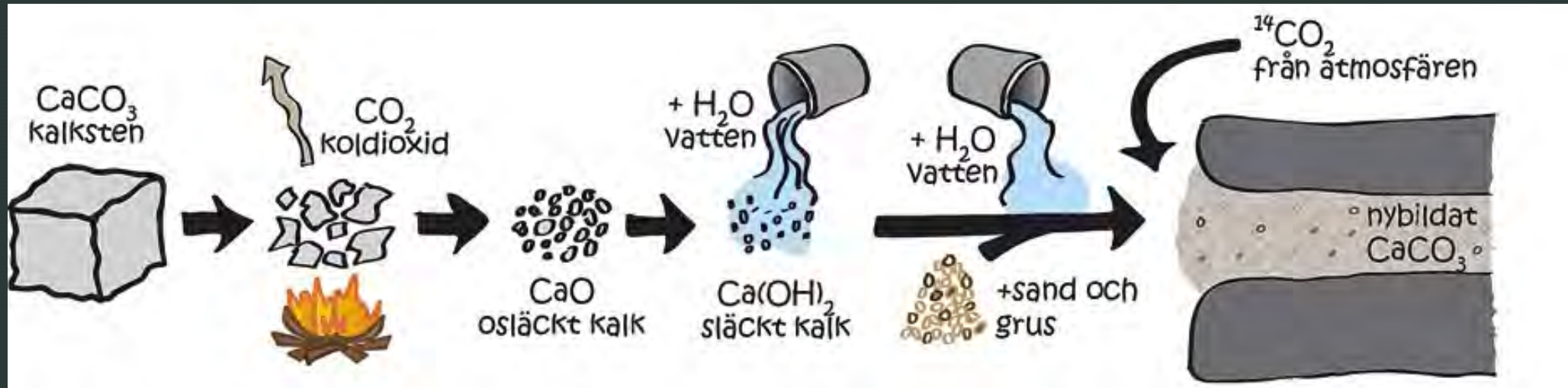


***It was meant to be!***

- ▶ *Tvärvetenskaplig forskning och om hur det kan gå till när konsthistoriker på 1980-talet fikar med geologer, exemplet kommer från Åbo Akademi.*



- Bland murbruksdateringens pionjärer i Finland måste man framförallt nämna fysikerna vid HU, med Högne Jungner i spetsen. Vi hade förmånen att inleda vårt projekt under hans ledning.





Jungner hade inbjudits till Newport, Providence, för att datera det berömda tornet, som lokala entusiaster menade vara uppfört av vikingar. Murbruksanalysen visade att tornet byggts på 1600-talet, troligen av nederländska invandrare.



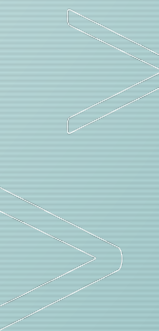


Här följer beskrivningen av hur det gick till när vi, en grupp forskare i Finland, USA, Schweiz, Polen och Danmark, småningom sammanstrålade för att vidareutveckla metoden. Ett av många möten i Bartsgårda.





Will Morgan, professor i arkitekturhistoria vid  
University of Louisville, Kentucky, en av  
nyckelpersonerna bakom vår internationella  
forskning



Nya rutiner vid ankomsten till UofL var att min man Håkan och jag dagligen lunchade med Will och hans vän John Hale, klassisk arkeolog. John frågade mig "What else do you do but Åland churches?"

Jag svarade "I do mortar dating".

John: "you do WHAT!!!???"

Did you know that for seventeen years we have been digging in Portugal, waiting for somebody to come around?







Torre de Palma,  
Vaiamonte, Portugal, den  
största romerska villa  
anläggningen på Iberiska  
halvön.

Basilika (kyrka) med dubbla  
absider (avrundat kor).  
Baptisterium (dopkapell) med funt  
och ett tjugotal andra byggnader.







Våra analyser visade att bosättningen i Torre de Palma härstammar från tiden 50 e.kr – 700-talet. Basilikan hade bl.a. dubbla absider och två olika dopfuntar.



