Wiggle Matching Analysis of the Doors of Santa Sabina in Rome

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Abstract

The doors of Santa Sabina on Rome's Aventine Hill are the most complete Late Antique doors surviving today. Widely studied in the last 150 years, the question of their dating has never been completely resolved. With the results of the initial Wiggle Matching Analysis on two selected panels, this article confirms the prevalent hypothesis of recent years: in spite of different "styles", the two panels analyzed are from the same time period. In addition, we argue that the tree that the panels were carved from was cut down probably at the beginning of the 5th century AD. Therefore, the generally accepted dating of the doors to the years of Celestine I (421–431) or maybe Sixtus III (431–440) also seems confirmed.

Contents

Introduction

[1] The doors of Santa Sabina on Rome's Aventine Hill are the most complete Late Antique doors surviving today. Widely studied in the last 150 years, the question of their dating has never been completely resolved.[1] One of the most striking questions has been the clear difference in the formal characteristics of the different panels on this huge door (Fig. 1-2).

[1] Of the most important contributions, see: Nikodim Pavlovič Kondakov, "Les sculptures de la porte de Sainte-Sabine à Rome", in: *Revue archéologique,* 2. sér., 33 [1876] (1877), 361-372; Joachim J. Berthier, *La porte de Sainte-Sabine à Rome*, Fribourg 1892; Johannes Wiegand, *Das altchristliche Hauptportal an der Kirche der hl. Sabina auf dem aventinischen Hügel zu Rom*, Trier 1900; Félix Marie Dominique Darsy, "Les portes de Sainte Sabine: méthode d'analyse formelle et de critique interne en histoire de l'art", in: *Rivista di archeologia cristiana* 37 (1961), 5-49; Gisela Jeremias, *Die Holztür der Basilika S. Sabina in Rom*, Tübingen 1980; Jean-Michel Spieser, "Le programme iconographique des portes de Sainte-Sabine", in: *Journal des Savants* (1991), no. 1-2, 47-81.

1 *Moses the Shepherd*, 421-440, cypress wood, 90 x 40 cm, Santa Sabina, Rome (© Centre for Early Medieval Studies, Masaryk University, Brno)

2 *Transfiguration* (?), 421-440, cypress wood, 40 x 28 cm, Santa Sabina, Rome (© Centre for Early Medieval Studies, Masaryk University, Brno)

[2] In 1876, Nikodim Kondakov claimed that four of the 18 surviving narrative panels had been integrally re-sculpted in the Early Modern period.[2] At the beginning of the 20th century, however, Adolfo Venturi put forward an idea, which gradually became the

[2] Kondakov, "Les sculptures", 371.

predominant one: the different "styles" are all Late Antique and are a material evidence of different artists working together on this important monument.[3] Recently, Ivan Foletti, accepting Venturi's postulate, suggested that the differences may arise from a conscious rhetorical concept: following Augustine's theory, different styles should be combined in order to make the monument more interesting and effective.[4]

[3] Despite these theories, scientific proof that the panels were perfectly contemporaneous was lacking. The doors were definitely restored in 1836, but from Roberto Saccuman's analysis we know that these restorations were minor ones; the only important alteration was the addition of a missing fragment in the panel of the *Crossing of the Red Sea*.[5] Despite this situation, even if the majority of scholars accepted the idea of a coherent late antique monument, uncertainty about the possible addition of an entire panel remained, especially since part of the decoration – 10 panels – had disappeared, probably in the Early Modern period. At that time, it's likely that the order of the sculpted depictions was modified.[6] In order to resolve this issue with more certainty and to confirm (or deny) the generally accepted dating of the doors to the reigns of popes Celestine I or Sixtus III (421–440), we decided to perform new scientific analysis, using the wiggle matching method, as part of the project *Transforming Spaces and Minds. Materiality, Performativity and Perception in Late Antique (4th–6th century) Baptismal Zones* (Masaryk University, MUNI/H/1402/2016).[7]

Methods

Wiggle Matching

[4] The wiggle matching method is based on dendrochronological analysis combined with radiocarbon dating. The analysis is performed on micro-fragments, containing a group of one or a few rings, which are carefully located in a tree-ring series (sequence). This method allows for very precise dating, overcoming the potential limitations of radiocarbon dating applied to a single wooden fragment, that is, a wide probability range, or even multiple ranges, of the calibrated date.[8] During the inspection of the doors of Santa

[3] Adolfo Venturi, *Storia dell'arte italiana*, vol. I: *Dai primordi dell'arte cristiana al tempo di Giustiniano*, Milan 1901, 476-477.

