It has been repeatedly surmised that the door in Verona comes from a northern Alpine workshop, cf. recently Olchawa 2019, 95–99.

27 Milone 2025 (in this volume).

28 An inscription has survived from the Oderisius door in Benevento in which it is described as *opus Oderisi*: Mende 1994, 51. The Oderisius workshop created a door for the Benedictine convent of San Giovanni in Capua as early as 1122. It too is now lost, but a 17th century drawing clearly shows the similarities with the door of the main portal of Troia: see fig. 34 in Mende 1994, 51.

29 Ciampini 1699, 25. The cardinal also left an inscription to this effect on the Pilatus panel: "Restaurata mense sept. A.D. MDCXIII a Card. Ursino Archiep. post Concilium Provinciale ab eodem habitum mense apr".: Cielo 1975, 355–359, inscription on page 355; Angelucci, Marinelli 1990, 448–449, with further sources for the door.

30 Mende 1994, 51; Cielo 1975, 356. In a register kept by the cardinal in 1693, the following entry is said to appear under the list of expenditure for the restoration: "Otone rotola centoquarantotto e tre quarti

panels.[31] However, the investigations were made more challenging by the further destruction that the door suffered during the bombing of Benevento in September 1943. At the time, efforts were made to safeguard the door with sandbags, which, when the cathedral burned, created a furnace-like environment, accelerating the melting of the bronze.[32] It was not until 1990, under the direction of Sergio Angelucci, that a restoration of the badly damaged panels was attempted, which visually added to the missing areas (fig. 5).[33]

A similar fate befell the bronze door of San Paolo Fuori le Mura in Rome, which was made in Constantinople in 1070. The great fire of 1823 damaged it so badly that it was not until 1956/66 that the panels were restored.[34]

It can be observed that the majority of restorations were accompanied by appropriation mechanisms. In the case of the Monreale and Troia restorations, the respective patrons inscribed themselves on the medieval objects, either through their coats of arms or inscriptions, thereby becoming part of the object biographies.

Furthermore, the updates to the doors were accompanied by changes to their significance. The connection to the supposedly eternal claim to legitimacy was not always as clear as in the case of the door of Montecassino. The door of the abbey church was created shortly after 1065 at the request of Abbot Desiderius (1058–1086) as a commissioned work made in Constantinople. It is the second in a series of at least eight Byzantine doors in Italy, which were made in Constantinople in the 11th century and then brought to the Apennine peninsula by ship.[35] In Montecassino, as early as the beginning of the 12th century, the door panels, with inlaid figures and inscriptions, were turned over in order to engrave a long list of the abbey's possessions on the reverse side.[36] A comparable occurrence transpired in Mainz, where the archbishop, Adalbert I of Saarbrücken (1111–1137), in 1135, had the city privilege he had bestowed upon the city commemorated with an inscription in the upper part of a bronze door, a door which was donated by Archbishop Willigis (940–1011) at the beginning of the 11th century.[37] In both cases, the inscribed bronze plates appear very similar to ancient law tablets.

Fig. 4: Heavily corroded panel, bronze door, 1087, Constantinople, San Salvatore de Birecto, Atrani (© Judith Utz).

per accomodo di detta porta, l'istesso che si prese dalla porta di S. Bartolomeo Ducati 50,51 9/12": Cielo 1975, 356.

31 Mödlinger, Ghiara 2025 (in this volume).

32 Angelucci 1999, 185. The Second World War left its mark not only on Benevento; the doors of Montecassino were also badly damaged in 1944 and had to be restored: Bloch 1987.

33 Angelucci 1999, 186. Photographs from before the war are documented here: https://www.bildindex.de/document/obj20181799?part=0&medium=fm2086 [last access: 13.03.2025].

34 Bloch 1968, 141. One of the unrestored plates is kept in the Palazzo Venezia in Rome. The malformation of the brass is clearly visible here.

35 Utz 2024b.

36 Bloch 1987.

37 This is one of the longest inscriptions of the Middle Ages, which is why it is not reproduced here, but can be found in Mende 1994, 133–134.

a

b

c

Fig. 5: Last Supper, around 1200, Cathedral of Santa Maria de Episcopio, Benevento.
a) Photograph from 1932 (© Bildarchiv Foto Marburg / photography: unkown; taken in 1932, image nr.: fm53668);
b) Condition after the bombings of the Second World War (© Bildarchiv Foto Marburg / photography: Hirmer, Albert / Ernstmeier-Hirmer, Irmgard; taken before 1983; former image nr.: 834.6151, convolute: Hirmer Fotoarchiv);
c) Condition after restoration by Sergio Angelucci, 1990 (© Martin Fera).

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Several moments can be identified in which a *tradition* of doors was established that continued in later doors. In a way, these role models live on in the later "copies". This is clear in two cases: firstly in the aforementioned door from Mainz, which clearly refers to the Aachen doors; and secondly in the case of most Italian doors from the12th century, which were modelled on Byzantine doors in terms of technique and construction.

The bronze doors that still adorn the portals of the Palatine Chapel in Aachen were funded by Charlemagne and are modelled on ancient Roman doors, with a few variations.[38] Each door wing is dominated by two or three large plain surfaces, which are framed only by a narrow ornamental frieze. The door in Mainz, made shortly after the year 1000, was modelled on this. The Mainz door is also simple in design, with two large, flat surfaces characterising each wing. The frames bear inscriptions that clearly refer to Charlemagne: "After the great Emperor Charles had given his life back to nature, Archbishop Willigis was the first to have door leaves made from metal […]."[39] It is noteworthy that the inscription is self-referential, underlining the particularly prestigious donation by Willigis.[40]

During the Middle Ages, the practice of workshops modelling their objects on other doors was a common occurrence. Traditions were established within this group of objects, and the then traditional nature of the medium contributed to its enduring appeal. The high quality of the material and the challenging manufacturing process of the doors, appear to have contributed to the fact that the most significant sacred buildings of the period aimed for monumental bronze doors. That metal doors functioned as status symbols is exemplified by the Byzantine doors in Italy, the oldest of which can be found in Amalfi. The Chronicle of Montecassino describes that it was soon copied. In 1065, Abbot Desiderius of Montecassino travelled to Amalfi to procure precious fabrics for the forthcoming visit of Henry IV (1084–1105). The Chronicle records the moment when Desiderius is said to have stood in front of the cathedral, admiring the bronze doors which "delighted his eyes and shortly afterwards he sent the measurements of the old door of his abbey church to Constantinople along with the order to make ones just like the one in Amalfi."[41] After the Montecassino door, six more doors were made in Constantinople, destined for sacred buildings in Monte Sant'Angelo, Rome, Atrani, Salerno, and Venice.[42] In turn, these Byzantine doors served as the model for other doors created in southern Italy during the 12th century. The workshops of Barisanus of Trani and Bonannus of Pisa adopted the formal and technical features of Byzantine doors, as did the workshop of Oderisius of Benevento, which operated before them. All of these workshops produced thin metal plates that were fixed to a wooden support using a frame system. This method of working was more expedient and less costly, as it permitted the use of less material.[43]

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38 They are located at the entrance to St Charles' Chapel, St Hubert's Chapel and the former St Anne's Chapel: Mende 1994, 25–27, 131–133; Ristow 2025.

39 "POSTQVA(M) MAGNV(S) IMP(ERATOR) KAROLVS SVV(M) ESSE IVRI DEDIT NATVRAE / WILLIGISVS ARCHIEP(ISCOPV)S EX METALLI SPECIE VALVAS EFFECERAT PRIMVS / BERENGERVS HVIVS OPERIS ARTIFEX LECTOR VT P(RO) EO D(EV)M ROGES POSTVLAT SVPPLEX": Mende 1994, 133.

40 It is unclear for which location the Mainz door was originally created, but it is usually assumed to be the cathedral. The reference to Charlemagne suggests that the Ottonians wanted to make Mainz Cathedral the coronation church for German kings: Lutz 2008, 22–23; Mende 1994, 25–33.

41 "Videns autem tunc portas aereas episcopii Amalfitani, cum valde placuissent oculis eius, mox mensuram portarum veteris ecclesiae Constantinopolim misit, ibique illas ut sunt fieri fecit. Nam nondum disposuerat ecclesiamo renovare, et ob hanc causam portae ipsae sic breves effectae sunt, sicut hactenus permanent": Chronica Monasterii Casinensis, III, 18, after Bloch 1986, 139.

42 Matthiae 1971; Frazer 1973. In Venice, the Byzantine door from the 1080s may itself have been the model for a second door, which today adorns the main portal of San Marco and must have been made between 1112 and 1138. However, it is debated whether this second door is a local or Constantinopolitan production: Matthiae 1971, 103–105, Bloch 1986, 166; Mödlinger et al. 2023.

43 Of course, solely wooden doors could also have served as a model, which are also divided into panels and which in turn could be decorated pictorially, cf. for example, the late antique doors of Santa Sabina in Rome and Sant'Ambrogio in Milan, as well as the medieval doors in Abruzzo (Santa Maria in Cellis near Carsoli, San Pietro di Alba Fucens, both first half of the12th century), Curzi 2020.

This reference to the Byzantine doors is further developed in Pisa and Florence. When the Florentine *Arte di Calimala* decided to add new metal doors to the Baptistery in 1329, there were neither models nor masters locally who were capable of creating such objects. Piero di Jacopo was therefore initially sent to Pisa "a vedere quelle che sono in detta città e le ritragga" and then to Venice,[44] "a cercare di maestro che le faccia".[45] In that year, there were three bronze doors at Pisa Cathedral, only one of which is still preserved today. The two that adorned the main and southern portals of the west façade were destroyed in the great fire of 1595.[46] The door which is still preserved today, from the Porta San Ranieri, was not signed by any artist, however it can also be attributed to Bonannus of Pisa based on a comparison with the door of Monreale. Early modern sources reveal that the lost door of Pisa's main portal was signed by him; the artist there not only gives his name and the year the door was completed – 1179 according to the Pisan calendar – but also boasts that he finished the door in just one year.[47]

In addition to the two Bonannus doors, the Florentine Baptistery door may have been modelled on another door in Pisa, which was also destroyed in the fire of 1595. It must have been located at the southern entrance of the west façade. The Pisan canon, Raffaelo Roncioni, was present during the time of the fire and recorded some of the lost objects in his *Istorie Pisane* (1553–1618), including the doors of the west façade:

> „Questo tempio ha sei porte: tre di bronzo, una coperta di ferro, e due di legname. La maggiore di tutte fu fatta, l'anno MCLXXX, da Buonanno Pisano, scultore eccellentissimo; e quell'altra porta, pure di bronzo, accanto alla principale (che non si costuma d'aprire se non giovedì santo), dove era intagliata la vita tutta di Gesu Cristo, nostro Signore, con le figure effigiate di puro argento, fu donata ai Pisani, l'anno MC da Goffredo Buglione […]."[48]

According to Roncioni, another bronze door depicting a Christ cycle came to Pisa in 1100 as a donation of Gottfried of Bouillon.[49] The latter was involved in the conquest of Jerusalem in 1099 as a military commander and acted as the first regent – but not king – of the city. His close links to Pisa are evident in the person of Dagobert of Pisa, the Latin Patriarch of Jerusalem (1099–1102) and former Archbishop of Pisa (1088–1099). Nevertheless, it seems unlikely that the door originated from Jerusalem. It is more probable that this door was also of Constantinopolitan origin, as there were already several examples in Italy. The construction of these doors was contingent upon the flourishing trade relations between the Italian maritime republics and the Byzantine Empire. The granting of a *fondaco* to the Pisans in Constantinople in 1111 would appear to indicate that the door was made as a consequence of this, and possibly in anticipation of the consecration of the cathedral in 1118. Such a commission may also have been influenced by the competition

44 Venice was already known for its bronze casters at this time: Rodriguez Suarez 2023.

45 "6 Nov. 1329. Si delibera che le porte della Chiesa di S. Giovanni si faccino di metallo o ottone, più belle che si può, e che Piero d'Iacopo vadia a Pisa a vedere quelle che sono in detta città e le ritragga, e dipoi vadia a Venezia a cercare di maestro che le faccia, e trovandolo, che lui deva essere il maestro a lavorare la forma di detta porta di metallo": Ex libro reformationum..., Artis Calismare, 1327–1331; 5 novembre (1329).

46 Von Erffa 1965/66, 55–56. Unfortunately, Piero di Jacopo's drawings have not survived, so it is not possible to reconstruct which of the three doors was of particular interest in Florence.

47 "Janua perficitur vario constructa decore / Ex quo virgineum Christus descendit in alvum / Anno MCLXXX ego Bonannus Pisanus mea arte / Hanc portam uno anno perfeci tempore domini / Benedicti operarii istius ecclesie": da Morrona 1787, 170; Boeckler 1953, 9, von Erffa 1965/66, 55; White 1988, 158–159. This gives us a sense of the temporal dimensions of such large bronzes. The workshop around Bonannus was relatively quick, as it worked with models and also reused them, as the comparison between the two doors in Pisa and Monreale shows. It is very likely that the workshop also used the same models for the lost main portal. While the Porta San Ranieri depicts the life of Christ, the thematic focus of the main portal may have been on the cycle of the Virgin Mary, as suggested not only by the cathedral's patron saint but also by the inscription on the door: "Janua perficitur vario constructa decore / Ex quo virgineum Christus descendit in alvum": Boeckler 1953, 9, von Erffa 1965/1966, 55.

48 Roncioni 1844, 109–111.

49 Von Erffa 1965/66, 55–56; Milone 1995, 198.

between the maritime republics.[50] The extent to which Gottfried of Bouillon *actually* acted as the patron of the door remains an open question though, as it is only Roncioni who reports this, almost five centuries later. It is likely that the significance of Pisan actors during the First Crusade merged with the provenance of the object, something recognised up until the 16th century, when Roncioni reports on it. This door, either associated with Constantinople or Jerusalem, in the southern side portal, also symbolises Pisa's wish in the 11th and 12th centuries to construct a glorious past and to represent its own significance in the present.[51] It is likely that the design of the Byzantine door and its technical particularities were directly copied for the two Bonannus doors in Pisa, and that it then also served as an inspiration for Piero di Jacopo in 1329. In a way, the lost doors of Pisa live on to this day in the Florentine Baptistery doors.

Lost

With Venice (1080s and 1120s), Salerno (1099), and Pisa (possibly 1110), almost all Italian maritime republics had bronze doors on their cathedrals at the beginning of the 12th century. Genoa, which also rose to become a powerful trading power in the Mediterranean at this time, could not initially claim this.[52] However, if the sources are to be believed, it also procured such a door for itself shortly afterwards. In the *Castigatissimi Annali* of the Archbishop of Genoa, Agostino Giustiniani, published in 1537, a passage is recorded according to which a man called Vassallo brought from Almerìa (destroyed by the Genoese in 1147) two "bellissime porte di bronzo" to Genoa, which "per lungo tempo stettero per clausura della chiesa di S. Giorgio, come si legge ancora adesso in una pietra marmorea affissa alla scala grande di essa chiesa". Where the doors were located *now* – in the middle of the 16th century – he did not know.[53] Today, not even the marble plaque mentioned by Giustiniani remains in San Giorgio, a small church close to the harbour. The church was completely renovated in the 17th century, which is probably when the plaque was lost.[54] It is therefore no longer possible to determine whether the Genoese actually stole a door from Almerìa, or whether such a legend was created at some point during a later period in order to attribute a bronze door tradition to the Ligurian maritime republic as well.[55] The door in question is lost, and was likely melted down at some point prior to 1537.

A considerable number of metal doors experienced a similar fate, and in all these instances, the expectation that the bronze would last *forever* was not fulfilled.

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50 It is possible that this door was positioned in the main portal of the west façade of the cathedral, which was built from 1063, until it was replaced by the Bonannus door. Doors with the *vita* of Christ can only be found on the Byzantine door of San Paolo Fuori le Mura in Rome and in Constantinople itself. In the *Alexiad*, Anna Comnena describes doors clad with silver panels in the Chalkoprateia church complex. She also writes of how they were melted down in 1082: Ristovska 2017, 379; Comnena 1969, 158–159; Utz 2024b, 83.

51 Milone 1995, 204 resp. whole article. Roncioni mentions a third door, which is said to have been brought from Mallorca in 1116. He does not specify its material, but Ranieri Sardo (d. 1422), who also mentions the door, describes it as a wooden: Sardo 1963, 24f. In both cases, its existence in Pisa is linked to the Balearic campaigns; the door must therefore have been brought to Pisa as a piece of booty. Ranieri Sardo lists it alongside various columns that also came to Pisa as booty, and also mentions that some of these objects went to Florence. This is why this event also found its way into Giovanni Villani's chronicle: "Negli anni di Cristo MCXVII i Pisani feciono una grande armata di galee e di navi, e andarono sopra l'isola di Maiolica che lla teneano i Saracini [...] E tornata l'oste de' Pisani dal conquisto di Maiolica, rendero molte grazie a' Fiorentini, e domandaro quale segnale del conquisto volessono, o le porte del metallo, o due colonne del profferito che'aveano recate e tratte di Maiolica": Villani 1990, 215–216, cited after Haug 2015, 19. However, Villani refers to a metal door, not a wooden one; a confusion that may have been caused by other bronze doors that came to Italy as booty.

52 The Genoese did not have much influence in Constantinople until the second half of the 12th century: Banti 1998, 8. It is possible that the (presumably Amalfitan) workshops in the city were no longer producing doors at this time.

53 Giustiniani 1834, 187 (Reprint of work from 1537, there fol. 40v). On page 180 of the reprint, it becomes clear that this is the campaign of 1147. Cf. on the tradition of the door: Calderoni Masetti 2017, 10, 18–19; Müller 2002, 204–205, cat. no. 6.

54 Müller 2002, 204, cat. no. 6.

55 I would like to take this opportunity to thank Marianne Mödlinger, who has repeatedly travelled to Genoa in search of the door. The fact that the city used such (sometimes idealised) trophies to subsequently enrich its urban history, can also be found elsewhere: see for example Haug 2015.

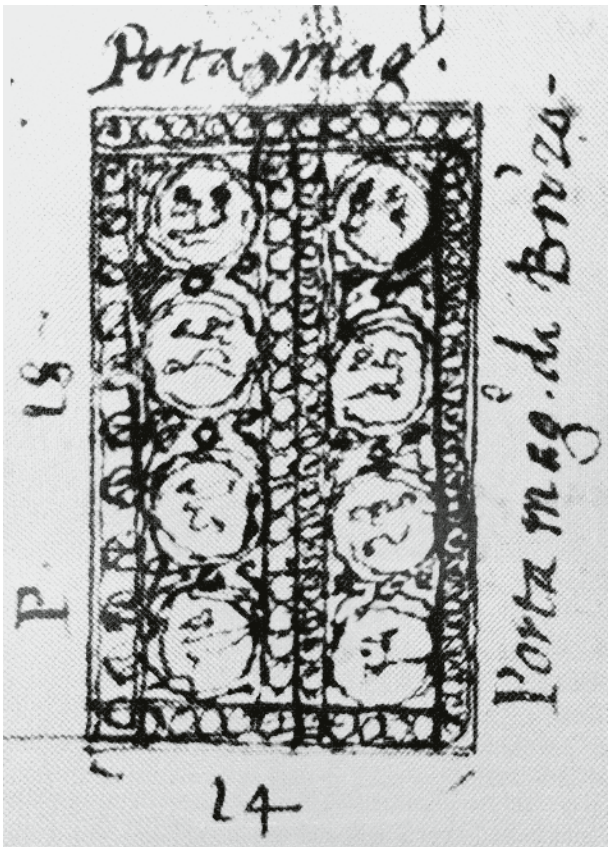

Fig. 6: The main portal of St Denis after a drawing from Vincenzo Scamozzi's travel sketchbook, around 1600, Vicenza, Museo Civico, Ms. C. 42, fol. 1v (after Mende 1994, 72, fig. 69).

