





Radiocarbon dating of cultural heritage objects – case studies of regional importance

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Dating – determination of the age of an object

Absolute dating of object of cultural heritage and art is one of the most important issues in art history studies and in archaeology.

Accurate dating in art history is essential for valuation of original objects of arts, for differentiation between the original works and later imitations and/or frauds and for recognition of reparation and restauration works.

Radiocarbon (¹⁴C) dating is a convenient and accurate method of absolute dating of organic materials.

Radiocarbon (¹⁴C) **dating**

- one of the most well-known radiometric methods of absolute dating
- it can be applied for dating materials of biogenic origin, such as wood, charcoal, bones, grains, paper, parchment, textile, etc.
- the range of ¹⁴C age determination spans from 19th century up to ~60,000 years in the past
- the anthropogenic influence on the natural ¹⁴C distribution during 20th century can be used for recognition of frauds



Measurement technique - AMS

Accelerator Mass Spectrometry (AMS)

number of ¹⁴C atoms is counted, together with the number of ¹²C and ¹³C

Required mass: <2 mg C, <1 g sample

The AMS measurement technique enables precise analysis of very small amount of samples, e.g. micro-sized samples, containing a few milligrams of carbon, or less, and is therefore applicable to various objects of cultural heritage. How to interprete radiocarbon dates and calibrated ages?

One has to keep in mind that radiocarbon dating gives the **age of material** (e.g., wood) and not the time of the creation of the art work, and that the creation of the art work cannot precede the formation of the material.

received a massive gilded wooden door on the Feast of St. George in 1214. The doors were made by the local craftsman Master Andrija Buvina.

530 cm high and the two wings 360 cm wide





exhibition

izložba / exhibition

Drvene romaničke vratnice splitske katedrale - istraživanje, restauriranje i zaštita Wooden Romanesque Doors of the Split Cathedral - Research, Conservation and Protection

8. svibnja - 8. lipnja 2018. May 8th - June 8th 2018

HRVATSKI RESTAURATORSKI ZAVOD CROATIAN CONSERVATION INSTITUTE

INSTITUT ZA POVIJEST UMJETNOSTI - Centar Cvito Fisković INSTITUTE OF ART HISTORY - Cvito Fisković Centre

Galerija umjetnina Split Museum of Fine Arts in Split



Određivanje starosti drvene građe Buvininih vratnica metodom ¹⁴C Carbon Dating of Buvina's Door from the Split Cathedral

Metodom radioaktivnog upijika "Codređena je starost pet drvenih fragmenata iz Buvininih vratnica katedrale u Spihu. Za dva uzorka pokazano je da potječu iz originalnih vratnica iz 1214. godine (rasponi kalibriranih godina cal AJ 1155 - 1210 i cal AJ 1054 - 119). Dva uzorka su nešto mlađa i jedan znatno mladi, što upućuje na podatak da taj fragment nije bio dio originalnih vratnica.

The age of five wooden pieces from Buvina's door from the Split cathedral was determined using carbon dating. The results of two samples indicate they belong to the original door from 1214 (calibrated years cal AO 1155 - 1210 and cal AO 1054 - 1191). Two other samples are somewhat younger, and the last one is considerably younger indicating that it could not have been built into the original door.

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Z-5720 R_Date(879,30)		 - +		-
Z-5721 R_Date(887,30)	-	 -	-	_
Z-5719 R_Date(775,30)			-	-
Z-6037 R_Date(784,30)			-	+
Z-6605k R Date(737,30)		-	-	-

Reputati analize četiri uzorka drva Buvininih vratnica i jednog uzorka konskih klupa splitske katedrale Results of the analysis of four wood samples from Buvina's door and one sample from chair benches of the Split Cathedral





Polikromija vratnica **Door Polychromy**

Fotografije vratnica snimljene prije restauriranja 1908. godine, premda crno-bijele, jasno govore o bogato nataloženim povijesnim slikanim slojevima. Odlukom o njihovu uklanjanju u restauratorskim radovima 1908. godine i upotrebom metalne nazubijene alakte za taj posao, do današnjega su vremena stigle tek čestice zivorne boje, koje su detskirane mikroskopima, a uzorci obrađeni u laboratoriju Hrvatskog restauratorskog zavoda i Tehničkog fakulteta u Minchenu. Virtualno su mogle biti rekonstruirane tek tri kasete, ali su istražene osobitosti slikarstva vratnica: punila i vezivo, paleta pigmenata te tehnike slikanja i pozlačivanja.