[4] Ivan Foletti and Manuela Gianandrea, *Zona liminare. Il nartece di Santa Sabina a Roma, la sua porta e l'iniziazione cristiana*, Rome 2015, 137-153.

[5] For the restorations see Roberto Saccuman, "Il restauro dell'antica porta", in: Foletti and Gianandrea, *Zona liminare*, 221-225.

[6] Foletti and Gianandrea, *Zona liminare*, 8-10.

[7] The research was partially supported by the "Departments of Excellence 2018"-Program (Dipartimenti di Eccellenza) of the Italian Ministry of Education, University and Research, DIBAF-Department of University of Tuscia, Project "Landscape 4.0 – food, wellbeing and environment".

[8] Manuela Romagnoli, Mara Sarlatto, Mauro Bernabei, Leone Fasani, "Dendrocronologia per i Beni Culturali", in: *Dendrocronologia per i Beni Culturali e l'Ambiente*, ed. Manuela Romagnoli, Florence 2008, 59-72; Manuela Romagnoli, Daniela Cavalli, Manuela Capani, Filippo Terrasi and Marco Togni, "Diagnostica. Datazione del legno della copertura", in: *Santa Maria Nuova a Viterbo. Nuove chiavi di lettura della chiesa alla luce del restauro della copertura*, eds. Manuela Romagnoli and Marco Togni, Florence 2013, 101-112.

Sabina, in October 2017, different panels were analysed with the wiggle matching analysis methodology. So far, however, it has been possible to investigate only two sequences: Sequence 2, the panel of *Moses the Shepherd* (Fig. 1), and Sequence 4, the panel of the *Transfiguration* (Fig. 2). Fortunately, the two panels are representative of the two main styles appearing on the doors: the first called "Hellenistic" and the second identified as more "Roman".

[5] Both of the panels are carved from cypress (Cupressus sempervirens), which is not the easiest type of wood from a dendrochronological point of view.[9] Its growth rings are very narrow, often less than one millimetre wide, and the wood systematically shows a ring anomaly, called a false ring. In wide ring species, this anomaly is quite easy to detect, while in very narrow rings, like in the panels of Santa Sabina, it is difficult to distinguish. Since we could disassemble the panels only for a short time, and since the boundaries of the rings were not always clearly visible, for the first dating, we counted the rings in the zones of the panels where annual rings could be detected with reasonable certainty. A 10x hand lens was used to to bring out the rings on the panel. After having marked out the positions of the adjoining rings, we took small fragments where the rings were easy to distinguish, specifically in the inner part of the ring growth pattern (closer to the tree pith). Radiocarbon dating on the selected fragments was performed by Accelerator Mass Spectrometry (AMS) at LABEC[10], Florence, a laboratory of the Istituto Nazionale di Fisica Nucleare associated with the Cultural Heritage Network (INFN-CHNet).

Collected Samples

[6] The positions of the ring groups are:

Sequence 2, Moses the Shepherd
1-2 (external part, closer to the tree bark), 13-15, 24-26 (inner part, closer to the pith)

Sequence 4, Transfiguration
1-4 (external part, closer to the tree bark), 25-32, 50-53 (inner part, closer to the pith)

Radiocarbon Measurements

[7] The wooden samples were chemically pre-treated according to the so-called ABA procedure, which aims at removing possible contaminations due to carbonates and humic substances. They were first soaked in 1M HCl at 80°C for 1 hour, then in 0.1M NaOH at room temperature for 30 minutes, and finally in 1M HCl at 80°C for 1 hour again. After drying completely, the cleaned samples were combusted to extract carbon as carbon dioxide, and finally converted to graphite. Two graphite pellets were prepared, starting from each of the cleaned samples.