The biographies of all bronze objects are similarly characterised by loss, given that the material was so easily recyclable.[56] In times of war, it was possible to extract considerable metal from monumental doors in order to cast weapons, primarily cannons. The three bronze doors of St Denis in France, for example, were destroyed in the aftermath of the French Revolution. The oldest door was located to the northern side portal and dated to Carolingian times,[57] the other two doors dated from the time of Abbot Suger (1081–1151). One of them was located in the large main portal, the other in the southern side portal. The larger one is said to have had medallions with depictions of Christ's Passion and Resurrection (fig. 6).[58]

It had a long inscription that also referred to the door itself and its splendour; it may have been gilded.[59] It is probable that the small door of the Bohemund mausoleum in Canosa di Puglia was nearly melted down during the Napoleonic campaigns in Italy. The door shows severe damage to the left door leaf, which is said to be due to the fact that French soldiers initially took the door with them, but then left it in a field outside the town for reasons that can no longer be reconstructed today.[60]

In addition to the needs of war, the evolution of aesthetic ideals also led to the reuse of medieval bronze objects. One illustrative example is the antique door that once adorned the main portal of the Lateran, which Pope Sixtus V (1585–1590) had melted down to create a sculpture of St Paul in 1588.[61]

It is uncertain whether another door in Apulia was melted down during the 19th century for similar reasons. As Antonio Iacobini was able to reconstruct, San Nicola in Bari must have had a door from the Barisanus workshop as well. Huillard-Bréholles mentions the door in a footnote in his *Recherches sur les monuments et l'histoire des Normands et de la maison de Souabe dans l'Italie méridionale* (1844): "Une petite porte également en bronze, à San-Nicola de Bari, rappelle aussi, tant par la distribution que par le choix des sujets, le dessin de celle de Trani."[62] In sketches made by Aubin Louis Millin during his travels through southern Italy in the early 19th century, Iacobini found a drawing made in January 1813 which is strongly reminiscent of the Barisanus doors (fig. 7).

56 The loss of objects is of course part of art history and is repeatedly addressed in the discipline: see Fricke, Kumler 2022.

57 Mende 1994, 22. This may have served as a model for the Aachen doors, even though it is said to have had figurative reliefs.

58 Mende 1994, 72.

59 "Portarum quisquis attollere quaeris honorem, Aurum nec sumptus operis mirare laborem, Nobile claret opus, sed opus quod nobile claret Clarificet mentes, ut eant per lumina vera Ad verum lumen, ubi Christus janua vera. Quale sit intus in his determinat aurea porta: Mens hebes ad verum per materialia surgit, Et demersa prius hac visa luce resurgit", Speer, Binding 2000, 324. A description of the door can be found in chapters 170–175, pp. 322–325. Cf. also Claussen 1996; Utz 2024a, 45–47.

60 Cilla 1993, 16. On the bronze door, see also Utz 2024a.

61 Iacobini 1990, 75.

62 Huillard Bréholles, 1844, 43, note 3; Iacobini 2010, 199–200.

► Fig. 7: Drawing by Ignazio Aveta of the lost door in Bari, 1813, Paris, Bibliothèque nationale de France, Estampes, fol. 132a, P62820 (© Bibliothèque nationale de France, Paris).

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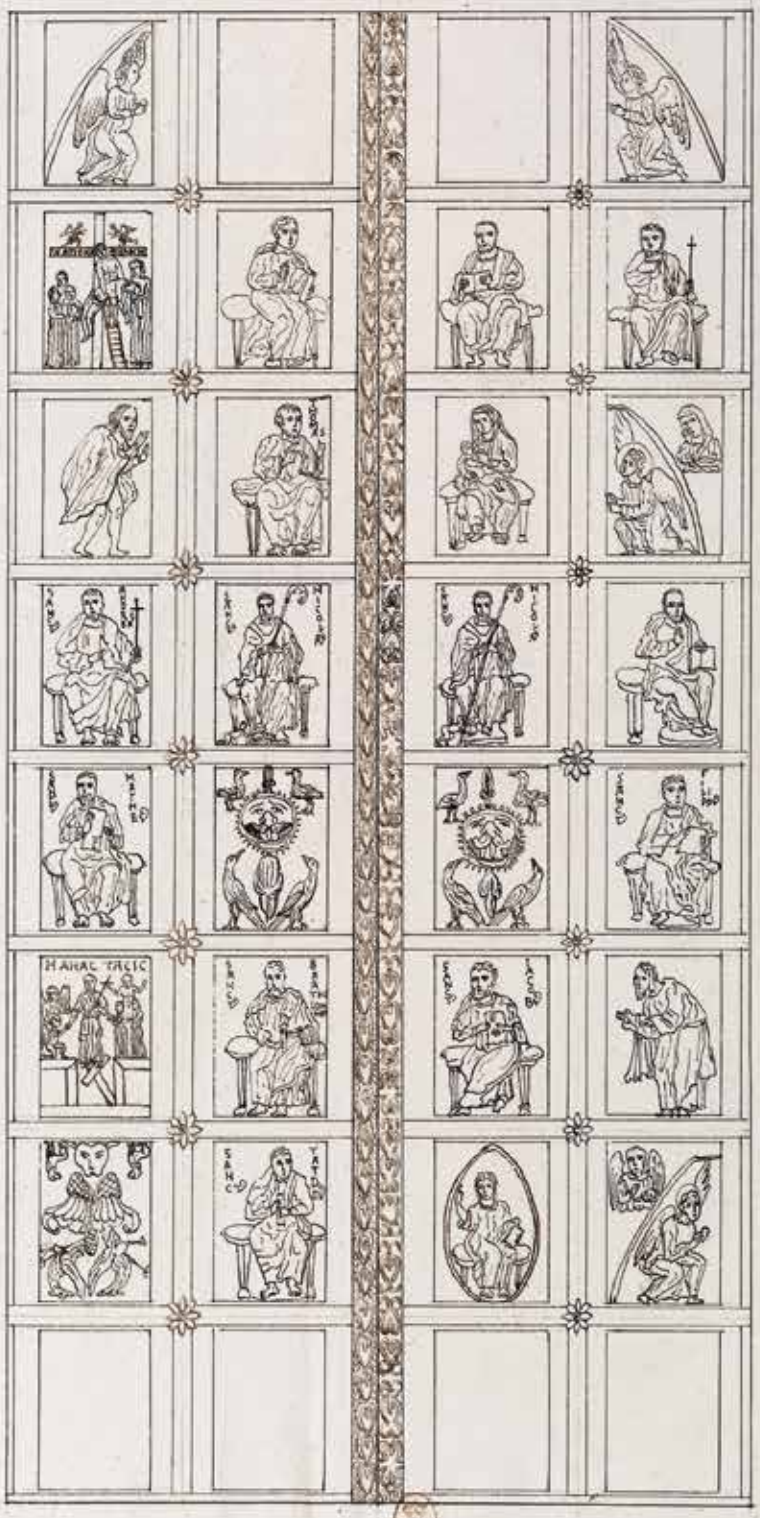

The door comprises several panels displaying the same iconography as the surviving Barisanus doors. The door's sketch comes with other drawings of objects related to San Nicola, such as a votive crown, which is believed to have been crafted during the reign of Roger II (1130–1154).[63] The order of the door panels is obviously not the original one, so the door must have been reassembled at least once. The angels that form the upper end of the respective panels in Ravello and Trani are present four times on the door in Bari. Two of them appear in the top register, one in the third, and one in the seventh register of eight. There are also four of these angels on the door in Ravello, each forming the upper end of the wing and framing a *Maiestas Domini*. The Ravello door has three columns of plates per leaf, whereas the Bari door has only two, according to the drawing. The two angels here could not have framed a central panel; it seems obvious that the drawn door is only a remnant of a much larger door, or even of two doors.[64] It remains unclear where these must have been located; the drawing does not specify this and Huillard-Bréholles only writes of "à San-Nicola de Bari". Iacobini was able to find a reference to the possible location of the door in a report of a visit from 1647. In the context of the southern atrium, this describes one of the side doors located near the stairs to the crypt as "completely covered with metal plates" and "of extraordinary beauty".[65]

It is convincing to think that the precious doors from the Barisanus workshop adorned both portals that give pilgrims access to the crypt of San Nicola, and that *two* doors can therefore be assumed to have been situated there. The *Codex Diplomaticus Barensis* probably contains an even older mention of the door in a document dated 17 November 1358, which also supports the positioning of the Barisanus door in the place suggested by Iacobini. It concerns a donation to San Nicola with the condition that a chapel be built, "by the staircase leading to the crypt of St Nicola, next to the door called the bronze door, where the image of St Nicholas is".[66] The sketch of the Barisanus door has two depictions of St Nicholas, which is probably due to the fact that the remains of two doors were merged into one here. However, the source only speaks of one door; the plural "porte vocate da brunzio" probably refers to the two door leaves.

It is not clear from Huillard-Bréholles' description whether he saw the door himself in Bari; surprisingly, it does not seem to have aroused his interest. It remains unclear whether it still existed in the mid-19th century or whether it was melted down shortly after Millin's stay in Bari. The drawing is a testimony to the extent to which the door was already damaged in 1813.

Remembered

The memory of the Bari door has only "survived" through the drawing and Huillard-Bréholles' brief mention of it. Given the importance of monumental bronze doors in general, and in the specific case of the Basilica of San Nicola in Bari in particular, it is surprising how much the tradition is determined by chance here.[67] Yet, "[f]orgetting, not remembering, is the norm in culture and society. Forgetting happens silently, unspectacularly and everywhere; remember-

63 Iacobini 2010, 193, 198; Iacobini 2012, 306–309; Iacobini 2018, 138–141.

64 Iacobini 2010, 198–199; Iacobini 2012, 312. Iacobini also makes w proposals for a reconstruction: Iacobini 2010, 199, 201, figs. 36, 37.

65 "[…] ianua preditta tota eneis laminis obserata est […] non ordinariae pulchritudinis": Iacobini 2010, 200, note 50; Iacobini 2018, 141, note 77, translation by the author.

66 "[…] sub tali conditioni quod ead. dom. Ecaterina construi faciet in ead. Eccl. suis expensis Cappellam unam in descensu scale confexionis ipsius Eccl. ex parte porte vocate da brunzio ubi est ymago beati Nicolai, in qua Cappella ead. dom. elegit sibi sepulcrum et in ead. Cappella se voluit sepeliri.": Codex Diplomaticus Barensis XVIII, no. 55, p. 101, translation by the author. Horst Schäfer-Schuchardt and Kai Kappel also mention the document, although they do not draw the conclusion of the existence of a Barisanus door in Bari from it: Schäfer-Schuchardt 1987, 59; Kappel 1996, 106. A later document from 1376 mentions the same chapel of the founder Ecaterina von Altamura: Codex Diplomaticus Barensis XVIII, no. 123, Nr. 124, pp. 252–256. No. 123. This mentions again the "porte vocate de brunzo ubi est ymago beate Nicolai" (p. 254).

67 For this methodological problem, see Esch 1985.

ing, on the other hand, is the unlikely exception that is based on certain preconditions."[68]

In this essay it has been made apparent that bronze doors were handed down in different ways. Written and pictorial sources bear witness to lost doors, but oral tradition in legends is almost as important. Although the Oderisius door in Benevento, for example, was destroyed in the earthquake of 1688, it is said to live on to this day in the cathedral door that was restored shortly afterwards. Genoa is said to have possessed a bronze door from Almerìa as a trophy of war, the transmission of which is even more precarious. We only know about it from the annals of Agostino Giustiniani, who writes about an inscription plate that mentions the door, but by the time these annals were written, there was no trace of the actual door left. Doors as war booty is also of central importance in those on the west façade of Pisa Cathedral; one door there is said to have come from Jerusalem, and thus refers to the successes of Pisa's compatriots during the First Crusade. In all the cases studied, it is clear that the doors were incredibly important to the local communities. This was evident through either restorations, updates, 'copies', or the creation of legends surrounding them. Whether objects are preserved or simply remembered, "memory creates community".[69] The scientific investigations of the GAPAMET project were able to investigate these updates and repairs on a material level, thus making a significant contribution to reconstructing the biographies of bronze doors in Europe since the 11th century. Restoring, copying, losing, and remembering artefacts are concepts and activities that are always interwoven, and thus it is particularly important and useful to approach these bronze objects in the semantic field between eternity and loss.

68 "Nicht das Erinnern, sondern das Vergessen ist […] der Normalfall in Kultur und Gesellschaft. Vergessen geschieht lautlos, unspektakulär und allüberall, Erinnern ist demgegenüber die unwahrscheinliche Ausnahme, die auf bestimmten Voraussetzungen beruht": Assmann 2016, 30, translation by the author.

69 Assmann 2016, 68.

Zusammenfassung

Der Beitrag widmet sich den Objektbiographien der Türen, d. h. ihrem Schicksal in den Jahrhunderten nach ihrer Herstellung. Viele der Türen befinden sich noch heute an dem Ort, für den sie entstanden – meist Portale bedeutender Kirchenbauten –, weitere wurden an andere Sakralbauten verbracht, sind in Museen ausgestellt, oder wurden gar zerstört. Am Nachleben der Objekte lässt sich ihre Bedeutung für die Gemeinschaften der späteren Jahrhunderte ablesen. So deuten Restaurierungen oder Ergänzungen auf eine immerwährende oder wieder erwachte Wertschätzung der Türen, Aktualisierungen in Inschriften auf auch spätere Inanspruchnahmen der Objekte durch profane oder sakrale Würdenträger. Auch wird im Beitrag thematisiert, was zum Verlust einiger Türen führte und wie diese Objekte bis heute in Erinnerung bleiben konnten. Der Beitrag untersucht damit auch ein dem Material Bronze inhärentes Spannungsfeld zwischen Ewigkeitsanspruch und Verlust.

Riassunto

Questo articolo è dedicato alle biografie delle porte, cioè al loro destino nei secoli successivi la loro produzione. Molte porte di bronzo si trovano ancora oggi nel luogo di destinazione – per lo più portali di importanti edifici ecclesiastici – mentre altre sono state trasferite in altri edifici sacri, esposte in musei o addirittura distrutte. La vita degli oggetti rivela il loro significato per le comunità dei secoli successivi. I restauri o le aggiunte successive, ad esempio, indicano un apprezzamento perpetuo o rinnovato per le porte, mentre gli aggiornamenti nelle iscrizioni indicano un utilizzo successivo degli oggetti da parte di dignitari laici o ecclesiastici. L'articolo discuterà anche le cause della perdita di alcune porte e il modo in cui questi oggetti sono stati tramandati fino ad oggi. Il testo esamina inoltre anche una aspirazione all'uso del bronzo come materiale, tra la pretesa di eternità e perdita.

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The Bronzes of the Carolingian Church of St. Mary's in Aachen

Sebastian Ristow

The bronze doors of the Carolingian church of St. Mary in Aachen

The archaeology and history of Charlemagne's palace in Aachen were fundamentally re-evaluated between 2010 and 2016.[1] Questions still remain though for the dating, interpretation and meaning of mobile monuments, such as the throne (fig. 1), the bronze casts from the vestibule of the cathedral, as well as the bronze equestrian statue that Charlemagne set up in the Palatinate, but which is not preserved.[2] The balustrades on the gallery were also re-examined, as were the three preserved small bronze doors and the large main door of the cathedral.[3]

The group of buildings in the Palatinate consist of the Church of St. Mary[4] and the auditorium hall, both places where the ruler appeared, one in a religious, the other in a secular context. The two buildings of today's cathedral and town hall in the centre of Aachen were connected by a 51.30 m long corridor (fig. 2). The enclosure and outbuildings that originally existed are archaeologically unknown.

The walls of the deepest, Roman period, layer run in a northwest-southeast direction (fig. 3). In addition to thermal baths in the area of the later cathedral, there was a Roman *burgus* where, in its southern part, the later *aula* was found. This is now the marketplace of Aachen. At the moment we cannot say if the *burgus* walls existed at their full height through to the period of Charlemagne, because we are awaiting the publication of their layers and finds. This could put the possible end of the *burgus* walls in the high medieval period, as hypothesised by Andreas Schaub.[5] In any case, this will give us an idea about the possible height for the walls, how useful they were, how they may have been conserved, and for what purpose, in the former Roman *burgus* in Carolingian times. The reconstruction (fig. 2) shows one solution, where a lower fragment of the wall was used to mark the border of the medieval marketplace. Shortly before 800, Charlemagne was not only harking back to the architecture and ruins of Italy or other crystalline points of ancient culture in his new buildings, but he also renovated the existing structures of his father Pippin. He certainly aimed to surpass them, helped by having superior building equipment. This initial phase is marked by tombs in the cathedral area interred before 800, and also by some archaeological features.[6]

According to the analysis of the wooden piles in the area, the *Marienkirche* was erected from 798 ± 5 AD, and was probably completed shortly after 803 ± 10 AD, so the construction ran for roughly 20 years. The *Aula* cannot be more precisely dated than "around and after 800".[7] Agnellus of Ravenna reports the removal of a large bronze from Ravenna in 787, which was believed

1 Ristow 2016.

2 Walahfridi Strabi Carmina, 374, 116–128 – Agnellus, Liber pontificalis ecclesiae Ravennatis 338, 17–21. – See: Thürlemann 1977.

3 The present essay is a modified short summary of: Ristow, Steiniger 2016; 2017a; 2017b. – For reading the English text I would like to thank Quentin Hutchinson/Seahouses.

4 Ristow 2014.

5 Schaub 2021, 153–156 with fig. 1, 3.

6 For a water supply channel which is definitely older than Charlemagne's constructions, see: Kyritz 2010.

7 Ristow 2016, 36 refers to the new dendrochronology of the wood used for its construction, which dates the area of the tower, which is built together with the *aula*, some time later than 800, and a second piece of wood dates to later than 815.

Fig. 1: Reconstruction of the location of the royal throne in the 9th century, close to the parapet and without a base. Image: ArchaeoPlanRistow (S. Ristow)/Narmer Architecture (© Zs. Vasáros, G. Nagy)

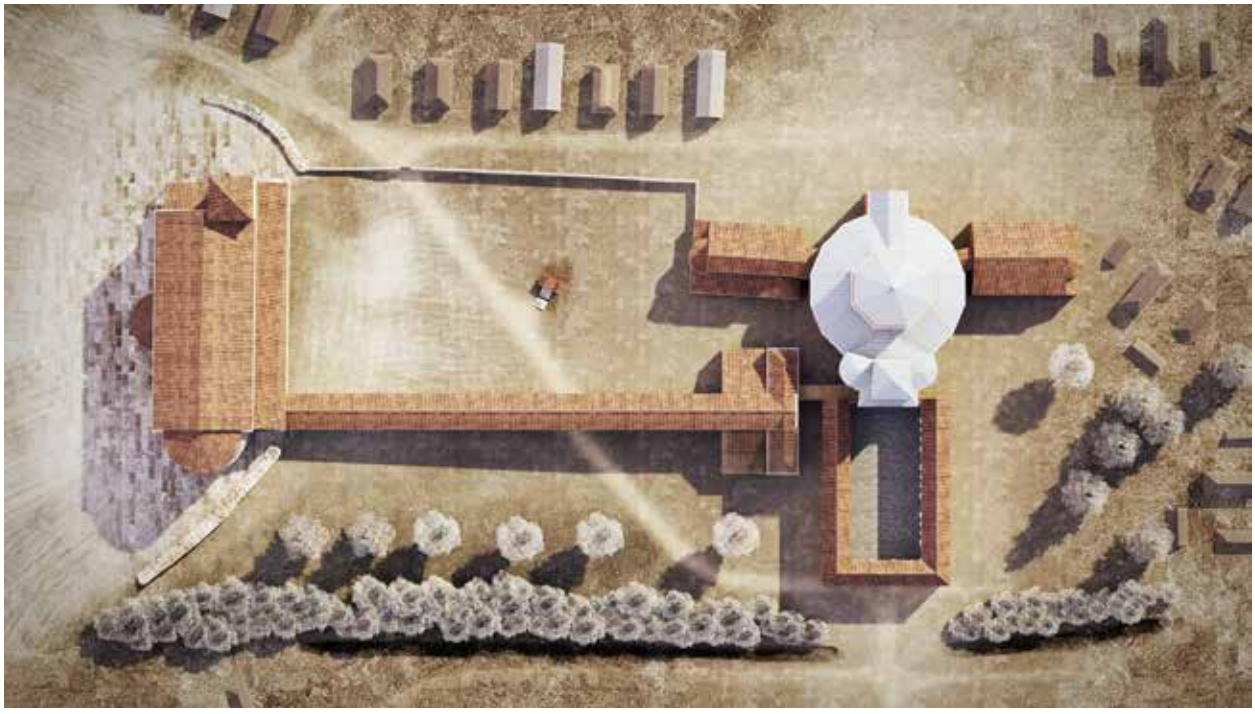

Fig. 2: Reconstruction of the Aachen Palatinate around 820, from a bird's eye view. Image: ArchaeoPlanRistow (S. Ristow)/Narmer Architecture (© Zs. Vasáros, G. Nagy).