Photographs of the door taken before the 1908 restoration, though black and white, clearly show centuries of rich painted layers. Because of the decision to remove the layers during the 1908 restoration using a metal notched tool, today we only have traces of the original color, detected by microscopes and analyzed at the laboratory of the Croatian Conservation Institute and the Technical University of Murich. Only three cassettes could be virtually reconstructed, but painting characteristics on the door were thoroughly researched – filters and binder, pigment palette, and painting and gilding techniques.





Reljef Raspeće, oznake pronađenih čestica sekundarne polikromije Crucifikion relief, markings of detected particles of secondary polychromy



Reljet Prikazanje u hramu Feast of the Presentation of Our Lord Jesus relief



During the study of the Master Buvina's door of the Split cathedral ¹⁴C method (AMS) was dated 5 wood samples from the door and 2 samples from the choir benches.





Split-Cathedral – conventional¹⁴**C ages**

Z-	Sample desc.	δ ¹³ C ‰	AMS Age	σ	comm
5469	Wood, Buvina's door, Split - Cathedral, br.inv. M6S 6671-1	-25.0	313 80		LSC
5719	Wood, Buvina's door, Split - Cathedral, cassette 24, (<i>Uzašće</i>) - wallnut, #1	-23.6	-23.6 775 22		
5720	Wood, Buvina's door, Split - Cathedral, between cassetes 21-22, wallnut, #2	-24.3 879 21			
5721	Wood, Buvina's door, Split - Cathedral, middle part of the door - oak, #3	-27.1	887	21	
6037	Wood (Juglans L.), Buvina's door, Split - Cathedral, cassette 1, #1	-23.2	784	22	
6038	Wood, Split - Cathedral, Choir bench, #2	-27.1	100.74	0.27	рМС
6605	Wood, Split - Cathedral, Choir bench, south-west verticale 13th century, #3	-26.9	737	21	



Radiocarbon determination (BP)





Sample **Z-5469** is considerably younger that the others, it is dated to cal AD 1481 - 1650 (probability 68.2 %), and therefore it was not a part of the original door.



Two samples from the **choir benches**



Z-6605 was dated to the second half of the 13th century (cal AD 1260 – 1285).



Calibrated date (calAD)

Z-6038 was dated to cal AD 1955, so it may be concluded that this piece of wood was added to the bench during reconstruction/repair in the second half of the 20th century.



Radiocarbon determination (F14C)

Summary

Samples Z-5720 and Z-5721 from the door give the calibrated age spans cal AD 1155 – 1210 and cal AD 1054 – 1191, respectively. It may be concluded that these two wooden pieces belong to the original door from AD 1214.

Samples Z-5719 and Z-6037 are somewhat younger (cal AD 1245 – 1272 and cal AD 1225 – 1266, respectively) indicating that these pieces could not have been built into the door in AD 1214.





Radiocarbon determination (BP)

Old Olive tree, Brijuni Islands

Olive trees do not form clear circular annual rings, and the most central wood is frequently rotted. Thus the direct dating of the tree based on ring counting in cores or radiocarbon dating of the pith cannot be carried out.



Olive oil production facility (oil mill) from the Roman times











Sample code	Sample name	δ ¹³ C (‰)	Conventional ¹⁴ C age (BP)	Calibrated age span (cal AD)	
Z-6568 A1575	Brijuni <i>, Olea</i> <i>europeae,</i> sample 1		150±20	1675 – 1942	
Z-6569 A1576	Sample 2		130 ± 20	1683 – 1930	
Z-6570 A1577	Sample 3	-25.5	110 ± 20	1694 – 1890	
Z-6571 A1578	Sample 4		126.3 ± 0.3 pMC Modern sample	1980 – 1981	
Z-6572 A1579	Sample 5	-23.7	105 ± 20	1695 – 1917	
Z-1	6572 R_Date(105,22)				
z-	6570 R_Date(111,22)				
z-	Z-6569 R_Date(127,22)				
z-	6568 R_Date(149,22)				
1550	1600 1650 170	1750	1800 1850 190	0 1950	



Calibrated date (caIAD)







Radiocarbon Dating of an Olive Tree Cross-Section: New Insights on Growth Patterns and Implications for Age Estimation of Olive Trees

Yael Ehrlich¹, Lior Regev¹, Zohar Kerem² and Elisabetta Boaretto^{1*}

Fojnica Franciscam Monastery, B&H

Fojnica is a town and municipality in central Bosnia and Herzegovina, located west of the capital Sarajevo.