# Planritning till Basilikan i Torre de Palma







Torre de Palma,  
Dyrbara mosaiker i  
villans matsal:

*De nio musorna*



Festligheter, eventuellt i  
samband med kapplöpningar  
Circus Maximus, Rom



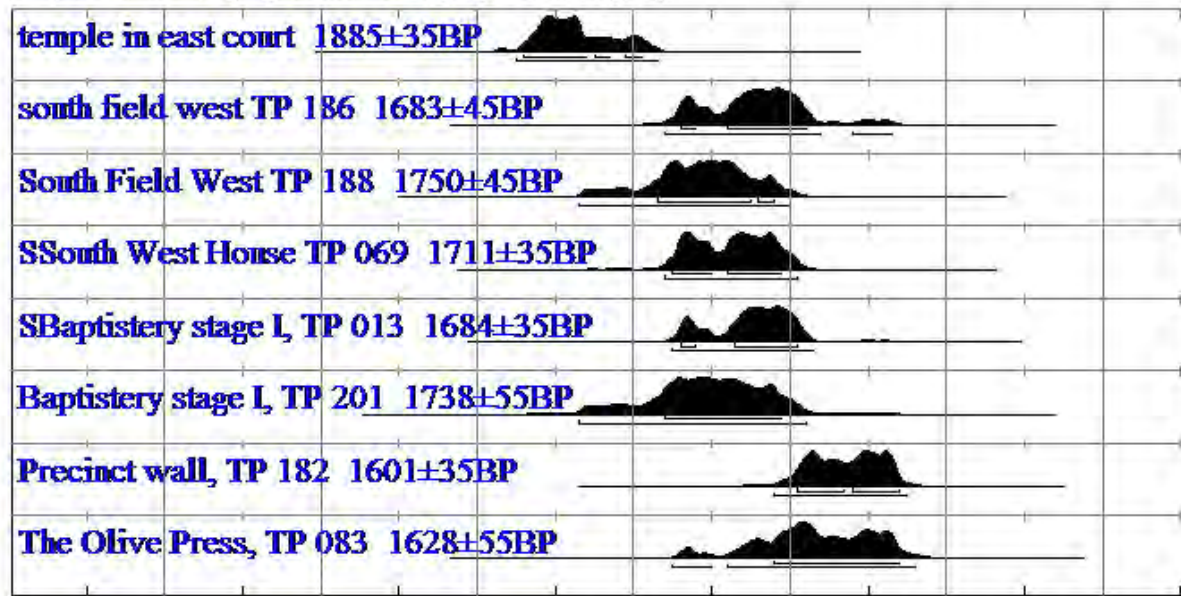
Torre de Palma, mosaik med porträtt av  
namngivna hästar, möjligen levererade till  
hästkapploppningarenan i Circus Maximus, Rom.





Äldre resultat, tyder på invandring ca 50 e Kr.

Atmospheric data from Reimer et al (2004); OxCal v3.10 Bronk Ramsey (2005); sub v5 ad:12 prob: usg[chron]