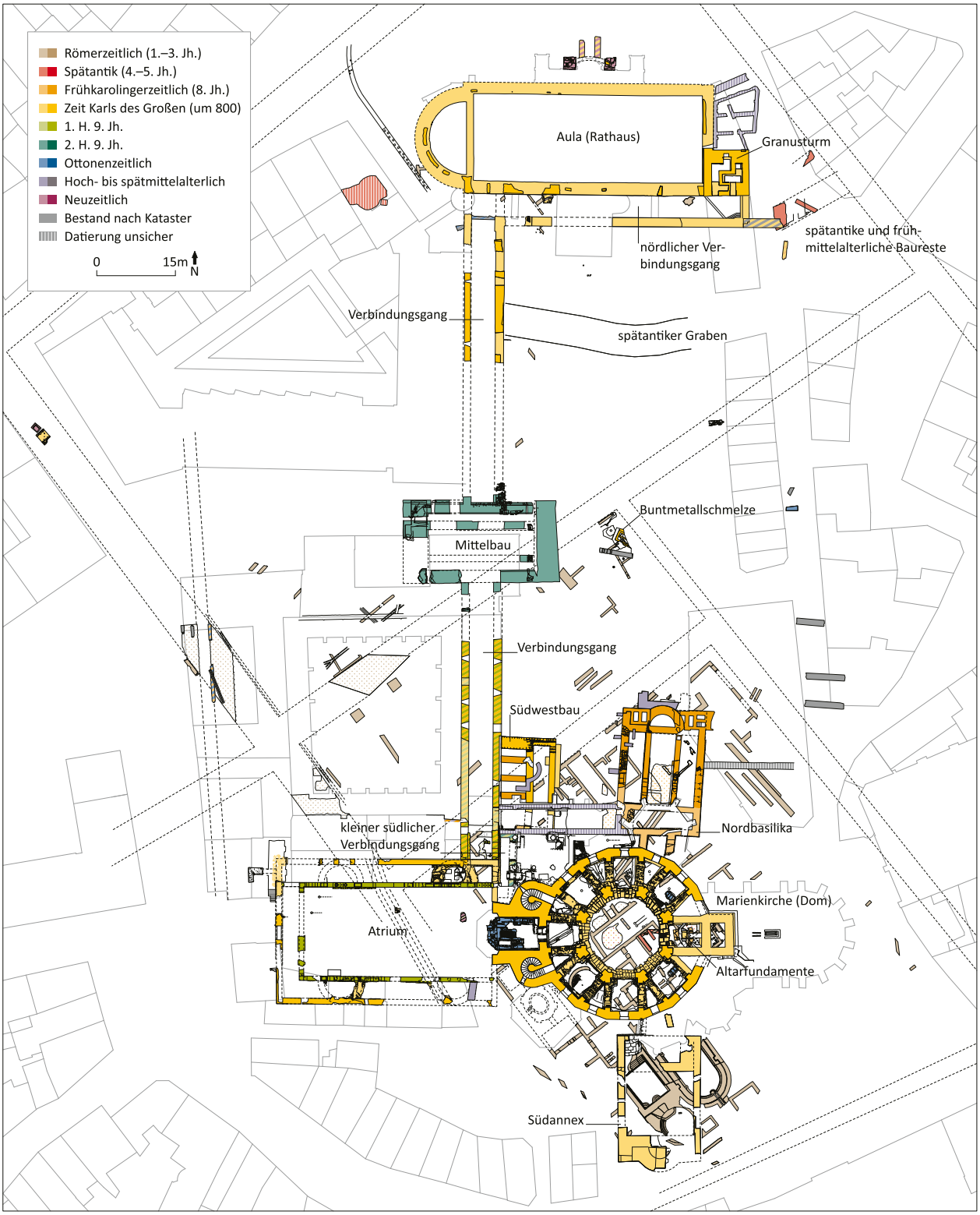

Fig. 3: General plan of the findings in the inner Palatinate area of Aachen. Plan: ArchaeoPlanRistow (© S. Ristow, A. Kobe).

Fig. 4: Daniel Steiniger and the author taking measurements at the Wolf Door in 2016. Photo: ArchaeoPlanRistow (© S. Ristow).

to be an equestrian statue of Theodoric the Great. In 829, i.e. after Charlemagne had died, Walahfrid Strabo wrote a poem about this bronze work and the design of the Palatinate featuring works in bronze.[8]

Bronze analyses

Together with Daniel Steiniger from the German Archaeological Institute, the company ArchaeoPlanRistow was able to carry out more than 200 measurements using portable energy-dispensive X-ray fluorescence analysis (XRF) on the bronzes in Aachen Cathedral between 2014–2016 (fig. 4). This was also with the support of the University of Cologne, Aachen Cathedral Construction Management, and especially from master mason Helmut Maintz. The intention was to research foundry-specific processes as well as the type and origin of the metals used. More than a hundred years ago, chemical analyses were carried out on the so-called 'Wolf Door' and the bars on the gallery of the octagon.[9] Two views on the manufacturing technique emerged from this based on the composition and origin of the metal:

1. The metal objects that Charlemagne brought to Aachen and installed there, were imported.
2. The Metals were likely melted on the Katschhof and were used to create large bronze objects during the construction of the *Marienkirche* around 800 AD. This may have included the door wings and inner gallery balustrades for the cathedral.

The archaeological finds uncovered in 1911 revealed a refining furnace and parts of a melting and casting trench, which, judging from its length, could have been used for the 3.94 × 1.37 m doors (fig. 5).[10] The structure of the casting furnace contained parts of now lost casting moulds. A find, lost in the Second World War, which survives only in the form of a photograph,[11] (fig. 6) shows there were also fragments of moulds for the production of wax models. These were based on patterns of the actual casting mould that had been replicated several times.[12] At least a third of this industrial site is still under the ground in central Aachen.

Until recently, due to a lack of archaeological evidence, some historians, as well as art historians, did not believe that a well-organised mining industry existed in the Early Middle Ages, and thus the possibility for raw material-based metal production.[13] It was assumed that, in this industry, large amounts of looted goods, spoils of war, or scrap metal were deliberately hoarded and melted down at this time. In the last few years, however, features and finds from mines dating back to the Carolingian period have increased. In ad-

8 Ristow 2014; Ristow, Steiniger 2016; 2017a; 2017b.
9 Peltzer 1908, 251. For more analyses, see: Buchkremer 1924, 12; cf. Goldschmidt 1926, 10–11.
10 Ristow 2013.
11 See Ristow, Steiniger 2016, 146, fig. 4.
12 Goldschmidt 1926, fig. 2.
13 For a summary of this belief, see: Baumeister 2004.

Fig. 5: Possible reconstruction of the bronze casting facility of the Carolingian period, based on findings from 1911. Image: ArchaeoPlanRistow (S. Ristow)/Narmer Architecture © Zs. Vasáros, G. Nagy).

dition to discoveries at Melle in France,[14] mines have been revealed in the Harz Mountains, Odenwald, the Black Forest, and the Vosges.[15] Furthermore, it is now believed that the so-called 'Aachen iron mass' could be from the Carolingian period.[16] This means that targeted and independent metal production may well have been used for the large bronzes in Aachen in the Carolingian era.

With the so-called 'Wolf Door' and the balustrades in the octagon, it was possible to take XRF measurements on the fresh metal surfaces, as their constant use has left brightly polished areas on which no patina could form.[17] The 'alloy mode' was largely used for the measurements, and a window opening of 8 mm and measuring times of 90 seconds were utilised. For comparison purposes, measurements were also carried out in places using the 'precious metal mode' for archaeometry, with a measuring time of 180 seconds. At least three individual measurements were taken at different points on the examined surface, and the values were averaged.

On the Wolf Door, large areas are covered with a thick patina, but there are three places in particular where the bare metal was visible and accessible for measurement.[18] On the outside of the two separately casted lions' heads, in the area of the mouths, the metal surfaces were completely blank and clean as a result of frequent handling, which made it possible to measure

14 Téreygeol 2002.
15 Bartels, Klappauf 2012.
16 Kronz et al. 2016.
17 Ristow, Steiniger 2016; 2017a; 2017b.
18 Ristow, Steiniger 2016, 150, Tab. 2.

Fig. 6: Fragment of a mould for a wax model from the casting area (after Goldschmidt 1926, Fig. 2).

the bronze composition without the influence of patina. The main alloy components of the lion heads are tin, lead, and antimony. The contents are between approximately 3–5 wt.% for tin, around 2.5 wt.% for lead, and around 2.6 wt.% for antimony. Arsenic and silver are also present, each at around 0.4 wt.%. Minor traces of zinc, iron, nickel, mercury, and bismuth complete the overall picture (fig. 7).

On the inside, on the right-hand door leaf as seen from this interior position, the patina has been worn away in a semicircular shape along a grinding mark on the locking bolt, so much so that there is a usable measuring surface directly on the door leaf for examination. Here, however, as on the outside of the door, in the heavily worn areas in the middle, the metal is microscopically interspersed with the products of corrosion, although macroscopically the surfaces give the impression of bare metal. The measurements at these points therefore revealed increased levels of tin, lead, antimony, silver, iron, and mercury, compared to the really fresh metal of the lion's head. Arsenic, on the other hand, was slightly depleted here and zinc was below the detection limit. Based on the relative distribution of trace elements, it can be assumed that the composition of the two lions, which is very similar, is also approximately identical to that of the two door wings. It is very likely that the small elements of the lions were made close together in space and time, possibly in the nearby workshop on the Katschhof. One can imagine that different masters worked on the design, but the casting process was perhaps carried out by the same craftsmen.

Fahlores and silver

Based on the composition of the lion heads and the door wings, the Wolf Door is a remarkable bronze casting, because, in addition to the tin and lead contents, which are certainly in the normal range (albeit at the lower end), there is 2.6 wt. % of antimony, approximately 0.4 wt. % of arsenic and silver, as well as distinct traces of mercury and bismuth, which is a clear indication of 'pale ore metal' or fahlores. While tin and lead are deliberately introduced additions to the copper in the production of large bronzes, the remaining trace elements are typically found in raw or black copper, which is obtained from complex sulphide copper ores, so-called 'sallow ores'.

The assumption, repeatedly made in the literature, that scrap metal was melted down for the Aachen large bronzes, can now be clearly refuted, due to the very distinctive chemical composition of the door. Roman and early medieval bronzes show clear differences in their main and trace elements.[19]

From the High Middle Ages, the mining of fahlores is primarily documented for silver production, while for the Early Metal Ages they are seen as the main raw material for the copper used at the time, which has very similar arsenic and antimony contents. In the more recent Metal Ages, the Roman period, and the Early Middle Ages, such alloys, which contain a similar amount of arsenic and above all antimony, are almost completely absent.[20] From a metallurgical per-

19 With different contributions: Willer 2014; Gramaccini 1995.

20 Ristow, Steiniger 2016, 203–204.

Aachen pRFA 2014-2016		Anzahl	Cu	Sn	Pb	As	Sb	Ag	Zn	Fe	Ni	Hg	Bi	Au	Sum Gew%
Wolfstür, innen, Nordflügel, wenig Patina	MW	15	68,93	11,36	4,10	0,23	4,05	0,58	0,22	3,41		0,469	0,023		93,40
Wolfstür, Löwe, Südflügel	MW	6	84,76	5,22	2,51	0,42	2,47	0,39	0,15	0,06	0,021	0,173	0,012		96,18
Wolfstür, Löwe, Nordflügel	MW	3	87,98	3,18	2,25	0,39	2,86	0,42	0,08	0,01	0,025	0,173	0,014		97,39
Karlskapelle, Tür, Südostflügel, Patina	MW	3	79,03	8,73	8,21		0,71		0,39	0,14	0,028	0,316	0,009		97,55
Karlskapelle, Tür, Sudostflügel, Löwe, Patina	MW	3	82,27	8,02	5,34		2,17	0,29	0,19	0,09	0,024	0,369		0,016	98,78
Bärin, hintere rechte Pranke, Patina	MW	3	48,07	10,76	33,33		0,17		0,67	1,35		0,937	0,112		95,39
Zapfen, Sockel, Patina	MW	3	48,35	33,90	9,19	1,89	0,40	0,22	0,20	1,42		0,241	0,064		95,88
Zapfen, Schuppe, Patina	MW	3	49,37	37,56	9,68	0,69	0,38	0,20	0,09	0,54		0,461	0,073		99,03
Gitter 1	MW	3	86,42	5,55	0,65	0,65	0,07		2,48	0,08	0,012		0,012		95,93
Gitter 2	MW	3	79,76	9,67	2,15	0,99	0,61		0,36	0,34	0,017	0,103	0,031		94,03
Gitter 3	MW	3	84,42	9,78	1,05	0,55	0,46		0,29	0,06		0,074	0,013		96,71
Gitter 4	MW	3	81,45	10,12	1,56	0,58	1,01	0,33	0,87	0,14	0,014	0,126	0,017		96,23
Gitter 5	MW	3	84,77	4,83	1,01	0,81	0,09		3,02	0,09	0,011		0,015		94,64
Gitter 6	MW	3	79,64	8,19	3,39	0,95	0,52		1,21	0,31	0,037		0,019		94,26
Gitter 7	MW	3	84,73	10,40	0,89	0,50	0,20		0,27	0,02		0,070	0,008		97,08
Gitter 8	MW	3	82,54	9,28	1,80	0,52	1,37	0,43	0,60	0,16		0,091	0,012	0,054	96,86

Fig. 7: Measurements of the bronze material of the Wolf Door (after Ristow, Steiniger 2016, 150, Tab. 2).

spective, and due to its unique position within the history of foundries, the composition of the bronze from the Wolf Door in Aachen, creates the impression that a copper ore rich in arsenic and antimony was intentionally mined here in a specific and perhaps nearby mining area, and was processed using a smelting technology which meant that the arsenic and antimony contents in the raw copper were preserved.

In some large bronzes from the High Middle Ages, such as the Bernward Door and Column in Hildesheim, or the cathedral door in Mainz,[21] there are also traces of arsenic and antimony, which could indicate fahlores as a source of raw material, but an antimony content of 2.6 wt. % is unique. Fahlores with a high antimony content do occur in the Harz Mountains, but rarely in combination with a high arsenic content. The very low zinc content in the Wolf Door argues against an origin of the calamine deposits around Aachen, a source used since Roman times.[22] The deposits in the Harz may therefore be the possible source of the copper in the door.

In summary, if one considers the Aachen Palatinate Church and its foundry workshop as a whole, it is likely that the lead that was used came from the Carolingian silver mines of Melle in France.[23] Large amounts of lead were quarried there for the production of silver coins. The lead seals on the iron band surrounding the base of the cupola of Aachen Cathedral, which have already been examined, are remarkably pure, and show lead isotope signatures that are consistent with the lead ores from Melle.[24] The origin of the tin in Aachen is also an important question; in prehistory and ancient times, the Iberian Peninsula and the south-west of England were the main suppliers of this.[25]

In any case, according to Otfrid von Weißenburg, in his gospel book from around 870, ore and copper were dug 'in the land of the Franks', more specifically iron and stones or ironstone, and silver and gold in their sands, that is river gold.[26]

The door to the Charlemagne Chapel

This is a stylistically similar, but smaller, bronze door compared to the Wolf's Door, that is located at the entrance to the Charlemagne Chapel in the north of the cathedral. One of the lion heads attached to it were also examined as part of the project, but only patinated areas could be inspected. Thus, the values for individual elements vary more widely, but the lead content appears to be exceptionally high, while arsenic and, in some cases, bismuth are below the detection limit. The increased lead levels are likely to be the result of segregation, but otherwise all the measured values lie within the range seen in the Wolf Door and the gallery balus-

21 Brockner et al. 1996.

22 Graf 1990.

23 Téreygeol 2002, 2007.

24 Téreygeol 2007.

25 Haustein 2013.

26 Cod. Pal. lat. 52, p. 10v, Universitätsbibliothek Heidelberg: http://digi.ub.uni-heidelberg.de/diglit/cpl52/0056 [last access: 13.03.2025].

Fig. 8: Measurements comparing the balustrade and door materials (after Ristow/Steiniger 2016, 155, Diagr. 2).

trades. From these results, it can be assumed that this door to the Charlemagne Chapel consists of a range of raw materials comparable to other large bronzes from the Carolingian period.[27]

The balustrades on the gallery

All eight bronze railings of the gallery of the *Marienkirche* had bare spots in their lower parts.[28] Some of the measured values show a composition comparable to that of the Wulf's door. In the case of the secondary and trace elements, however, they show greater ranges of variation. Everything points to a casting process carried out in pairs, with each batch having similar values. The revealed secondary and trace elements, especially the arsenic and antimony, are to be interpreted as the use of pale ore metal, as in the Wolf Door. In terms of foundry technology and metallurgy, both the Wolf Door and the door to the Charlemagne chapel and all the gallery rails are very similar, despite minor differences. They were probably made together in the same workshop (fig. 8).

The equestrian statue of Metz

Remarkably, analyses of the equestrian statue from Metz, which consists of several components, show that the tin, lead and zinc content of the rider's body is almost identical to railings 1 and 5 from Aachen.[29] The only contemporary sculptures of a comparable size with the rider and horse from Metz are found on some balustrade railings from Aachen, but also on parts of the Wolf's door. It is very likely that raw copper similar to that used in the Aachen bronzes was utilised. This copper, a fahlore metal, had varying proportions of tin, lead and possibly zinc added to it. Perhaps the equestrian statuette was made in a workshop that was technologically related to the Aachen foundry, sourcing the copper from a similar supply of raw materials. In any case, the alloy differs significantly more from the bronzes of the High Middle Ages than from those from the Carolingian period in Aachen.

The female bear

According to its chemical composition, the bronze cast of the female bear clearly belongs to a series of large Roman bronzes.[30] A characteristic of bronzes from the period of the mid-Roman Empire seems to be the high proportion of lead, and the almost complete absence of fahlores.

The pine cone

The pine cone has traces of having been used as the top of a fountain, and has been preserved in the area of the west portal of Aachen Cathedral since the 15th century.[31] Perhaps its associated fountain had stood there in the atrium. As previously suspected by Hans Drescher, the cone is extremely unlikely to have been made in Aachen at the time of Charlemagne, or taken there so early.[32] Rather, based on historical considerations,[33] a more likely scenario is that during the time of the works of Emperor Otto III in Aachen, or at least with the remodelling of the Palatinate in the 11th cen-

27 Ristow, Steiniger 2016, 207.
28 For this and the analyses, see: Ristow, Steiniger 2016, 207–210.
29 Gaborit-Chopin 1999, 12–19, for the analysis see p. 14, cf. also: Ristow, Steiniger 2016, 150, tab. 3, 157–158 with diagr. 3 and footnote 53. – For the numbers see Pawelec 1990.
30 Ristow, Steiniger 2016, 210–211; Ristow 2020.
31 Konnegen 2006, 71.
32 Ristow, Steiniger 2016, 211–214.
33 Falkenstein 1998.

tury at the latest, the cone was produced or appeared in the church.

Conclusion

Our scientific analyses confirm the assumptions made by some recent art historians on the origins of the Aachen bronzes described above. The gallery railings and Wolf Door are very similar in their chemical composition, and can therefore be assumed to have been made in Aachen in the non-ferrous metal workshop on the Katschhof (fig. 5), which has been found archaeologically. It is very likely that the bronze casts were made there between 793 and 813, the construction period for the *Marienkirche*. The new discoveries of the sources for the raw materials used at that time are also of importance beyond Aachen. Due to the secondary and trace elements found in the Carolingian bronzes, the use of large amounts of scrap metal for their production can be ruled out. Instead, very specific ore types were used, which indicates a functioning and well-organised mining and metallurgical infrastructure. This reliably supplied this major construction project in Aachen with the necessary raw materials. While the alloy and stylistic characteristics of the well-known female bear from the cathedral can be traced back to antiquity, the pine cone, now also displayed in the cathedral's entrance hall, can probably be attributed to the beginning of the High Middle Ages.