The most important cultural site in Fojnica is the Holy Spirit Franciscan Monastery which houses an important part of the nation's cultural heritage, maintained by the Franciscan Province of Bosna Srebrena.

The Franciscan monastery in Fojnica has a large library of philosophical and theological works printed from the 16th to the 19th centuries, with some dating back to 1481.





Fojnica Armorial

Fojnički grbovnik *Fojnica Armorial* an early modern roll of arms including heraldry of South Slavic history. The manuscript is an important source of the classical heraldry of the Balkans peninsula. The manuscript contains a total of 139 coats of arms.

Various estimates of its ages (from 1340 AD to 18th cent.) Most probably dated to in between **1675 and 1688**, i.e. in the context of the revolts against Ottoman rule during the Great Turkish War.



¹⁴C dating – 2 samples, paper, AMS

ID	Sample name	Conventional ¹⁴ C age (BP)	δ ¹³ C (‰)	Calibrated age (cal AD)	median cal AD
Z-5700 A1079	Paper (thick), #1	270 ± 20	-25.6	1635 – 1662 (60,5%)	1645
Z-5701 A1080	Paper (thin), #2	105 ± 20	-24.9	1695 — 1917 (68,2%)	1840





Most probably restauration/reparation

Confirmed hypothesis for the time of origin (17th century, 1675-1688)

Fojnica Ahd-Namah

The monastery's museum collections hold the Ahd-Namah (the Order) of Sultan Mehmed II the Conqueror (**1463 AD**) guaranteeing security and freedom to the Franciscans. This document allowed the Franciscans of the day to preach freely among the Catholics in BiH, which in turn enabled the preservation of Bosnian Catholicism through the centuries.

In 2013 celebration of the 550th anniversary of Ad-Namah

Expected origin: Ottoman Empire, Sultan Mehmed II, 1463 AD





Paper sample taken from upper part of Ahd-Namah (sample #1)

Paper sample taken from lower part of Ahd-Namah (#2)





Calibrated date (calAD)

¹⁴C age of Ahd-Namah

Upper part (#1) **Z-5124** A628

¹⁴ C conventional age (BP)	215 ± 30
Calibrated age (cal AD)	1650 — 1799 (55.9%)
Median cal AD	1773



Lower part (#2) **Z-5126** A630

¹⁴ C conventional age (yr BP)	439 ± 17
Calibrated age (cal AD)	1438 – 1451 (68.2%)
Median cal AD	1445

Archives of Vojvodina, Novi Sad, Serbia





manuscripts with liturgical texts in Latin were used as binders for the notebooks from the end of 16th cent (1569-70 AD, 1590 AD)



Archives of Vojvodina, Novi Sad, Serbia manuscripts on parchment

manuscripts K3 and K4 with liturgical texts in Latin Used as binders for the notebooks from the end of 16th cent (1569-70 AD, 1590 AD)

K3

36



manuscripts with liturgical texts in Latin from the Archives of Vojvodina, Novi Sad Used as binders for the notebooks from the end of 16th cent (1569-70 AD, 1590 AD)

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K4

Lab. no	Sample name	Concentional ¹⁴ C age (BP)	δ ¹³ C (‰)	Calibrated age span (cal AD)	median cal AD	Expected period
Z-5806 A1140	Parchment K3	565 ± 20	-21.0	1325 — 1410 (68.2%)	1349	14th c.
Z-5807 A1141	Parchment K4	785 ± 20	-21.4	1225 – 1265 (68.2%)	1247	12th c.



Radiocarbon determination (BP)

CONCLUSIONS

- Radiocarbon dating gives the age of material (e.g., wood) and not the time of the creation of the art work – however, the creation of the art work cannot precede the formation of the material
- Radiocarbon dating cannot give a single year a range of years is obtained with a certain probability, the width of the range depends on the measurement uncertainty and on the shape of the calibration curve
- Interpretation of results should be performed in close collaboration of art historian and radiocarbon specialists