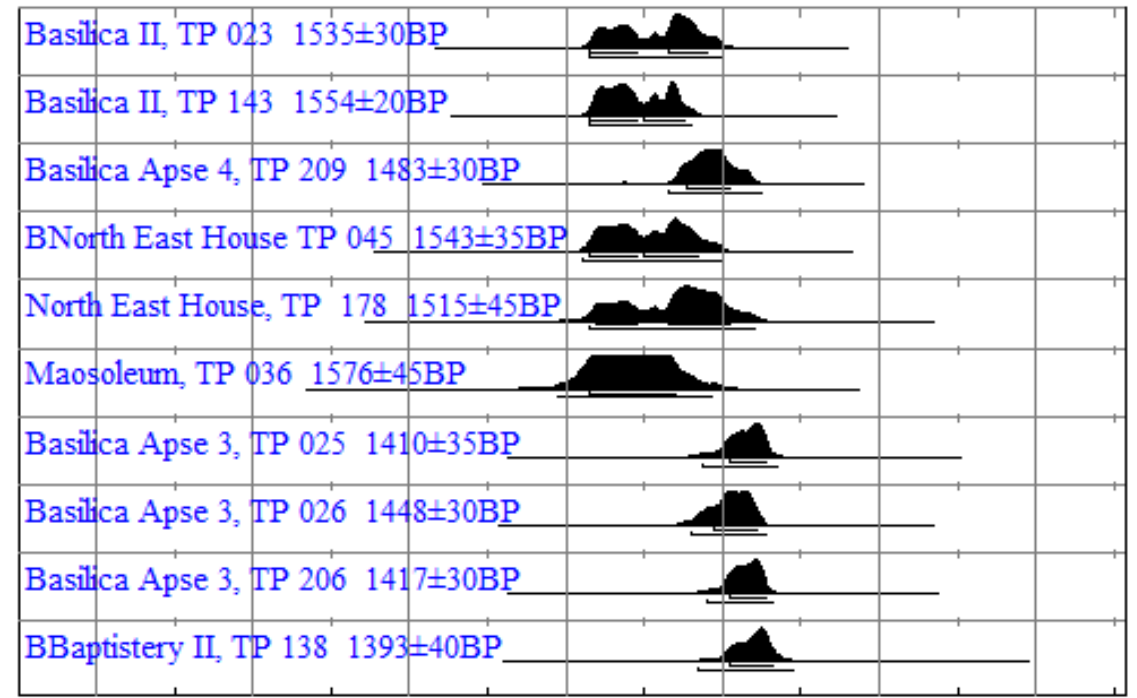


400CalBC 200CalBC CalBC/CalAD 200CalAD 400CalAD 600CalAD 800CalAD

Calibrated date

Yngre resultat från Torre de Palma, upphör före morernas inflyttning på 900-talet

Atmospheric data from Reimer et al (2004); OxCal v3.10 Bronk Ramsey (2005); sub v5 ad:12 prob: usg[chron]



200CalBC CalBC/CalAD 200CalAD 400CalAD 600CalAD 800CalAD 1000CalAD

Calibrated date

Resultat från våra murbruksdateringar i Torre de Palma



Konferens i Chicago, 1997, arrangerad av American Institute of Archaeology, där jag tillsammans med John Hale presenterade läget för forskningen kring murbruksdatering.







- Father Leonard E. Boyle OP (Ordines Predicatori) Dominikanermunk, medeltidsforskare, specialist på medeltida handskrifter, chef för Vatikanbiblioteket (avled 2019). Grundare av FIDEM. (Federation Internationale d'Etudes Medievales). Inbjöd mig att bli medlem av FIDEMs styrelse. För min del innebar det talrika möten och regelbundna resor till Rom. Hans sista publikation gällde dominikanernas liturgi, det s.k. Sankta Sabina manuskriptet.

-



Father Leonard Boyle, kom också till Åland, dit han inbjudits för att leda ett nordiskt konsthistoriskt medeltidssymposium på Havsvidden.

Han fascinerades av kalkmålningarna i Finströms kyrka, och kunde bekräfta att kyrkan följde den dominikanska ordens liturgi. Petrus Martyr t.ex. var synnerligen viktig för dominikanerna.

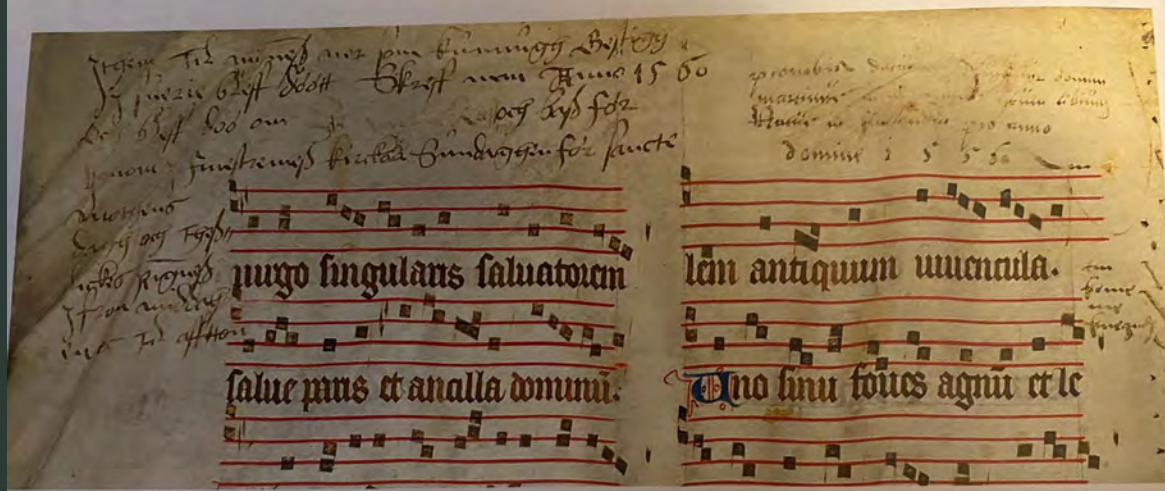




# Dominikansk liturgi bevarat i räkenskapsböcker från Kastelholm. Härstammar från Finströms kyrka, i början av 1300-talet. Bl.a. Mikaeels sekvensen. *Laus Erumpat*. Information av Anja Inkeri Lehtinen.