Zusammenfassung

Im Rahmen der archäologischen Aufarbeitung der Grabungen und Untersuchungen zur Pfalzanlage aus der Zeit Karls des Großen in Aachen konnten Daniel Steiniger und der Verfasser mit maßgeblicher Unterstützung der Universität zu Köln, des Deutschen Archäologischen Instituts und der Aachener Dombauleitung auch zahlreiche Messungen mittels pRFA an den großen und den kleinen Türen, den Gittern auf der Empore und anderen Bronzebildwerken im heutigen Dom durchführen. Dabei wurden Messpunkte möglichst ohne störende Patina angestrebt.

Es zeigte sich, dass eine hohe Wahrscheinlichkeit besteht, dass Gitter und Türen vor Ort in der 1911 auf dem Katschhof zwischen Dom und Rathaus ausgegrabenen karolingerzeitlichen Buntmetallschmelze hergestellt wurden. Die Verwendung von Kupfer aus Fahlerz für die Herstellung der Bronze legt nahe, dass höchstwahrscheinlich eigens in der Karolingerzeit gewonnene Rohstoffe verwendet worden sind und nicht, wie oft angenommen, in großem Maßstab römerzeitliche Bronzereste zur Herstellung herangezogen werden. Hohe Arsen- und Antimongehalte ergaben in Aachen im Zusammenspiel mit Zinn und Blei eine besonders harte Bronze.

Die bekannte Bärin aus der Vorhalle des Domes und der Pinienzapfen scheinen, anders als die Gitter und Türen, nach Aachen verbracht worden zu sein. Die Bärin dürfte antiken Ursprungs sein, der Zapfen möglicherweise ottonenzeitlich.

Riassunto

Nell'ambito dell'elaborazione archeologica degli scavi e delle indagini sul complesso del palazzo dell'epoca di Carlo Magno ad Aquisgrana, Daniel Steiniger e l'autore, con il significativo supporto dell'Università di Colonia, dell'Istituto Archeologico Tedesco e della direzione dei lavori della Cattedrale di Aquisgrana, hanno potuto effettuare numerose misurazioni con l'ausilio di XRF mobile sulle porte grandi e piccole, sulle grate della galleria e su altre sculture in bronzo dell'attuale cattedrale. L'obiettivo era quello di trovare punti di misurazione con una patina il meno possibile impattante sull'affidabilità della misura.

È emerso che le grate e le porte sono state prodotte molto probabilmente in loco dalla fonderia di metalli non ferrosi di epoca carolingia (scavata nel 1911 sul Katschhof) tra la cattedrale e il municipio. La composizione dei minerali di estrazione del rame, identificati come Tetraedrite (un *fahlore*) suggerisce con un'alta probabilità che siano state utilizzate materie prime ottenute specificamente in epoca carolingia e non, come spesso si presume, da resti di bronzo romano normalmente utilizzati per la produzione su larga scala. Ad Aquisgrana, sono stati rilevati alti livelli di arsenico e

antimonio che in combinazione con stagno e piombo hanno prodotto un bronzo particolarmente duro.

Il noto orso del vestibolo della cattedrale e la pigna sembrano essere stati portati ad Aquisgrana, a differenza delle grate e delle porte. L'orso è probabilmente di origine antica, la pigna forse del periodo ottoniano.

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Preliminary Results of the Chemical Analyses of Selected Bronze Doors from the 11th–12th Century

Marianne Mödlinger · Giorgia Ghiara

Introduction and State of the Subject

Until now, there have been almost no specific technological studies on "bronze" doors. As a result, they have usually been referred to unquestioningly as bronze doors, even though previous analyses and, in particular, the analytical results obtained during our GAPAMET project, show otherwise. The doors were actually made of leaded tin-bronze, leaded brass or a quaternary alloy containing copper, tin, zinc and lead, or a combination of these alloys. They were even referred to as "gilded" in older written sources due to their colour and shiny appearance[1] (for instance with the Gniezno door), which added to the confusion about their actual chemical composition.

Up to now, only the doors from Monte Sant'Angelo and Canosa in Italy,[2] Troia,[3] Trani,[4] and the doors in Augsburg[5] and Hildesheim[6] in Germany have been (partly) analysed, to detect the chemical composition of the metal, any corrosion, and inlays. For the door of Hildesheim, its casting technology and mistakes, and post-casting work were also discussed. Chemical analyses of the bronze doors from Aachen, Hildesheim, and Mainz point to their usage of fresh copper made from Fahlore.[7] The construction and alloys used by some Byzantine doors have been discussed by Braca and Angelucci,[8] and Banti provides us with an overview of the analyses, working techniques, and conservation of bronze doors.[9] Further publications, presenting some of the outcomes of the GAPAMET project, discuss the doors from Venice, Verona, and Troia, the Barisano doors from Trani, Ravello, and Monreale, the doors from the Lateran, Rome, and Byzantine doors.[10]

In this paper we will briefly discuss the chemical composition of the following doors: the main doors of the Cathedral of Santa Maria de Episcopio in Benevento, the doors of St Clement in Casauria, the doors of the Mausoleum of Bohemond in Canosa di Puglia, and the two doors of the Capella Palatina of the Palazzo Reale in Palermo.

Methodology

Major and minor elements influence the main physical characteristics of an alloy and other material characteristics, such as the alloy's colour. We were well aware of the influence of segregation and (surface) corrosion on any measurements,[11] so areas with low or no corrosion were analysed if possible. As our method is non-inva-

1 Utz 2020; Mende 1994.
2 Van der Werf et al. 2009.
3 Buccolieri et al. 2023.
4 Riederer 2000.
5 Mach 2009; Riederer 1995.
6 Drescher 1993.
7 Ristow, Steiniger 2016.
8 Braca 2009; Angelucci 1989; Angelucci 2009.
9 Banti 1999.
10 Asmus et al. 2025; Mödlinger et al. 2023; 2024; 2025b; 2025c; 2025d.
11 Heginbotham et al. 2010; Heginbotham et al. 2015.

sive, a statistically significant number of analyses were carried out on different parts of the doors, and by using the same analytical equipment and methodology on all doors, comparable results were possible.

Non-invasive XRF-analyses with a portable ED-XRF analyser were used to identify the chemical composition of the different metal parts of the doors. All measurements were carried out with an X-MET5100 model with a high-resolution detector from Oxford Instruments with the following measurement parameters: 40 kV voltage, 10 µA current and 60 s acquisition time, with spot measurements of approximately 9 mm in diameter. The following alloying elements were considered as quantitative: Cu, Sn, Zn and Pb, while others were only qualitatively identified due to surface corrosion layers.[12] Sulphur was not detectable by this method. Calibration was carried out with the help of standards made from alloys of different chemical compositions similar to those of the doors, made by the researchers.[13] The different metal parts (panels, frame elements and others) of each door were analysed between four to ten different areas to determine an average chemical composition.[14]

Principal component analysis (PCA) was conducted on the data matrix following an established protocol.[15] PCA is a robust technique that reduces the complexity of data sets, facilitating comprehension by identifying the most salient information and presenting it in a more concise format. The method of principal components transformation (PCs) entails the reduction of a set of correlated variables into a smaller set of uncorrelated variables, which retain the majority of the original data's variance. PCA looks at all your data and finds the main directions in which the data varies the most (highest variance). It transforms the original dataset into a new geometric space, wherein the x-axis represents the first principal component (PC1), the y-axis represents the second principal component (PC2), the z-axis represents the third principal component (PC3), and so on. Each axis is aligned with the highest variance in the data. The results of the PCA are presented in three graphical representations: the loadings matrix, which demonstrates the relative importance of each original variable; the scores matrix, which illustrates the projections of the samples in the newly defined space; or a combination of both. The analysis, which included centring and autoscaling the raw data, was conducted using CAT (Chemometric Agile Tool) software.[16]

In order to ease the localisation of measurements, the panels of each of the doors were given names in this order: letters A, B, C, and so on from left to right, and numbers 1, 2, 3, and so on from top to bottom. Panel A1 is the panel at the top left, panel C4 is the panel in the third column (from left) and the fourth row (from the top), and so on. Further information about the localisation of the measurement area can be found in the relevant Excel files (see the download links in the footnotes). This information is presented in both a descriptive manner and in the form of x,y coordinates.

The doors

Benevento

The 4.5 m high and 3.1 m wide metal doors of the main entrance of the Cathedral of Benevento, were constructed during the second half of the 12th century, most likely by the caster Oderisius of Benevento, who was also responsible for the doors from Troia, and, most likely, for the door handles from Sepino as well, a small village close to Benevento.[17] Likely, the donor for the Benevento door was Bishop Roger (1179–1221), the artist remains unknown. Probably, Oderisius was also responsible for another metal door at Benevento, which was destroyed during the earthquake of 1688, a door said to have been recycled to restore the Ca-

12 Heginbotham et al. 2010; Heginbotham et al. 2015.
13 Mödlinger et al. 2023.
14 Prange et al. 2016.
15 Mödlinger et al. 2024a.
16 http://gruppochemiometria.it/index.php/software [last access: 13.03.2025].
17 Milone 2025.

thedral door. The main doors of the cathedral today consist of 74 panels devoted to the story of Christ (43 panels) and show 24 suffragan bishops of Benevento and the pope (panel G6) (fig. 1). The doors underwent at least two restorations: in 1693, after the earthquake of 1688, when 24 rosettes, eighteen frame elements and one door ring were substituted; and between 1890–1905. During the Second World War, in 1943, the cathedral was subjected to a series of bombings that resulted in extensive damage, with the doors also sustaining considerable harm from the subsequent fire. Restoration work on the doors finished in 1999.[18] We have to assume a different order of the panels exists today than the original ordering according to the different marks on the panels, indicated in the exhibition catalogue *Janua Major*.[19] These signs only appear on some of the panels devoted to the story of Christ.

Chemical analyses

The Benevento door was made from a quaternary alloy comprising Cu, Sn, Zn, and Pb.[20] The chemical composition of the original metal elements, both within the frame and the panels, is challenging to ascertain due to the extensive damage caused by the fire during the Second World War, which has irreversibly altered the surface composition of the original alloy. This is particularly evident in the amount of Pb: areas with a more blackish surface have significantly higher amounts of Pb than more reddish areas in the immediate vicinity. It is therefore essential to exercise caution when interpreting the data presented on the original parts, given the likelihood of consistent alteration to the surface. This may have involved the enrichment of phases with higher melting points or the melting/solidification of more volatile elements (such as Pb, which is immiscible in the alloy). Furthermore, the temperatures reached and the time of exposure of the door parts to the fire remain unknown, despite the implementation of an advanced documentation process. This is due to the fact that the melting point of the door is dependent on its chemical composition. It is therefore imperative to exercise caution when interpreting the data presented in fig. 1.

An examination of the Sn and Zn frequency plot reveals a distribution of elements and average content that is consistent with the findings of previous studies conducted by the same authors.[21] The Sn dataset exhibits a log-normal distribution curve with the main peak occurring at 4–6 wt.%. In contrast, the Zn data set displays an exponential distribution with the main peak occurring at 1 wt.%. The distribution plot for Pb is skewed towards lower concentrations. However, an examination of the x-axis reveals that the points distribute up to 70 wt.% Pb. It is assumed, based on the findings of other analyses conducted by the same authors,[22] that the Pb content above 35 wt.% is unreliable due to surface alteration.

To overcome this issue, the application of PCA could be helpful in elucidating the relationships between the data and the associated information. The XRF measurements constitute a dataset comprising numerous samples (XRF points of analysis) and a multitude of variables (elements constituting the alloy). Consequently, the analysis and visualisation of this data set can prove to be a challenging undertaking. The X-ray fluorescence (XRF) measurements of the door are defined by a matrix of 482 rows (points of analysis) and eight variables (elements of the alloy that give the composition). Among the doors analysed, the Benevento door poses the greatest challenge as it is known that at least two restoration procedures were carried out during the 17th and 18th century, as well as a later restoration in the 20th century after the bombing during the Second World War irreparably damaged most parts of it. The results of the PCA computation on the raw data are displayed in fig. 2.

The majority of the points are grouped around a main cloud or cluster, which also includes some mod-

18 Janua Major 1988; Angelucchi, Lanuti 2005; Basile 1988; Milone 2025.

19 Janua Major 1988.

20 See the link to the XRF-analyses of Benevento: https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_BENEVENTO.xlsx [last access: 13.03.2025].

21 Mödlinger et al. 2023; 2024; 2025a; 2025b; 2025c; 2025d.

22 Mödlinger et al. 2023; 2024; 2025a; 2025b; 2025c; 2025d.

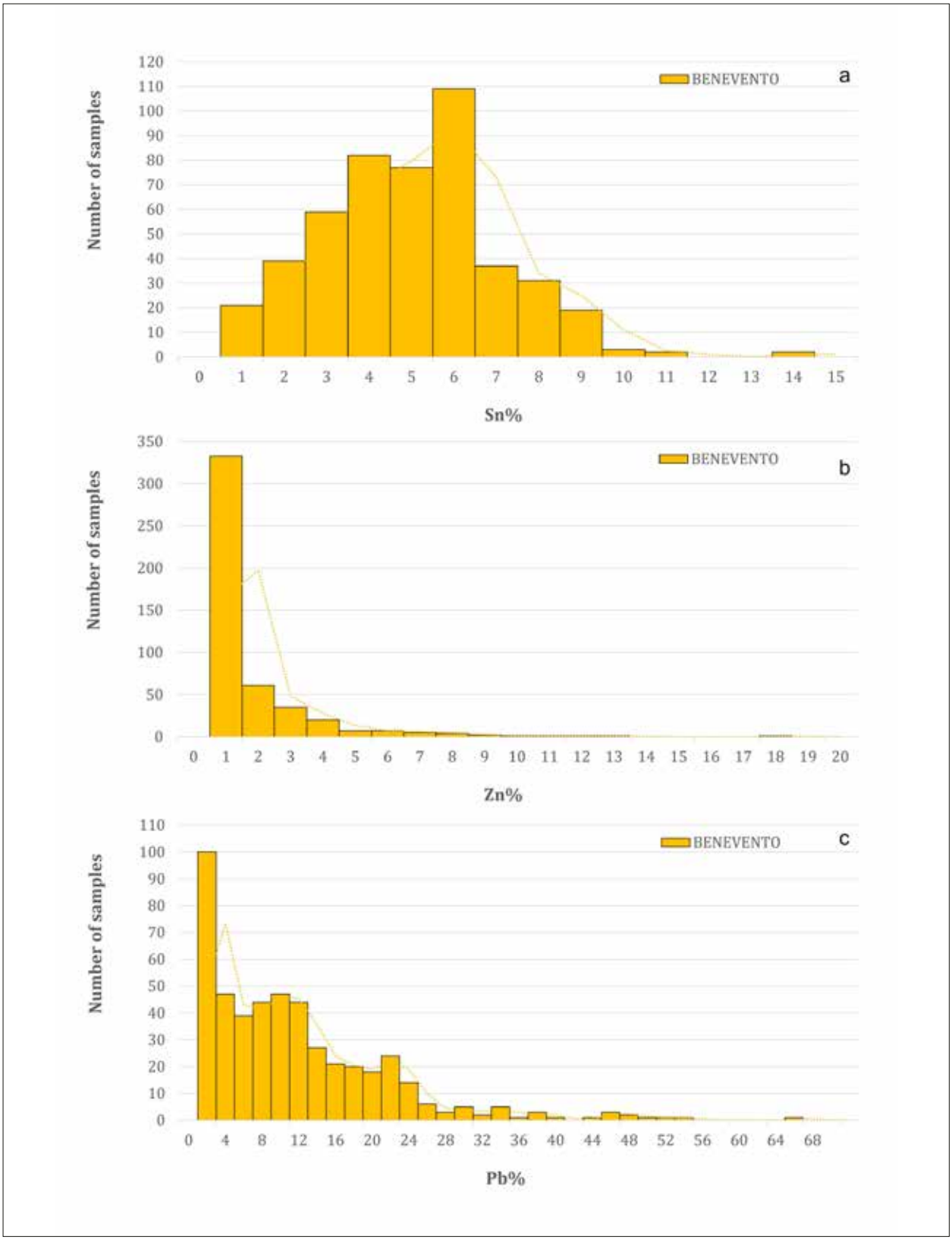

Fig. 1: Frequency distribution of the main alloying elements from the XRF analyses of the Benevento door: a) Sn; b) Zn; c) Pb (© Giorgia Ghiara).

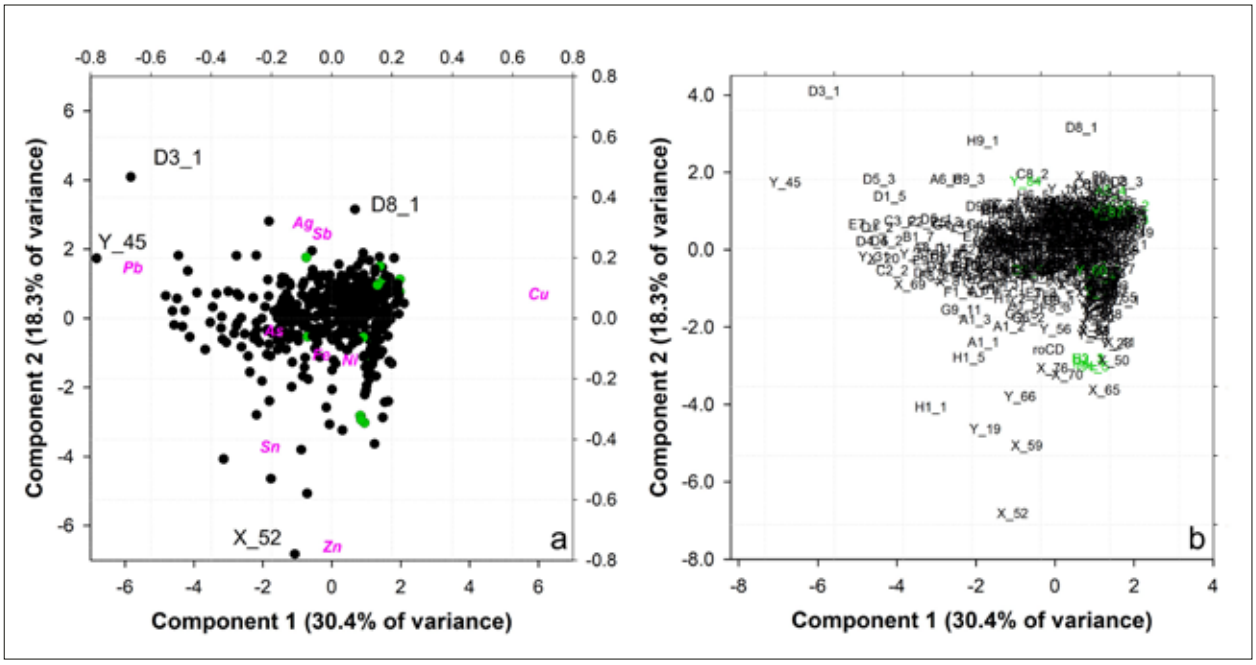

Fig. 2: PCA computation (PC1 vs PC2, total explained variance of 48.7 %) on the matrix of the XRF analyses carried out on the Benevento door: a) biplot; b) score plot. Green dots=modern elements (© Giorgia Ghiara).

ern elements, placed during the restoration after the fire during the Second World War. The cluster extends in the direction of the second principal component (PC2), which primarily carries information about the variable Pb (the closer the point to the variable, the higher its content in the alloy). It can be seen that some points are clearly separated from the primary cluster and are in agreement with the XRF analyses, showing a markedly different chemical composition compared to the average composition of the door. The Pb content of points D3_1 and Y_45, measured on the background of panel D3 and on the frame to the right of panel E5 respectively, is particularly high (52.4 wt% and 65.3 wt% Pb). This is inconsistent with the production of a copper-based alloy. It can be reasonably deduced that the increased Pb content is a consequence of the modification of the surface, which has taken on a black colour as a result of the combustion process. This has led to an accumulation of Pb which has been transformed into Pb oxides on the surface of the areas under investigation. The point corresponding to X_52, measured on the frame at the bottom of panel A5, shows an anomalous Zn content (significantly higher than the average of the door, 20.2 wt.% vs. 1.2 wt.%). This could indicate the use of a different alloy. However, it is not possible to determine whether the choice of alloy was made by the original workshop or following restoration procedures prior to the Second World War. Point D8_1, measured in the lower left part of panel D8, showed a high Sb content (1.4 wt.% vs. 0.2 wt.%), which has not yet been substantiated by any evidence.

A further differentiation between the panels and frames was carried out to eliminate possible anomalies and to distinguish modern elements from older ones. This involved running two different PCA calculations. Fig. 3 shows the calculation performed on the panels.