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[9] Elio Corona, "Valore dendrocronologico del cipresso sempreverde", in: *Monti e Boschi* 19 (1970), no. 5, 21-25; Paola Lanzara and Manuela Romagnoli, "Un esempio di applicazione della xilo-dendrocronologia nel restauro dei parchi e giardini: Analisi di un cipresso a Villa Mellini (Roma)", in: *Linea Ecologica* 3 (2002), 51-53.

[10] M. E. Fedi, A. Cartocci, M. Manetti, F. Taccetti, P. A. Mandò, "The 14C AMS Facility at LABEC, Florence", in: *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms* 259/1 (2007), 18-22; https://doi.org/10.1016/j.nimb.2007.01.140.

[8] The radiocarbon concentrations of the prepared graphite pellets were measured by AMS: samples prepared from NIST Oxalic Acid II and from IAEA C7 were used as primary and secondary standards, respectively. The measured isotopic ratios were corrected for background and for isotopic fractionation. Calibration of the measured conventional radiocarbon ages was achieved using OxCal 4.0 software,[11] exploiting the D_Sequence model, which allows for wiggle matching. IntCal13 was used as a calibration curve.[12]

Radiocarbon Results

[9] Table 1 summarises the radiocarbon measurements results.

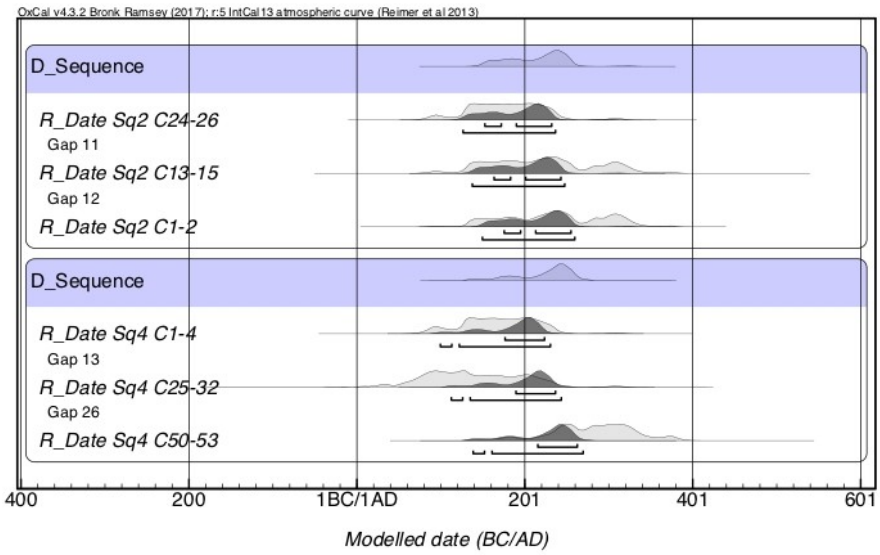
Samples	Lab codes	^{14}C concentration (pMC)	t_{RC} (years BP)
Sq2_C1-2	Fi3680, Fi3681	80.01 ± 0.37	1790 ± 35
Sq2_C13-15	Fi3682, Fi3687	79.94 ± 0.40	1800 ± 40
Sq2_C24-26	Fi3686, Fi3689	79.57 ± 0.31	1835 ± 30
Sq4_C1-4	Fi3704, Fi3709	79.48 ± 0.32	1845 ± 30
Sq4_C25-32	Fi3705, Fi3710	79.17 ± 0.44	1875 ± 45
Sq4_C50-53	Fi3706, Fi3708	80.35 ± 0.37	1760 ± 35

Table 1: Measured 14C concentrations and correspondent conventional radiocarbon ages for tree-ring samples. For each of the samples, two graphite pellets were independently prepared and measured. After verifying the statistical compatibility between the two measured fractions, for each sample data are reported as their weighted average. Uncertainties are quoted at 1 sigma.