The graph confirms the previous remarks and shows that the data is arranged in a primary cluster that extends towards the Pb variable. This is reflected in the heterogeneity of the compositions, which show some anomalies (D3_1, already discussed). It is noteworthy that points with a high Pb content are characterised by a black patina and measurements taken from relief decorative elements. The presence of high levels of Pb on the reliefs in question is probably due to segregation of Pb during the casting and cooling pro-

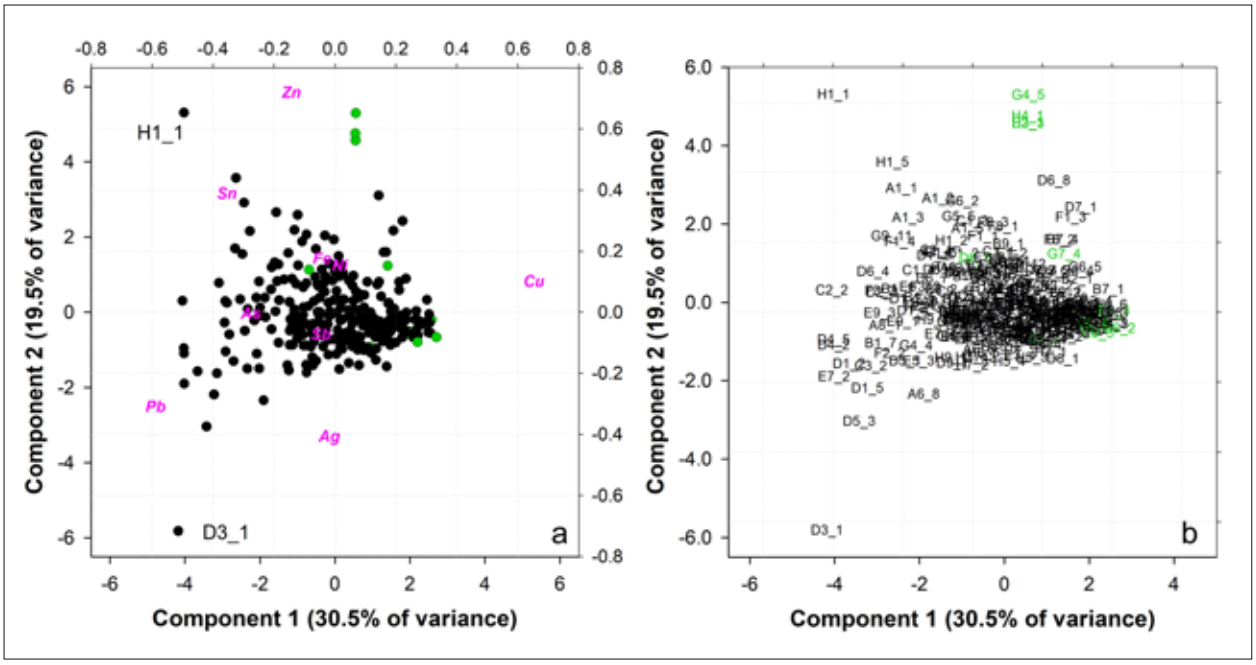

Fig. 3: PCA computation (PC1 vs PC2, total explained variance of 50.0 %) on panels of the Benevento door: a) biplot; b) score plot. Green dots = modern elements (© Giorgia Ghiara).

cess (Pb does not dissolve in Cu and segregates on the surface of the object during cooling, forming globular inclusions in the copper or tin-bronze matrix), if not to segregation during exposure to the fire after the bombing in the Second World War. The only additional anomaly is point H1_1, measured in the upper right corner of panel H1. This point has elevated Pb and Zn contents (21.8 wt.% and 7.3 wt.% respectively), as does the adjacent point H1_5 (with 20.1 wt.% Pb and 5.3 wt.% Zn), which is noteworthy. This is most likely explained by a reddish crust on the surface that extends over both fragments, but not on the rest of the original fragments of this panel. Normally, higher amounts of Zn (> 4 wt.%) are associated with modern parts of the door, added during the last restoration.

It is also evident that certain elements of modern production are located at a considerable distance from the primary cluster, oriented towards the Zn variable (green dots corresponding to points G4_5, H3_3, H4_1, E2_1). This indicates a higher than average Zn content (between 6 and 7.5 wt.% compared to 0.9 wt.%). However, it is noteworthy that some of the modern elements (D6_5, E6_2–3, E6_5–7) do not have the same Zn composition, as they are perfectly contained in the main cloud (composition comparable to the average of the door), indicating the use of an alternative alloy very similar to the original one. Additionally, a PCA computation was conducted on the frames, with the resulting data displayed in fig. 4.

The graphs show the composition of each data point collected for each frame. The only outlier has already been dealt with (point Y_45). The frames belonging to the left wing are labelled 'X' and assigned a sequential number.[23] The frames belonging to the right wing are labelled 'Y'. The data are arranged in a main cluster around the central point. It is noteworthy that

23 See the link to the XRF-analyses of Benevento: https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_BENEVENTO.xlsx [last access: 13.03.2025].

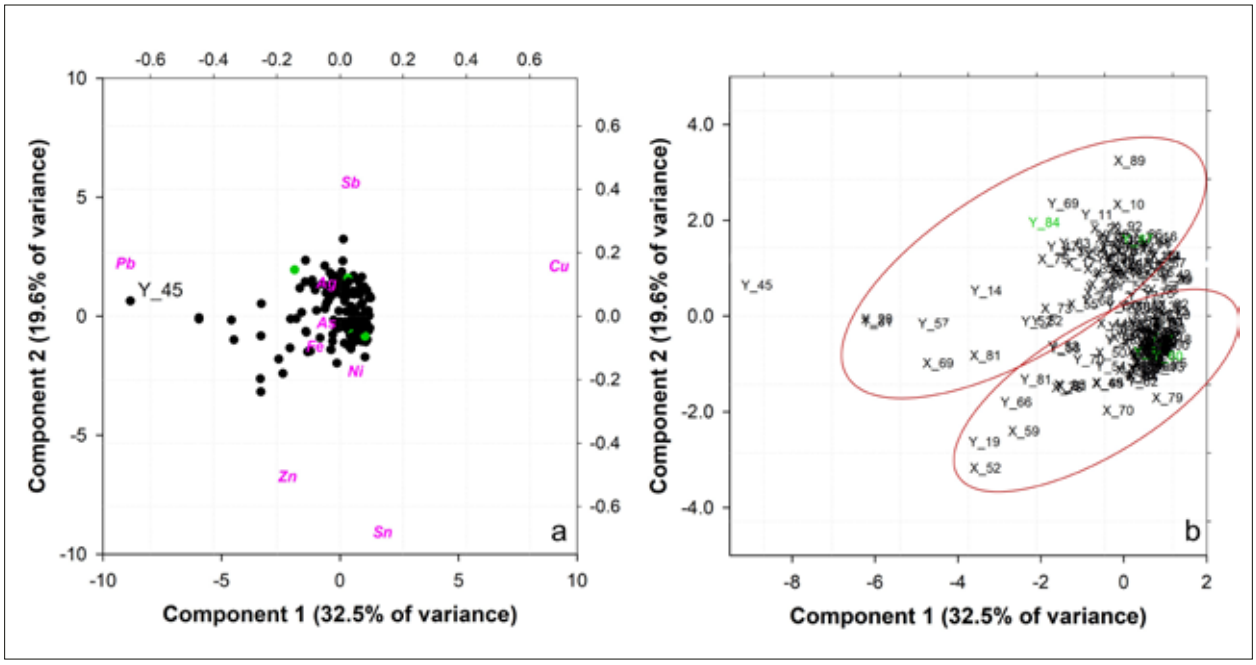

Fig. 4: PCA computation (PC1 vs PC2, total explained variance of 52.1 %) on frames of the Benevento door: a) biplot; b) score plot. Green dots= modern elements (© Giorgia Ghiara).

the heterogeneity of the composition of the frames is not determined by the Pb variable. In fact, the main cluster is elongated in a direction that connects the variables Zn, Sn to Sb. An examination of the score plot (right graph) shows that the macrocluster can be divided into two subgroups that differ in their Zn concentration and are elongated towards Pb. The lower cluster has a Zn concentration between 2 and 8 wt.%, while the upper cluster has a Zn content <1.5 wt.%. This result could be interpreted as evidence that the frames are composed of two different alloys, one with a higher Zn concentration than the other.

Casauria

The bronze doors from the church of St Clement in Casauria were made in 1191 when Abbot Iole was in charge, and are divided into 72 rectangular panels arranged in six columns, depicting various images such as crosses, figures (Gioele, St Clement, patron saint of the church, Emperor Louis II the Younger, founder of the monastery, and King William II), rose patterns, and fourteen castles (and their estates) that were subjects of the abbey.[24] During the restoration work carried out at the end of the 19th century, it was discovered that many metal parts had been stolen, moved, or misplaced.[25] Unfortunately, 26 of those panels are now lost; two of them were destroyed during the Second World War when they belonged to the Bode Museum in Berlin (Inv. Nos. 2990 and 2991), which acquired them from the Roman antiquities market in 1905. Two other slabs are now in the Walters Art Gallery, Baltimore Museum (inv. nos. 54.1058 and 54.1057), purchased via the Roman antiquities market in 1902. Their chemical composition agrees well with the analyses presented here.[26] Today, the lost panels have been replaced by green-painted wooden panels, as are the now lost frame elements of the previous 104 frames.

24 Curzi 2012; 2025; Iacobini 2021.

25 Richardson 2010/2011.

26 Richardson 2010/2011.

The various panel and frame elements were cast using the lost wax technique. In order to reduce weight and material requirements, the panels were cast hollow, i.e. they do not have a flat back side, but follow the motif of the front side, while maintaining a uniform thickness of the panel. The surface was then heavily worked and decorated with chisels and punches of various shapes.

Chemical analyses

The metal parts of the Casauria door were made of a quaternary alloy of Cu, Sn, Zn, and Pb.[27] The chemical composition of the different metal elements – both in the frame and in the panels – is quite homogeneous, with 4–9 wt.% Sn (peak at 5 wt.%) and 1–8 wt.% Zn (peak at 2–4 wt.%) (fig. 5).

The amount of Pb in the alloy varies considerably from 6 to 31 wt.%, probably due to segregation during the casting process. Only the rings of the lion-head door handles (panel D9) were made from leaded bronze with approximately 14 wt.% Sn, 12 wt.% Pb and only 1 wt.% Zn. The XRF measurements of the door represent a dataset with numerous samples (XRF analysis points) and multiple variables (elements that make up the alloy), making analysis and visualisation challenging. PCA proved to be an important tool in the interpretation of the data, particularly in the context of identifying multiple alloys for the production of the panels. The information provided by all three principal components (PC1, PC2 and PC3) was critical to the interpretation of the raw data. Consequently, two different visualisations were chosen: PC1 vs. PC2 and PC1 vs. PC3. The results of the XRF measurements (127 rows × seven columns) are shown in fig. 6.

The data are organised in a single macro cluster, with a minimal difference in composition for the Sn and Zn variables. A more pronounced variation is observed for Pb, reflecting the heterogeneity of the composition. In the left graph, which carries the most information, a shift of several points in the clusters towards the variables Sb, Fe, and Ag is observed. The data indicates a slight increase in the concentration of Sb, reaching approximately 1.1 wt.% (compared to an average content of 0.7 wt.%). However, this observation is not statistically significant. On the other hand, point F1_1 is an anomaly, showing a markedly elevated concentration of both Sb (1.9 wt.%) and Fe (2.1 wt.% vs an average of 1.4 wt.%), which is statistically significant. It is possible that contamination from Fe nails may have occurred, and therefore this point should be discussed carefully.

The graph on the right provides further assistance in differentiating between the various points that comprise the main cloud. It can be observed that the measurements taken from panel B7 exhibit a shift towards the Zn variable, which serves to differentiate them from the other panels in terms of their higher Zn content. Given that the concentration of panel B7 is approximately twice the average concentration in the alloy (7.1 wt.% vs 3.0 wt.%), it can be postulated that panel B7 was manufactured using a different alloy than that used for the majority of the panels in the door. The Sb content (1.5 wt.%) observed in panels C1 (C1_1 and C1_3) and D10 (D10_1) is also noteworthy. It may be attributed to the utilisation of a distinct copper source, characterised by antimony, which could indicate the employment of a disparate alloy. While the F1 panel may be regarded as a potential example of the same alloy, the influence of contamination and the contrasting Sb content observed in another point, which is lower, precludes a definitive conclusion. It is, however, a distinct possibility that the Casauria door panels were produced using three different alloys, one of which had an alternative copper source.

Canosa di Puglia

The Canosa doors were presumably made between 1111 and 1118 for the mausoleum of Bohemund, which is attached to the cathedral of San Sabino. They were commissioned by Bohemund himself or his family, and Rogerius of Melfi (Amalfi?) is usually mentioned as the possible artist.[28] While the left wing was cast in one single piece (the lower part broke off and was

27 See the link to the XRF-analyses of Casauria: https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_CASAURIA.xlsx [last access: 13.03.2025].

28 Utz 2017.

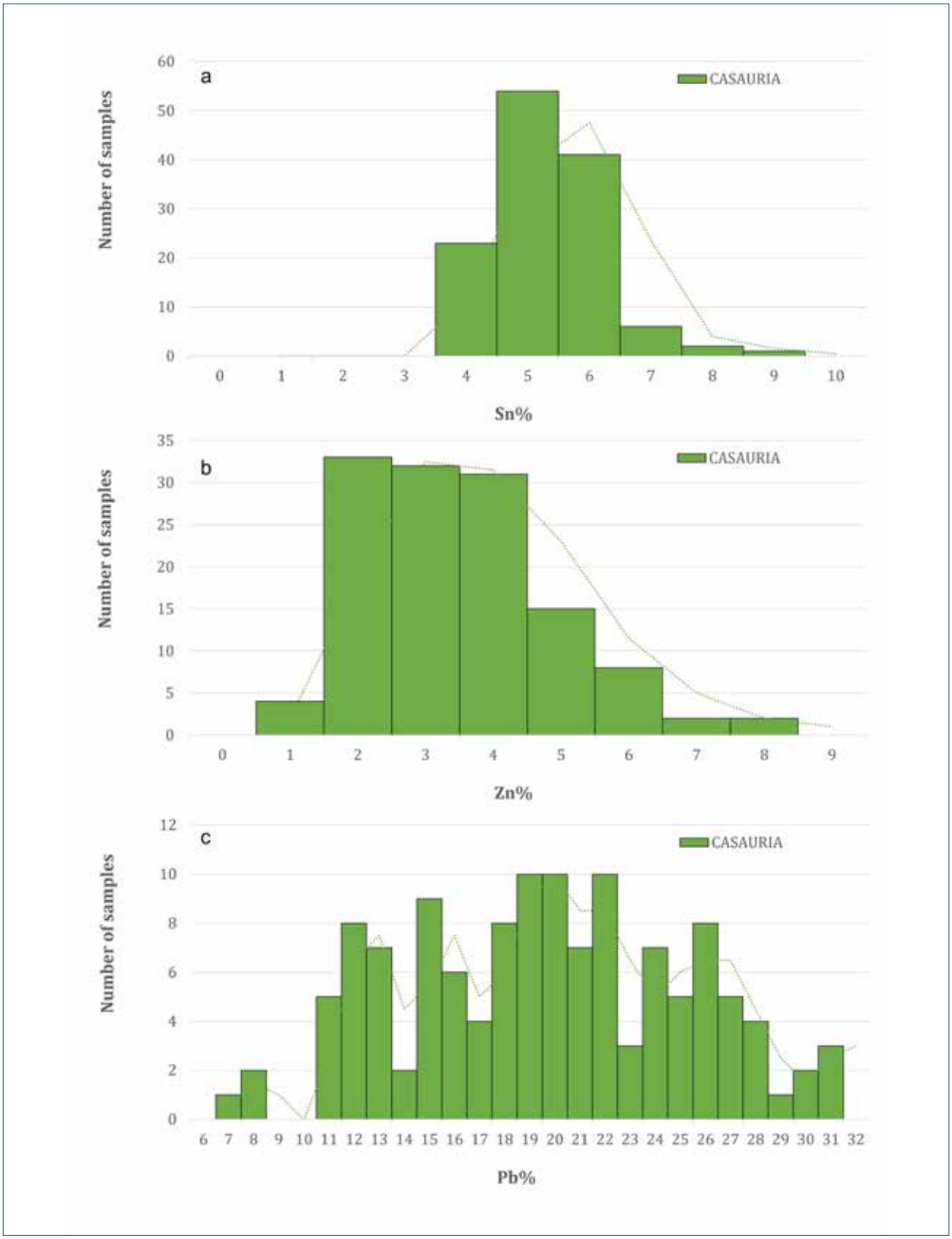

Fig. 5: Frequency distribution of the main alloying elements from the XRF analyses of the Casauria door: a) Sn; b) Zn; c) Pb (© Giorgia Ghiara).

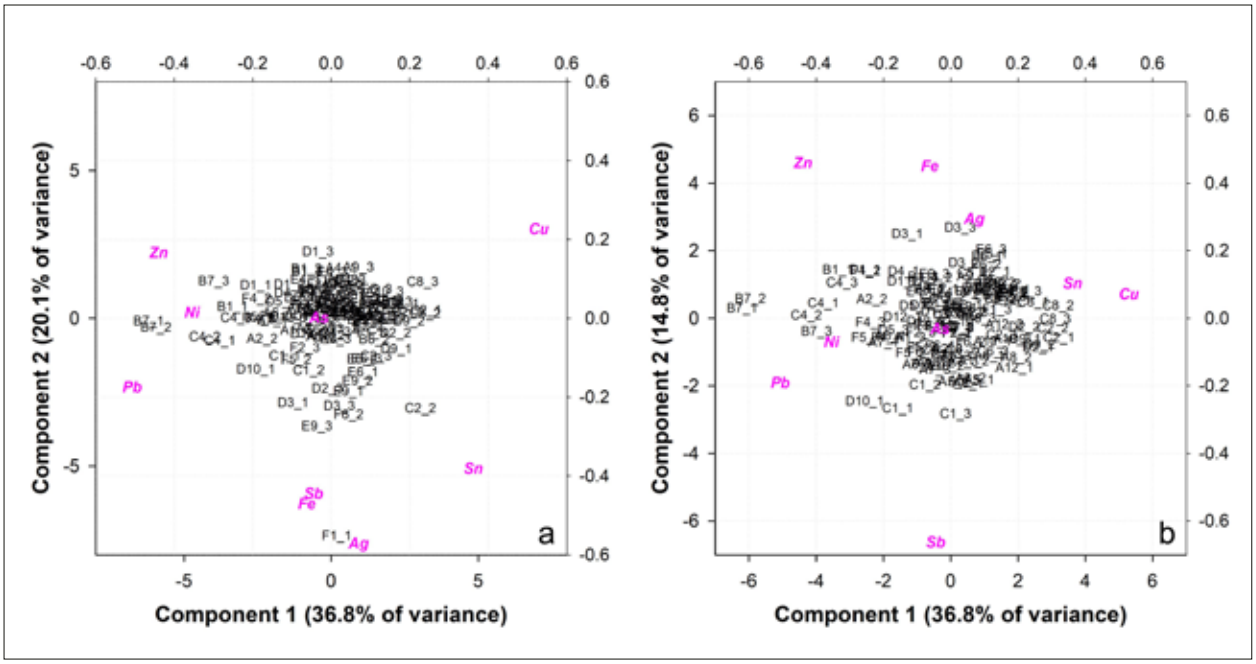

Fig. 6: PCA computation on the matrix of the XRF analyses carried out on the Casauria door. Biplot of all decorative elements: a) PC1 vs PC2, total explained variance of 56.9 %; b) PC1 vs PC2, total explained variance of 51.6 % (© Giorgia Ghiara).

repaired at a later point), the right wing is cast from four single pieces joined together mechanically by a plug-in system, and consecutively fixed by a Sn-Pb solder. During the last restoration, carried out in 1914, additional brass bars were attached to the inside of the doors in order to increase their stability.

Chemical analyses

The first chemical analyses of the doors by non-invasive XRF have already been carried out by other authors recently.[29] The broken off part of the left wing was replaced with a quaternary alloy containing about 16 wt.% Sn, 17 wt.% Pb and up to 4 wt.% Zn.[30] The original door was made of leaded bronze. Of the alloying elements, significant amounts of Fe (1–3 wt.%), Ag (0.1–0.5 wt.%), and Sb (0.1–0.4 wt.%) were also present. Traces of As were found only in the recent repair of the left wing. Fig. 7 illustrates the frequency distribution of the main alloying elements of the door.

The Sn content of the door is relatively consistent for the main door elements, the (original) left wing, and the four large parts of the right wing: it ranges, evenly distributed, from about 9–23 wt.%. The relatively wide range is probably due to the presence of more severe corrosion in some areas (up to 31 wt.%). In particular, part B4 shows lower amounts of Sn (10.5–14 wt.%); the repair of the left wing concentrates at 15–16 wt.% Sn, the two lion heads measured on the left wing at 14 wt.%, and the two door knobs analysed on the left wing at 25 and 30 wt.% respectively. The high amount of Sn (and also Pb) is related to the presence of solder, which was probably used to fix the now lost Ag foil in the engraved cavity of the feet of the depicted person. This higher presence of Sn/Pb has also been noted on Byzantine doors, such as those at San Paolo Fuori le Mura, where Ag foil was applied (usually to the feet, hands, and face of the person depicted).

29 Buccolieri 2022; Van der Werft et al. 2009.

30 See the link to the XRF-analyses of Canosa: https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_CANOSA.xlsx [last access: 13.03.2025].

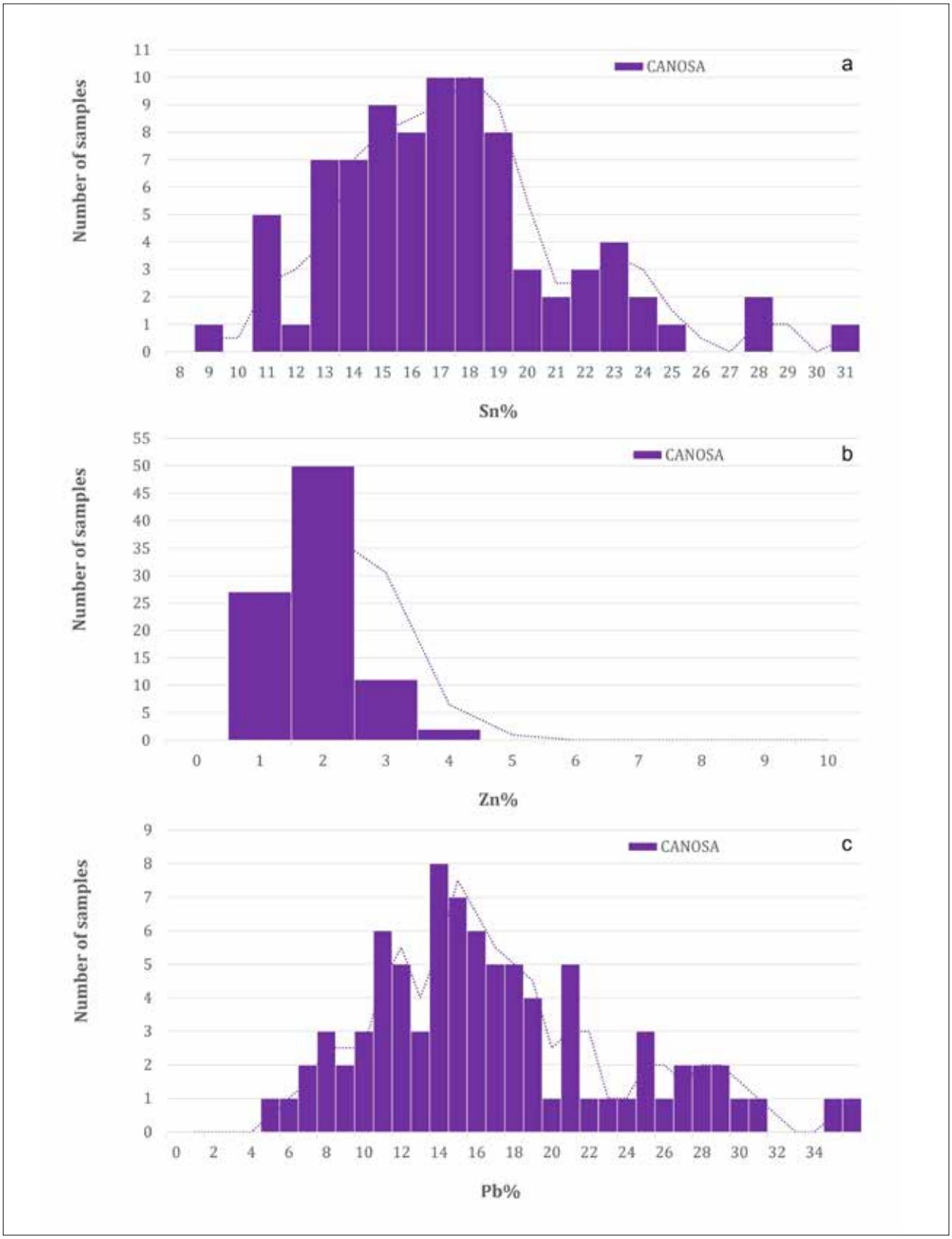

Fig. 7: Frequency distribution of the main alloying elements from the XRF analyses of the Casauria door: a) Sn; b) Zn; c) Pb (© Giorgia Ghiara).

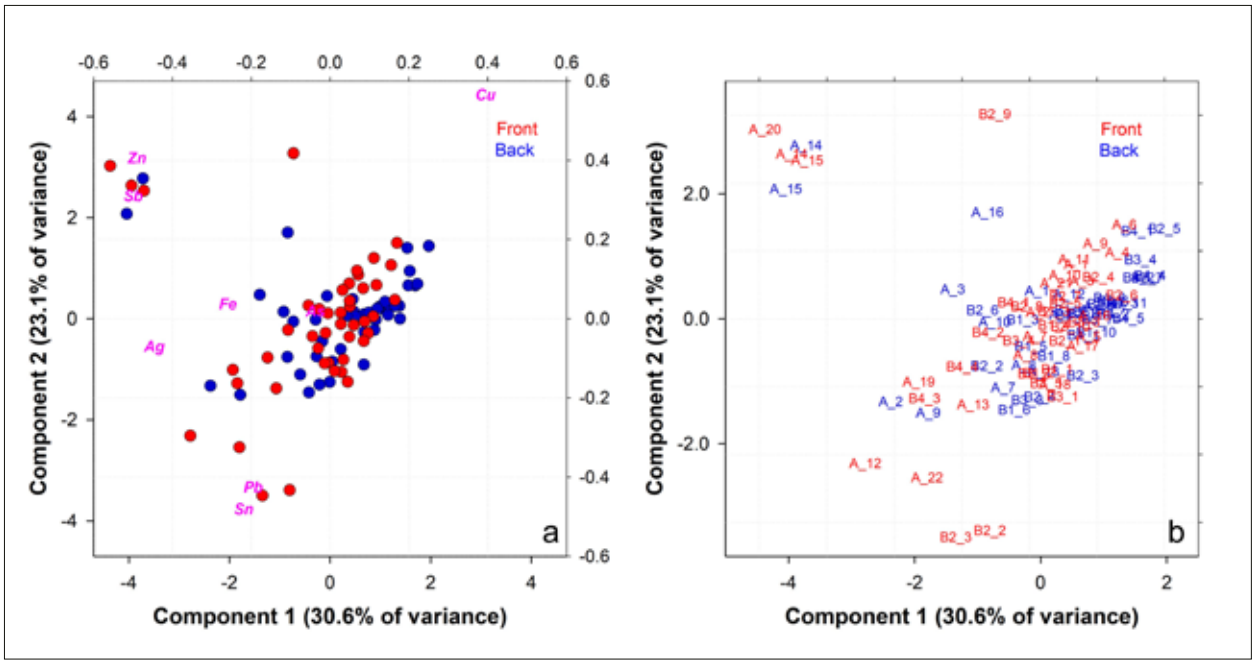

Fig. 8: PCA computation (PC1 vs PC2, total explained variance of 53.7 %) on the matrix of the XRF analyses carried out on the Canosa door: a) biplot; b) score plot (© Giorgia Ghiara).

Due to segregation and corrosion, the Pb content varies greatly in each piece of metal (4–35 wt.%): on the left wing between 5–30 wt.% and in its repair between 11–14 wt.%, while it is rather stable on the door knobs (15 wt.%) and the lion heads (15–16 wt.%). Pb levels >20 wt.% are associated either with segregation (inner side of the left wing) or with the filling of cavities or the application of inlay (outer side). Particularly in the case of large leaded bronze objects, the Pb is pressed to the outside/surface of the object, forming a layer of Pb or at least a Pb-rich layer of the alloy on the surface of the object. The four parts of the right wing (B1, B2, B3 and B4) show some slight differences in the amount of Pb added to the alloy: 12–17 wt.% for B1; 8–15 wt.% for B2; 10–17 wt.% for B3; and 10–14 wt.% for B4. Higher values are due to segregation in the upper parts during casting, dropped solder (inside), or solder residues from the application of silver foil (outside).

Traces of a red and black inlay were noted on the outside, but could not be measured accurately due to the size of the XRF opening and the fact that the inlay was only present in traces in the cavities of the decorative part of the door. No Hg was detected, although it was cinnabar that was used for the red inlay. The chemical composition of the blackish inlay is also not very different from that of the base metal, with some higher Pb levels: this is probably due to the fact that it was only present in traces and was more distant from the XRF-instrument than the base metal. Further (invasive) analysis would be required to correctly identify the inlay material.

A PCA was conducted on the Canosa door with the objective of identifying potential repairs and replacements of elements that were not previously documented. The XRF measurements were conducted on both the front and back of the door, and the resulting data was organised in a matrix comprising 99 samples (points of analysis) and seven variables (the main alloying elements). The results are displayed in fig. 8.

Both the biplot and the score plot demonstrate a consistent alloy composition and a coherent relationship between the front and back of the door. This is corroborated by the frequency distribution plots, illustrated in fig. 9, which exhibit an overlapping of distribution functions in terms of both shape and position.

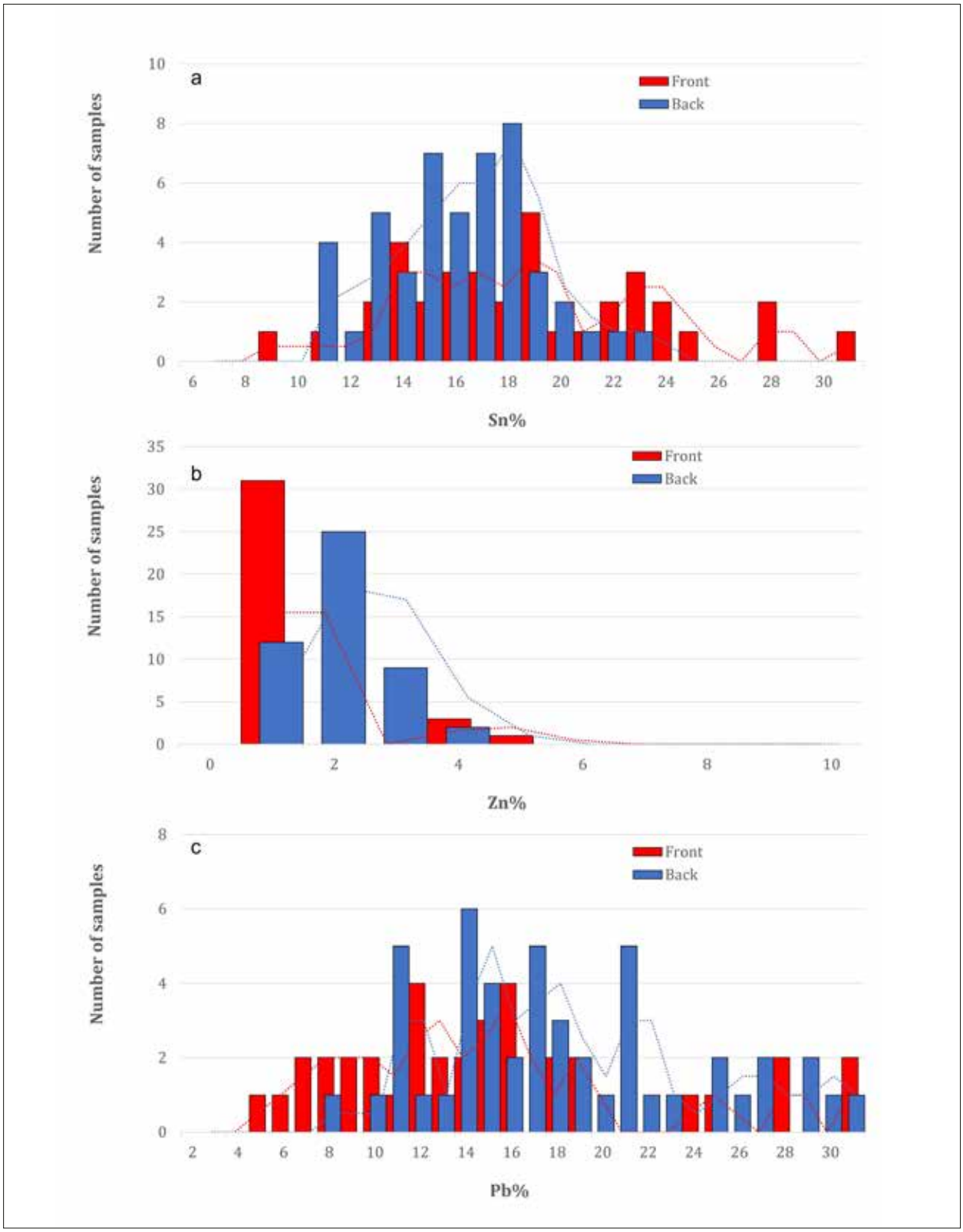

Fig. 9: Frequency distribution of the main alloying elements from the XRF analyses of the front (red) and back (blue) of the Canosa door: a) Sn; b) Zn; c) Pb (© Giorgia Ghiara).

A more detailed examination of the PCA reveals that the data is arranged in a main cluster, elongated in a direction that is aligned with the line connecting the element Cu with the elements Pb and Sn. The alloy is therefore ternary, and the heterogeneity in composition, which is a natural phenomenon in large-scale objects, is determined by the content of Pb and Sn. The coherency observed is not limited to the front and back, but is also evident in the two wings of the door. The homogeneity of the composition permits the conclusion that a single alloy was employed in the production of both sides of the doors. Some points of the XRF measurements are situated at a considerable distance from the primary cluster, indicating that their composition is not aligned with the overall composition of the door.

Two minor clusters are thus identified. The lower cluster comprises the points A_12, A_22, which were measured on the door knob in the shape of an animal head and on a solder close to the same lion head, and B2_2 and B2_3, which were measured on a relief character on panel B2. All points exhibit a markedly elevated Sn and Pb content, which is justified in varying ways depending on the point under consideration. Point A_22 is evidently a Sn-Pb solder, while points A_12, B2_2 and B2_3 are affected by the heterogeneity of the solid solution (A_12) and the likely application of Sn-Pb solder/paste before the application of the Ag-inlay in the area of the person's feet (B2_2-3).

The upper left cluster is of particular interest as it encompasses both the front (A_14, A_15, and A_20) and back (A_14 and A_15) points. The distance from the main cloud implies a different alloy composition, richer in Zn. It is worth noting that the points from the back of the door are measured from the replacement part of the bottom of the left wing (not original and added more recently), while the points on the front are all taken from the lion head at the centre of the door's left wing. This suggests that the alloy used for the production of the lion is the same as that for the replacement part, indicating that the lion head still present on the left wing of the door is a replacement of an original decorative element. Points A_16 (derived from the replacement component) and B2_9 (the lion head on the B2 frame) exhibit a divergence from the upper cluster with regard to the x-coordinate, suggesting the presence of a somewhat higher content of Cu. However, given that A_16 is part of the same replacement component, it can be hypothesised that the lion head on the B2 frame is also a more recent fabrication, given the elevated Zn content compared to the average of the door (3.3 wt.% vs 1.0 wt.%).

Palermo

Two doors from the Capella Palatina of the Palazzo Reale in Palermo have been analysed. The doors are generally dated to the mid-12th century.[31] Both doors are rather small (about 250 cm high and 110–120 cm wide) and are very similar in both construction and decoration. Their construction, i.e. the way in which the four different parts of each door wing are joined together by means of a plug-in system and then fixed in place with a Sn-Pb solder, is similar to that of the right wing of the Canosa door. Additional vertical iron rods (three per door wing) are passed through loops cast together with each door wing. In terms of style, the southern door is the more refined, while the northern door seems to imitate the first one, which is why Gaspari suggested that the northern door was made later.[32] It is interesting to note that the size of the doors matches the two door frames in the "Sala di Ruggero" in the Palazzo Reale, perhaps an indication of a different original location?

Chemical analyses

The close similarity, if not the same alloy, used for the production of the two doors renders a proposed time distance in their production rather unlikely.[33] However, perhaps two different artists or workshops were responsible for the wax model of the doors. Both doors

31 Mende 1994; Gaspari 2016.

32 Gaspari 2016.

33 Gaspari 2016.

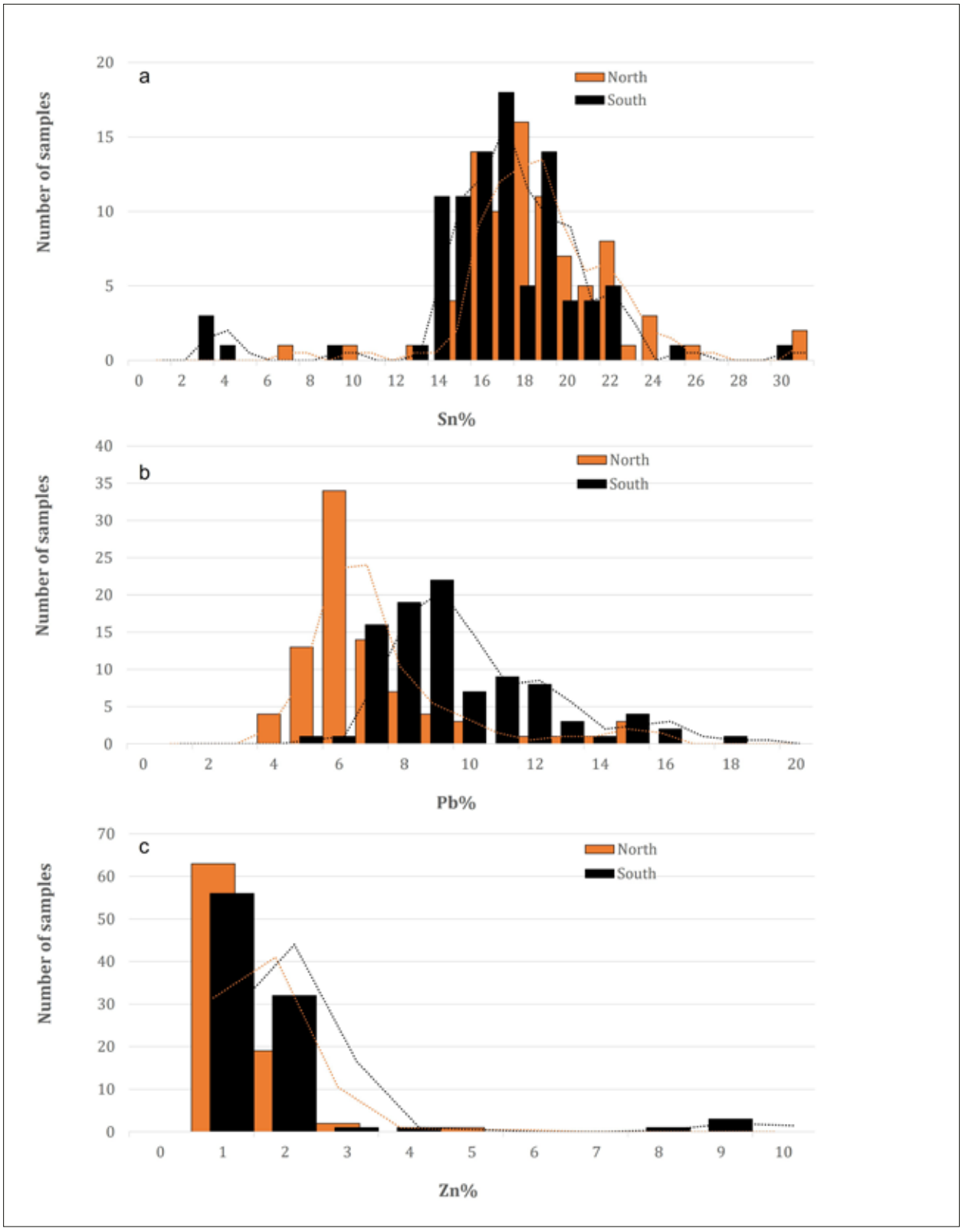

Fig. 10: Frequency distribution of the main alloying elements from the XRF analyses of the North (orange) and South (black) door of the Palazzo Reale of Palermo: a) Sn; b) Pb; c) Zn (© Giorgia Ghiara).

were made of leaded tin-bronze with < 2 wt.% Zn.[34] Notably, only the small lionheads, although not all of them, were made from a quaternary alloy of Cu, Sn, Zn, and Pb (see fig. 10 for the frequency distribution plot of the alloying elements).