As explained in the Methods section, calibration of measured radiocarbon ages was performed taking the known distributions of rings into account. The results are shown in Figure 3:

[11] Christopher Bronk Ramsey, "Bayesian Analysis of Radiocarbon Dates", in: *Radiocarbon* 51 (2009), no. 1, 337-360.

[12] Paula J. Reimer et al., "IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years cal BP", in: *Radiocarbon* 55 (2013), no. 4, 1869-1887.



3 Probability density functions of the calibrated ages of the dated samples: Sq2 identifies *Moses the Shepherd*; Sq4 identifies *Transfiguration*

The most external rings can thus be dated to the following periods:

Sequence 2, *Moses the Shepherd*: 175-260 AD (at the probability level of 68%), 150-260 AD (at the probability level of 95%).

Sequence 4, *Transfiguration*: absolute dating 215-265 AD (at the probability level of 68%); 135-275 AD (at the probability level of 95%).

Discussion

[10] The wiggle matching analysis confirms that the two panels belong to the same period (Fig. 3), and, from the dendrochonological analysis, we expect they could synchronize. From an optical examination of the growth rings at the edge of the panels, the growth patterns seem very similar.

[11] The most recent date found through the wiggle matching method (260 in the case of *Moses the Shepherd,* and 270 in the case of the *Transfiguration*) does not correspond to the last year of the tree (mother tree) the wooden panels were cut from. In fact, as previously mentioned, in order to avoid errors in the sampling phase, we preferred to operate in areas of the tree-ring sequences where the rings were easy to distinguish and false rings could reasonably be identified. Starting from the more recent dates of the rings analysed by radiocarbon, it would be necessary to count the number of rings up to the outermost part of the panel. By a rough estimation, that could be 50-60 years or more, moving from the last ring of wiggle matching to the outside part of the panel, both in *Moses the Shepherd* and in the *Transfiguration*. Likely, even more rings could be counted due to the overestimation of false rings. In the examined panels, these seem to exceed one in a single ring width.

[12] In both panels, sapwood was absent, as it was surely cut during processing. Sapwood is quickly destroyed by fungi and insects and is always discharged, especially if the artefact is very precious, as is the case with the wooden door of Santa Sabina. It is not easy to estimate the number of rings lost with sapwood. We must also compare cypress samples from living plants in order to elaborate certain models. Nevertheless, taking into

account the very small width of the last evident rings in the panels, we can hypothesize a time interval covering another 50-60 years.

[13] The wood of *Moses the Shepherd* and the *Transfiguration* is from the same period. The terminus post quem of the two panels by wiggle matching is 265-270 AD; it is reasonable to add at least 100 – 120 years to this date (not counting the rings in the outer part of the panels and sapwood), which shift the terminus post quem likely to the beginning of the 5th century AD.

[14] A more in-depth investigation with the chance to perform a longer and more precise survey is needed, looking at the different possibilities of tree-ring width synchronization, which requires more time to perform a more precise counting of false rings. Furthermore, an evaluation of cypress sapwood rings, by analysing the sapwood of standing trees, could refine the preliminary but reliable dating of the panels, allowing a closer estimation of the year of the tree's felling.

Conclusion

[15] Following this initial analysis, we can confirm the main hypothesis of the research since 1900: in spite of the different "styles", the two panels analysed are from the same time period. In addition, we argue that the tree was cut down probably at the beginning of the 5th century AD. Therefore, the generally accepted dating of the doors to the years of Celestine I (421–431) or maybe Sixtus III (431–440) seems also to be confirmed.

[16] Further analysis is planned for the coming years, in order to confirm these initial results. However, one key question seems to be solved from a scientific point of view: despite the diversity in forms, both panels were carved from trees of the same period. Thus, it seems even more plausible that we are dealing with a unique and coeval artistic project.

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