The frequency distributions of Sn and Zn exhibit a degree of overlap in terms of both shape and position. The Sn content is observed to average at 16–17 wt.% for both doors, falling within the normal distribution curve. The Zn peaks between 1 and 2 wt.% in the exponential distribution plot. The average change in composition is attributable to the presence of the element Pb, which exhibits a skewed distribution curve for the northern door and a log-normal distribution curve for the southern door. Additionally, the two curves exhibit a discrepancy in the position of the main peak, which is situated at 6 wt.% for the northern door and 8–9 wt.% for the southern door.

Apart from the alloying elements, Sb (0.2–0.9 wt.%), As (0.1–0.9 wt.%), and Ag (0.1–0.2 wt.%) were also detected. The amounts of Fe (0.6–6 wt.%) vary significantly; however the higher values for iron, specifically on the backside of the doors, is very likely due to the corrosion of the iron bars. Ni was not detected.

A PCA was conducted on both doors with the objective of identifying anomalies that could be attributed to contamination and/or the installation of modern replacements. The front and back of the doors were subjected to analysis. However, the advanced state of degradation of the back and the lack of cleaning procedures during centuries of neglect, precludes the possibility of obtaining reliable information regarding the alloy composition. Consequently, only the front of the two doors will be the subject of discussion. The matrix, comprising samples (points of analysis) and variables (alloying elements), has 179 rows and seven columns. The results are presented in fig. 11.

The graph illustrates the XRF measurements conducted on both the northern (orange points) and southern (black points) doors in the newly rotated principal component (PC) space, showcasing the impact of each variable on the chemical composition of each point. The majority of the points are concentrated in a primary cluster in the vicinity of the centre point, thereby corroborating the univariate frequency distribution with a partial overlapping of numerous XRF measurements. This indicates that the chemical composition of both doors is highly consistent, suggesting that they were produced from very similar alloys. However, a subtle distinction in composition is discernible in the score plot (right graph), with points from the northern door situated in the upper portion and points from the southern door positioned in the lower cluster. This is attributable to the minor, yet discernible, variations in Pb composition between the two doors.

As with some of the preceding doors, points that deviate from the principal cluster exhibit a distinct compositional profile from the mean. We can distinguish two smaller clusters, one related to higher Fe contents, and the other to elevated amounts of Zn. It is necessary to differentiate between the points, as the PCA only indicates potential anomalies and does not provide a comprehensive interpretation of the data.

The Fe content of points A1_4, measured on the frame below the A1 panel of the northern door, and A4_1, measured on the base below A4 of the southern door, is higher than the average composition of the doors (7.6 wt.% compared to 1.6 wt.% for the northern door and 6.6 wt.% vs 1.9 wt.% for the southern door). This may be attributed to contamination or the thickening of the corrosion layer on the surface, which encompasses Fe-rich oxides. A group of points, originating from both doors, forms a semicircular arrangement around the central cluster. The group of the northern door includes points A1_3, A2_10, A2_11, A4_2, B3_10, and B3_11, while the southern door group includes points A2_4, A2_10, A4_5, A4_6, B2_10, B2_12, and B3_11. These clusters can be attributed to higher levels of Fe or higher levels of Zn. Concerning the northern door, it should be noted

34 See the link to the XRF-analyses of the two doors of the Capella Palatina of the Palazzo Reale in Palermo: Palermo Nord: https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_PALERMO_Nord.xlsx [last access: 13.03.2025] Palermo Sud: https://gapamet.imareal.sbg.ac.at/api/attachment/XRF_PALERMO_Sud.xlsx [last access: 13.03.2025].

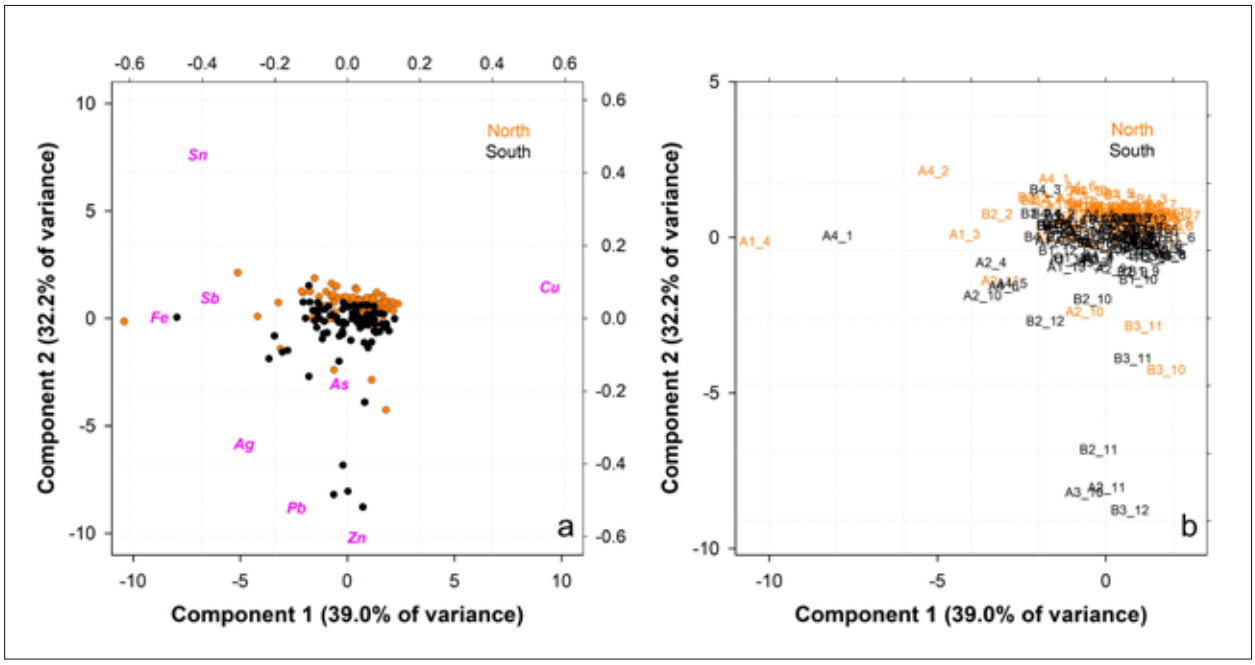

Fig. 11: PCA computation (PC1 vs PC2, total explained variance of 71.2 %) on the matrix of the XRF analyses carried out on the North (orange) and South (black) doors in the Cappella Palatina, Palazzo Reale of Palermo: a) biplot; b) score plot (© Giorgia Ghiara).

that the composition of points A1_3 and A4_2, which were measured on the bases beneath A1 and A4, respectively, is consistent with that of the other points on the base A1 (northern door) and of the southern door (A1 and A4). It is therefore proposed that Fe contamination is the most plausible hypothesis for both measurements. Similar observations were also made on the southern door: an anomalous Fe content was identified in points A2_4 and A2_10, located on the lower right frame and on the ring of the lionhead of the A2 panel, respectively. In addition, points A4_5 and A4_6, both measured on the decorative elements (leaves) of the frame on the left of A4, were also found to have an anomalous Fe content (up to 4.1 wt.% compared to 1.3 wt.% of the average door). They are therefore classified as points where iron contamination has occurred.

Basically, the points related to higher amounts of Zn present (in the right lower corner and above, Figure 11) in the alloy are all attributed to small lionheads. While all the four mechanically attached central flowers on both doors (each panel A1 and B1) fall into the main cluster, the situation differs for the attached lionheads. Small lionheads are located in pairs on the top of panels A2, A3, B2, and B3 on both wings of both doors; unfortunately, only seven are preserved today on the southern door and four on the northern door (on panels A2 and B3). It seems implausible that the observed Zn enrichment is the result of corrosion, given that Zn is a highly soluble metal and is rarely found in corrosion products of bronzes, except under specific conditions.[35] Due to the fact that most of the lionheads contain significant amounts of Zn (2–9 wt.%), we can assume, if they were not made with a contemporary (different) quaternary alloy, that they were a likely later addition to the door.

Northern door: apart the significantly higher amount of Pb, the two lionheads from panel A2 contain, like the two lionheads from panel B3, notably more Zn than the rest of the door (2–4 wt.%); only the right lionhead on panel A2 shows slightly less Zn (1.6

35 Bongiorno et al. 2017.

wt.%); however, its high Sn amount of over 20 wt.% indicates a high level of corrosion. It is also worth mentioning that all four lion heads show comparably rather high amounts of Pb (13.6–15 wt.%) than most of the northern door. This discrepancy in composition can be attributed to surface heterogeneities resulting from the greater concentration of Pb on the surface due to its immiscibility in the solid solution.

Southern door: panel A2, lionhead top right (point A2_11); panel A3, lionhead left (point A3_10); panel B2, both lionheads (points B2_11 and B2_12); panel B3, both lionheads (points B3_11 and B3_12). These lionheads contain about 3–9 wt.% Zn, i.e. significantly more than the rest of the door (usually < 3 wt.%). Only the lionhead from panel A3 on the right (point A3_11) does not contain significant amounts of Zn (< 1 wt.%).

The two bigger lion heads situated on panel B2 (southern door) do not contain significant amounts of Zn. Their equivalents on the northern door are not preserved.

Conclusions

The Benevento door was made from a quaternary alloy containing Cu, Sn, Zn and Pb. As a result of the exposure to the fire caused by bombing during the Second World War, the amounts of Pb vary considerably (blackish areas usually have significantly higher amounts of Pb than nearby areas of the same panel). In addition, during the last restoration, alloys similar to the original were used to reconstruct damaged and missing elements, and the patination of the surface of these new elements makes the identification of original and recent parts difficult. Consequently, our study focused on the panels. However, it was not possible to identify elements added during the 1693 restoration and/or elements from the second door from Benevento, which is now lost.

The metal components of the Casauria door, comprising the frame and panels, were cast with a quaternary alloy (Cu, Sn, Zn, Pb). The chemical composition of Sn and Zn is remarkably consistent across the entire door, while the Pb-amounts vary significantly, likely due to segregation. In contrast, the lion head door knobs featured distinct rings made from leaded tin-bronze.

The original door of the Bohemond Mausoleum in Canosa was made of leaded bronze; the lower part of the left wing of the door was broken and repaired with a quaternary alloy (Cu, Sn, Zn, and Pb). Interestingly, the lion's head on the left wing was made from the same alloy, suggesting a contemporary repair and addition of the lion's head. While the left wing was cast in one piece, the right wing was cast in four single pieces, which were mechanically connected by a plug-in system and subsequently fixed by a Sn-Pb solder. The silver plating for the faces, hands and feet of the depicted persons is no longer preserved; however, the remnants of the Sn-Pb solder for the application of the silver foil were noted, as were residues of inlays in red and black.

The two doors from the Cappella Palatina, Palazzo Reale, Palermo were made from leaded bronze; most of the small lionheads attached to them were of a quaternary alloy (Cu, Sn, Zn, and Pb). For the interpretation of the analyses, only the measurements from the front side were taken into account, as the backside is significantly more corroded. The alloy composition of the two doors is very similar, suggesting that they were made in the same workshop at the same time, although stylistically the northern door appears to be a less refined copy of the southern door, which might be related to a different wax worker(s). The question of whether the small lion heads are contemporary and simply made of a different alloy, or whether they were added at a later date, must remain open.

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Zusammenfassung

Die Metalltüren des 11. und 12. Jahrhunderts stellen den größten Komplex mittelalterlicher Großbronzen dar. Bis heute wurden sie nur einzeln, aber nie als Objektgruppe gesamt dokumentiert, analysiert, und ausgewertet: dies wurde nun erstmals im Rahmen des GAPAMET-Projekts durchgeführt. Mit Ausnahme der Tür in Novgorod wurden alle Türen umfassend dokumentiert und auch ihre chemische Zusammensetzung bestimmt. Auch wenn die Türen allgemein aus Bronzetüren angesprochen werden, trifft dies eigentlich nicht zu, da die Türen aus verschiedenen Legierungen wie Bleibronze, Bleimessing, und Rotguss, einer Vierstofflegierung aus Kupfer, Zinn, Zink und Blei, hergestellt wurden. In diesem Kapitel wird kurz auf die Beschaffenheit und, ausführlicher, auf die chemische Zusammensetzung von fünf ausgewählten Türen eingegangen, um einen kurzen Überblick über die verwendeten Materialien zu geben: Die Türen von Benevento, Casauria, Canosa und die beiden Türen aus dem Palazzo Reale in Palermo.

Riassunto

Le porte bronzee dell'XI e XII secolo rappresentano il più grande complesso di bronzi monumentali del medioevo. Ad oggi queste sono state documentate, analizzate e valutate solo singolarmente. Per la prima volta nell'ambito del progetto GAPAMET si è voluto caratterizzare questi bronzi monumentali come complesso di oggetti, testimonianza dell'avanzamento tecnologico del periodo. Quasi tutte le porte (28 sul totale) sono state documentate con tecniche avanzate e la composizione chimica identificata, ad eccezione della porta di Novgorod, situata in Russia. Nonostante le porte siano generalmente classificate come porte di "bronzo", dalle analisi chimiche ottenute si è appreso che queste siano costituite da diversi tipi di leghe a base rame: bronzo al piombo, ottone al piombo, lega quaternaria di rame, stagno, zinco e piombo. In questo capitolo si descriverà brevemente la composizione di alcune delle porte analizzate, soffermandosi sulla composizione chimica di cinque porte ritenute rappresentative, per fornire una breve panoramica dei materiali utilizzati: Benevento, Casauria, Canosa e Palermo (due porte all'interno del Palazzo Reale).

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Photographic Documentation and 3D-Surface Modelling of Mediaeval Bronze Doors

Martin Fera

Introduction

Mediaeval bronze doors are significant artefacts that offer insights into the craftsmanship, iconography, and cultural context of their time. Metallurgical and technological analyses can shed light on some of these aspects, but this requires detailed spatial documentation of the investigated objects. A photographic documentation of these doors poses challenges, due to their dimensions, surface characteristics, and often inaccessible locations. Advancements in photographic documentation and 3D modelling have transformed the study and preservation of these historical objects. This chapter explores the methodologies, technologies, and academic significance of photographic documentation and image-based modelling in the context of the studied mediaeval bronze doors.

The Importance of Photographic Documentation

Photographic documentation plays a crucial role in the study and documentation of cultural heritage objects, and recent developments have added new possibilities to a field with a long tradition.[1] Beside regular photographic captures of the objects, orthophotos derived by photogrammetric methods have proven to be efficient in both equipment cost and data acquisition time.[2] The photographic documentation of doors provides several essential benefits:

- Preservation of Detail: High-resolution photographs capture intricate details of the bronze doors, ensuring that the subtleties of the artwork are preserved for future study.
- Accessibility: Photographic images can be widely disseminated, facilitating research and public engagement without necessitating physical access to the doors.
- Baseline Records: Photographs serve as baseline records for monitoring the condition of the doors over time, aiding in the detection and documentation of changes or damage.
- Documentation of Measurements: The scaled photographic products establish a basis for precise measurements, by capturing details of both the geometric features and surface textures of the objects, thus supporting the documentation of scientific work done on the objects.

Methods

Techniques in Photographic Documentation

The main objective of the photographic documentation was to establish an accurate metric base by creating a high-resolution digital surface model (DSM) of

1 Verhoeven 2016, offering an overview for its application in the field of cultural heritage.

2 Georgopoulos 2017.

the relief front together with a corresponding high-resolution true orthomosaic. Therefore, in addition to capturing high-resolution images of individual panels and areas of interest, the front of the doors was documented using image-based modelling (IBM) techniques. Image-based modelling uses photogrammetry to reconstruct 3D surfaces from a series of 2D photographs taken from different camera positions.[3] In this process Structure-from-motion (SfM) approaches allow the generation of spatial information from bundles of overlapping images using computer vision (CV).[4]

The versatility and usability of derived 3D models and computed orthoimages are evident and well recognised in the field of cultural heritage documentation. In summary, the photographic documentation included the following techniques:

- High-Resolution Imaging: Utilising high-resolution cameras is essential for capturing fine details. Macro photography techniques can document even the smallest elements of the doors.
- Image-Based Modelling: By applying advanced computational algorithms, images can be utilised to derive a 3D-surface of the doors. Advanced digital processing and visualisation techniques for these DSMs can accentuate the depth and contours of the relief.
- Stitching and Orthomosaics: For larger doors, multiple images can be stitched together to create a comprehensive view, ensuring that the entire surface is documented in high detail. By using the 3D-surface derived from IBM, a True Orthophoto can be generated that can be used for measurements and spatial analysis.

Documentation Strategy and Workflow

The corpus of the mediaeval bronze doors is multifaceted. There is a wide range in terms of: dimensions (ranging from 2 m to over 8 m in height), construction (individual door leaves are cast in one piece while others are made up of individual elements), installation (many doors are still in use in cathedrals, some are in museum rooms), and surface treatment (some are heavily corroded, others have been restored and surface-treated).

For logistical reasons, the images were recorded at the same time as the scientific measurements on the individual objects. A robust, scalable recording methodology was therefore required that was suitable for all conditions, and did not take up too much time on site. An image-based approach was chosen because the scalability, adaptability and achievable resolution were appropriate to meet the project's objectives. While other methods, such as laser scanning or structured light scanning, can provide high quality and high-resolution results,[5] their operation, handling and cost can be prohibitive.

The hardware setup consisted of a Ricoh GR IIIx camera, featuring a 26.1 mm focal length (57° diagonal angle of view) and an RGB primary colour CMOS sensor (23.5 mm × 15.6 mm, 24.24 megapixels, pixel pitch 3.9 µm). The camera was handheld and used in separate acquisition steps for lower parts of doors. For doors exceeding 2 m of height the camera was either used while standing on a scaffolding, provided for the metallurgical measurements, or mounted on a rig. This was constructed using a motorised 3-axis gimbal attached to a telescopic carbon fibre mast with a maximum extension of 4 m. This allowed us to cover all scenarios and collect data capable of producing comparable results (fig. 1).

Nevertheless, the different locations presented a challenge, especially when it came to lighting the objects. Wherever possible, naturally diffused ambient light was used. Artificial museum lighting was used for objects inside buildings. For individual objects, indirect 100W LED spotlights with a colour temperature of 5600 K were utilized. The spectrum of possible solutions ranges from a set-up of two 5600 K tube lights mounted on the side of the camera on the rig to a manual ring flash on the lens, featuring the same colour temperature. The choice for each door was based on test series on the respective objects and considered

3 Remondino 2006.
4 Chiabrando et al. 2015.
5 Hassani 2015.

Fig. 1: Data acquisition setup with digital camera Ricoh GRIIIx on rig with tube lights (left). Scaffolding used for the monumental bronze door at Monreale cathedral (right) (© M. Fera/Novetus/GAPAMET).

both the accessibility/size, the surface quality/reflectivity, and the level of detail of the artistic execution. However, the scalability and robustness of this method and equipment allowed for the smooth integration of photographic documentation alongside other data collection steps.

Processing of the images was conducted using Agisoft Metashape software (Version 1.7.2). Scale was established through measurements of specific distances on the object, and scaled poles (horizontal and vertical) were included in the acquired photographs to serve as reference scale bars during processing. The resulting DSMs were used to define a projection plane for the generation of an orthomosaic for each door.

We used a geographic information system (GIS) to visualise and process the individual DSMs in order to answer the questions posed in individual research papers within the project. We generated relief representations for visual and metric analyses based on a combination of different visualisations of surface data (sky-view factor, hillshade, slope gradient, openness). These techniques enable a realistic and legible visualisation of larger relief structures, while maintaining small surface details. The high-resolution orthomosaic, when combined with the other data, allows us to identify elements that can be used for a metric comparison in the projection plane through measurements on the image (fig. 2).

We managed the entire extensive data set collected during the investigation within a geospatial database in the GIS environment. This consolidated dataset includes tabular data from chemical analyses, geometric data from 3D modelling, and detailed images of the individual doors, focusing on their artistic and constructional features. These datasets were systematically organised and combined for analytical purposes.

Subsequent processing stages involved constructing a textured 3D model from a point cloud containing a high point count. Medium resolution 3D models were exported and uploaded to a data repository to provide them to a broader public.

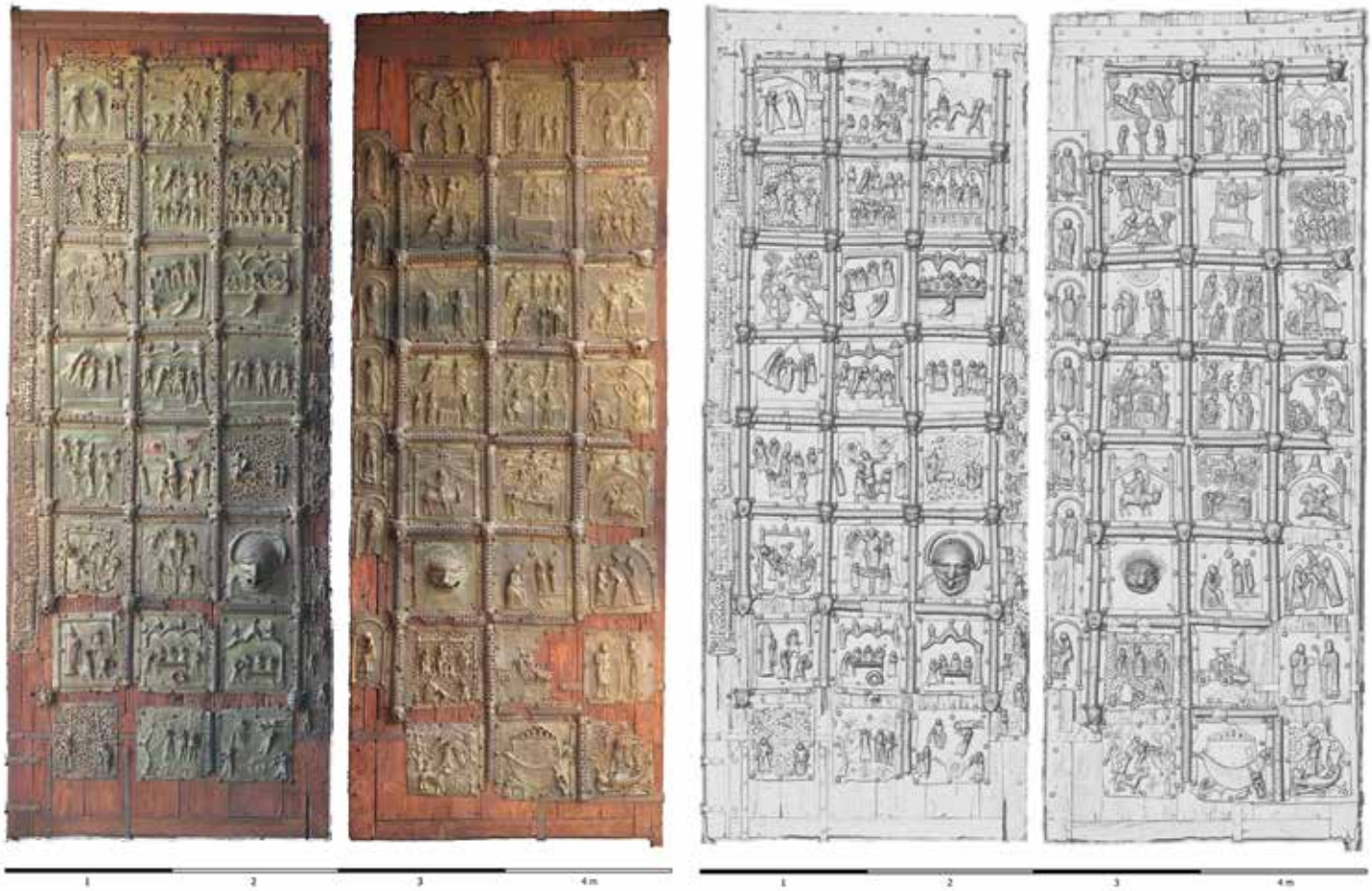

Fig. 2: San Zeno, Verona, Italy. Orthophoto of the two leaves of the portal (left). Shaded visualisation (© M. Fera/Novetus/GAPAMET).

Results

The use of image-based modelling within the project has proved to be of great benefit on many levels. It supports the spatial documentation of the chemical analyses, but also helps in the interpretation of the construction and shows the current conservation status of the investigated objects. For long-term preservation, the data is prepared for the IMAREAL repository at the University of Salzburg. Semantic annotations based on the ontology of the well-established RealOnline database will be added. This will support and enable future research on this corpus by making it more accessible to a wider audience. It can foster collaborative research and provide a tool for the digital preservation of these artworks by forming the basis for the development of Heritage Digital Twins, a concept that has been introduced in the field in recent years.[6]

Essentially, the results can foster the following areas:

- Virtual Preservation: 3D surfaces and orthoimages serve as digital preservation tools, safeguarding the details of the doors against potential future damage.
- Interactive Research: Researchers can interact with the data, examining details from various angles and

6 Nicolucci et al. 2022.

Fig. 3: Basilica di San Marco, Venice, Italy. Orthophoto detail, shaded Digital Surface Model. a) Main door, right leaf, plates E2 (left) and F2 (right). b) Door San Clemente, left leaf, plates A2 and B2 (© M. Fera/Novetus/GAPAMET).

conducting measurements that would be challenging on the physical object.

- Public Engagement: 3D models can be used in virtual tours and educational programmes, making mediaeval bronze doors accessible to a broader audience.

In the field of interactive research, the usefulness of the data has been proven by a number of detailed studies on specific topics. They show that the methodology presented enables the generation of various products which, in addition to complete documentation, can also be useful in answering specific questions.[7]

7 Asmus et al. 2025.

Case Studies

Venice, San Marco

The spatial situation at the site of the doors in Venice only allowed the recording of individual door leaves in the open position as single parts. Data acquisition was carried out in parallel with the chemical and dendrochronological analyses. The images were taken with a Ricoh GR IIIx camera with a focal length of 26.1 mm (57° diagonal) and an RGB primary colour CMOS sensor (23.5 mm × 15.6 mm, 24.24 megapixels, pixel pitch 3.9 µm) mounted on a 3.5 m long hand-held carbon rod. Illumination was provided by an array of three manual indirect flashes mounted on a rig with a reflective umbrella. Agisoft Metashape software (version 1.7.2) was used for processing. The scale was deter-

mined by measuring different distances on the object, which were used as scale bars during processing. As an example, the right leaf of the main door (max. extent 4.7 × 1.45 m, coverage area 6.63 m²) was covered by 444 images at an average perpendicular distance of 1 m. The overlap is over 60 % and most parts are covered by at least six images. The resulting DSM has an object resolution of 0.141 mm/pixel. On this basis a True Orthophoto was generated as an orthomosaic with a resolution of 0.2 mm/pixel, using an orthographic projection normal to the surface plane (fig. 3). The resulting products supported the analyses of the chemical investigation and were presented in a scientific paper[8].

The bronze doors of Barisanus of Trani in Trani, Ravello, and Monreale

For a study of the 12th-century doors that were produced by the artist Barisanus of Trani, his doors in Trani, Ravello, and Monreale were recorded and processed. Due to the different dimensions of the three objects and their different spatial positioning – two doors are still installed in functional portals today, while one door has been preserved and mounted in the interior of the church building for viewing – the approaches varied slightly.

All photographs were taken using a Ricoh GR IIIx camera. For the data acquisition in Monreale and in Ravello the camera was used on a gimbal mounted on a 3 m monopod for the upper parts. The lower parts were photographed handheld without an additional extension pole. Due to their position outdoors, the illumination provided by dispersed natural light could be utilised, while avoiding direct sunlight on the object. For the door in Ravello, a scaffolding had to be used in combination with the pole mounted gimbal for the upper parts. The location of the door within a poorly lit church room, required additional artificial lighting, which was realised by two 100 watt LED spotlights with 5600k colour temperature.

Processing of the images was conducted using Agisoft Metashape software (Version 1.7.2). Scale was established through measurements of specific distances on the object, and scaled poles (horizontal and vertical; metre sticks of 2 and 3 m length with 'mm' markings, CE accuracy class II/error within 0.035%) were included in the acquired photographs to serve as reference scale bars during processing.

The data set obtained for the door of Trani (4.92 × 2.76 m) was generated using 1,388 camera positions with an average perpendicular distance of 1.48 m to the object. The reconstructed surface yielded a sampling distance on the object of 0.216 mm per pixel. The calculated scaling error should be within 0.0938%, controlled by the scale bars with a measured distance of 2.5 m. The data for Ravello (3.78 × 2.66 m) is based on the processing of 1,188 camera stations to a reconstructed surface with 0.223 mm per pixel. The control measurement gives an error of 0.0225 % at the scale bar of 2 m. For Monreale, side door, 541 images were used and a surface with a resolution of 0.206 mm per pixel was achieved. The error utilising a scale bar measurement of 2 m length, shows to be within 0.1047 %. To generate products for further analyses, it was necessary to define a projection plane for every single door. This was achieved by the definition of a plane, providing a local rectilinear coordinate system, by the definition of a horizontal and vertical axis on door parts with equal relief levels. This plane was used as a projection plane for the generation of the three DSMs with a resolution of 0.2 mm per pixel. Based on that, a true orthophoto orthomosaic was generated at a resolution of 0.2 mm per pixel for each object (fig. 4).

In this case, the orthoimages helped to investigate questions in regard to the manufacture of the doors. The precise measurements on the digital twins allowed for the investigation of small changes in dimensions of the identical motifs of St George on three of the doors (twice on the door of Ravello) (fig. 5). By this, information on the production sequence can be deducted, as is discussed in a dedicated paper.[9]

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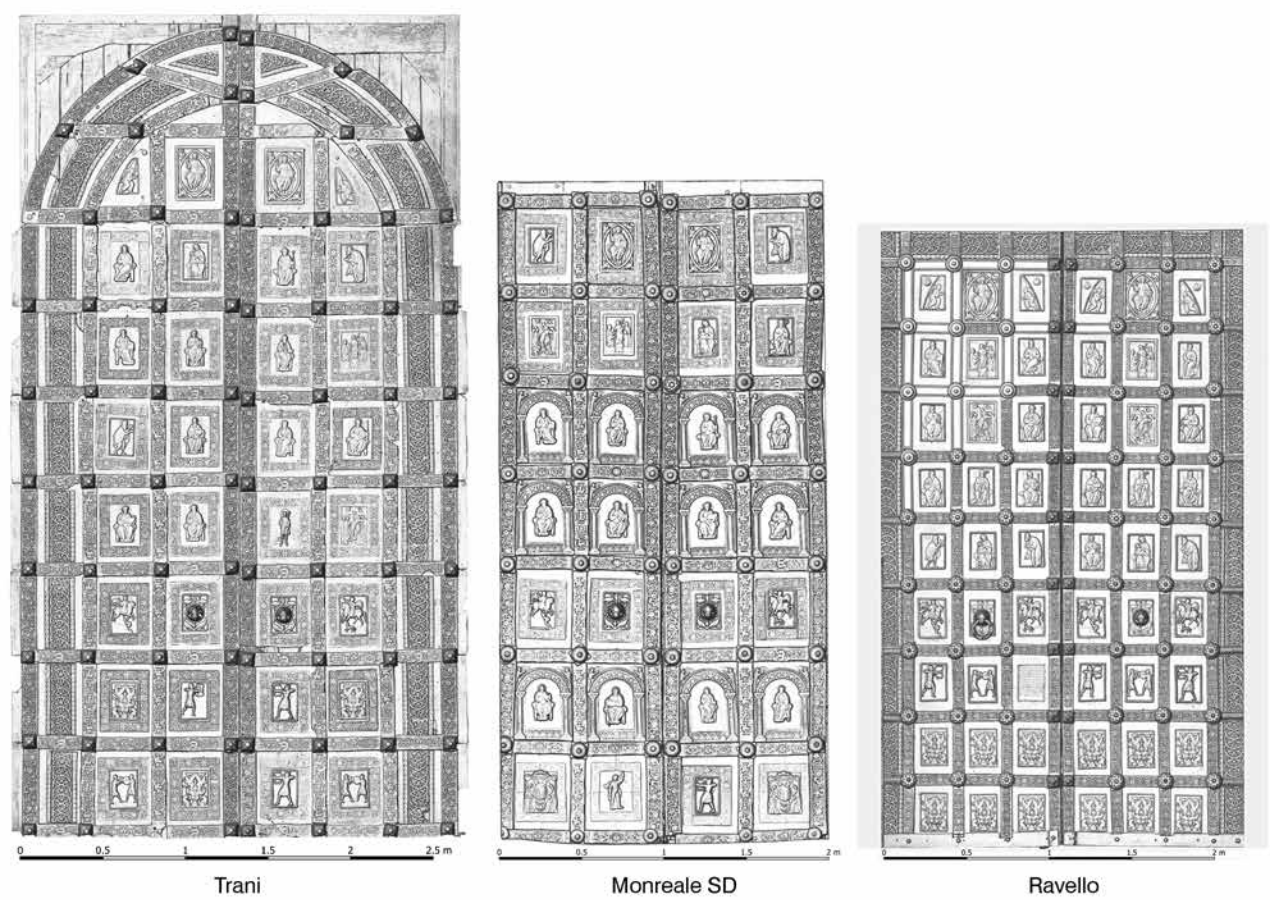

Fig. 4: Relief visualisations based on digital surface models of the doors of Trani, Monreale and Ravello, Italy (© M. Fera/Novetus/GAPAMET).

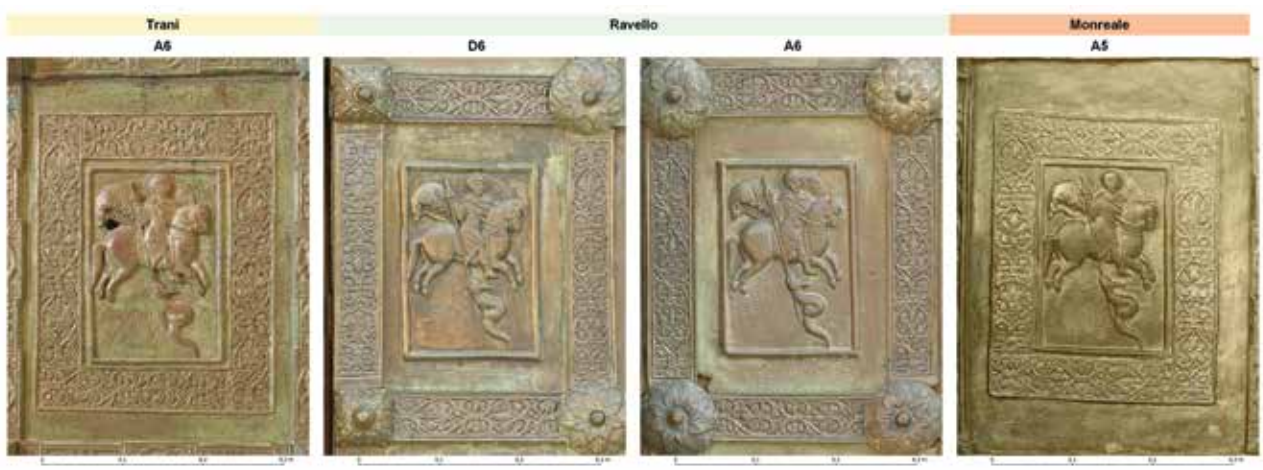

Fig. 5: Scaled comparison of the motif of St George on the doors of Trani, Ravello and Monreale, Italy (© M. Fera/Novetus/GAPAMET).

Challenges and Future Directions

While advancements in photographic documentation and 3D modelling are significant, several challenges remain:

- Technical Limitations: High-resolution imaging and 3D modelling of such large objects require advanced equipment and expertise, which can be costly and resource-intensive.
- Environmental Factors: Outdoor bronze doors are subject to weathering and environmental conditions that can complicate the documentation process.
- Data Management: The large volumes of data generated by high-resolution images and 3D models require robust storage and management solutions.

Future developments may include the integration of AI and machine learning to enhance the accuracy and efficiency of 3D modelling, as well as the development of more affordable and accessible documentation technologies, including active methods like highly mobile scanners.

Conclusion

Photographic documentation and 3D modelling represent significant advancements in the preservation and study of mediaeval bronze doors. By capturing and preserving intricate details, these technologies facilitate research and public engagement, ensuring that these historical artefacts are accessible for future study. Furthermore, the ability to use scaled images and models to conduct quantitative analyses, opens a field for new possibilities in analysing these objects that previously were not available. As technology continues to evolve, the methodologies and applications of documenting mediaeval bronze doors will likely advance, offering further opportunities for scholarly discovery and preservation.

Zusammenfassung

Dieser Artikel beschreibt die Techniken und Methoden, die für die fotografische Dokumentation und 3D-Oberflächenmodellierung mittelalterlicher Bronzetüren verwendet wurden, und deren Bedeutung für die Erforschung und Erhaltung materiellen Kulturerbes. Mittelalterliche Bronzetüren sind komplexe Artefakte, die wertvolle Einblicke in historische Handwerkskunst und kulturelle Kontexte bieten. Traditionelle Ansätze zur Dokumentation dieser Türen sind oft durch deren Größe, Oberflächenbeschaffenheit und Zugänglichkeit erschwert. Fortschritte in der Photogrammetrie, der bildbasierten Modellierung (IBM) und der 3D-Technologie haben jedoch die Möglichkeiten zur Dokumentation und Erforschung dieser Kunstobjekte erheblich erweitert. Techniken wie hochauflösende digitale Bildaufnahmen, Orthofotografie und digitale Oberflächenmodellierung (DSM) liefern detaillierte Aufnahmen der Oberflächen- und Strukturmerkmale der Türen. Fallstudien von Türen in Venedig, Monreale, Trani und Ravello zeigen die praktische Anwendung dieser Methoden, die metrische Analysen, virtuelle Konservierung und interaktive Forschung ermöglichen.

Trotz mancher Herausforderungen durch die unterschiedlichen Standortbedingungen und das Prozessieren und Management großer Datenmengen unterstreicht diese Studie den Wert der digitalen Dokumentation und 3D-Modellierung im Bereich der Erforschung materiellen Kulturerbes und bietet Vorschläge für zukünftige Innovationen, um weitere Fortschritte zu ermöglichen.

Riassunto

Questo articolo descrive le tecnologie e i metodi utilizzati per la documentazione fotografica e la modellazione 3D delle porte medievali in bronzo e la loro importanza per lo studio e la conservazione del patrimonio culturale materiale. Le porte medievali in bronzo sono manufatti complessi che offrono preziose indicazioni sullo stato di avanzamento tecnologico e sui contesti culturali. Gli approcci tradizionali alla do-

cumentazione di queste porte sono spesso ostacolati dalle loro dimensioni, dalle caratteristiche della superficie e dalla loro accessibilità. Tuttavia, i progressi della fotogrammetria, della modellazione basata sulle immagini (IBM) e della tecnologia 3D hanno migliorato notevolmente la capacità di documentare e studiare questi manufatti. Tecniche come l'imaging ad alta risoluzione, l'ortofotografia e la modellazione digitale della superficie (Digital Surface Model – DSM) forniscono immagini dettagliate della superficie e delle caratteristiche strutturali delle porte. I casi studio delle porte di Venezia, Monreale, Trani e Ravello dimostrano l'applicazione pratica di questi metodi, consentendo analisi metriche, conservazione virtuale e ricerca interattiva.

Nonostante le sfide legate al contesto (condizioni del sito) e all'elaborazione e gestione di grandi quantità di dati, questo studio evidenzia il valore della documentazione digitale e della modellazione 3D nel campo della ricerca sul patrimonio materiale e offre suggerimenti per possibili future innovazioni al fine di ottenere migliori risultati nel campo.

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