cirka 1 500 olika liturgiska, teologiska och juridiska böcker i bruk under katolsk tid.<sup>1</sup> Samlingen i SRA, Asa Ringbom, som också påvisade innehållet i piktur (handstil) med fragmentet F.m.I 171 i HUB. Detta



91. Påskriften i marginalen till Maria-sekvensen *Salve sancta Christi parens* knyter fragmenten till Finströms kyrka. F.m.I 162, fol. 7 verso.  
The annotation in the margin of the Marian sequence *Salve sancta Christi parens* connects the fragment to the church of Finström. F.m.I 62, fol. 7 verso.





Lynne Lancaster, (professor i klassisk arkeologi vid Oxford University). En av de främsta experterna på Roman Pozzolana / romerskt murbruk. När John Hale 1997 presenterade murbrukdateringen vid AIA mötet i Chicago räckte Lynne upp handen och frågade om vi inte ville komma till Rom och ta prover av pozzolana, romerskt murbruk.



Lynne Lancaster ordnade med alla våra tillstånd att ta murbruksprover i Rom, inklusive Colosseum. Resultatet blev att arenan faktiskt uppfördes ca 80 efter Kr. eller under Kejsar Titus, helt enligt skriftliga källor.



...nämnda metodikens grunder. Sedan Irka  
*the Laboratory of Ion Beam Physics ETH,*  
12 anslöt sig till gruppen, delar hon oc



... Murbrukdateringsgruppen utanför Colosseum, fr. v. Lancaster, Jan Heinemeier, Åsa Ringbom och Alf Lindroos, *mortar dating group in front of the Colosseum, from the le*



# Optimisation of the radiocarbon dating process of mortar samples. A case study in the Colosseum, Rome (Italy)

Rita Vecchiattini<sup>1</sup>, Alf Lindroos<sup>2</sup>, Giovanni Luca Pesce<sup>3</sup>, Åsa Ringbom<sup>2</sup>, Lynne Lancaster<sup>4</sup>, Jan Heinemeier<sup>5</sup>

<sup>1</sup>University of Genoa, Italy; <sup>2</sup>Abo Akademi University, Finland; <sup>3</sup>Northumbria University, United Kingdom; <sup>4</sup>Ohio University, Athens, US; <sup>5</sup>Aarhus University, Denmark

## INTRODUCTION

This project highlights the importance of an integrated planning of field and laboratory procedures for the success of the radiocarbon dating of mortar samples.

In this research bulk mortar analysis was complemented with lime lump analysis. The two materials were dated at different laboratories.

Results are discussed considering the historic and archaeological information available on the building and on the structure where the sample was collected.

## THE BUILDING

The *Amphitheatrum Flavium* (known as *Colosseum* or *Coliseum*) is an iconic public building constructed in Rome (Italy, Southern Europe) between the 70 and the 79 AD by the Roman Emperor Titus Flavius Vespasianus.

Despite the magnificent opening in the 80 AD, the construction works continued in the following years under the Emperor Domitian who modified the underground environments, the highest level of the caves, and the external area.

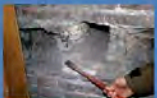
After Domitian, Antoninus Pius (138-161 AD) carried out further works, known as *Instauratio Amphitheatrum*.



From then, the building has undergone a number of destructions (generated by events such as fires and earthquakes), modifications and additions that have heavily affected its original structures and finishes, in particular at ground level.

## SAMPLING AND SAMPLES

Sampling work was carried out in 2001 as a part of the Abo Akademi International Mortar Dating Project.



The specimen dated in this study was carefully sampled in an interior brick wall of the second room, west of the North entrance of the Colosseum. The room was probably built during the Flavian period and it has always been well covered and never restored.

The specimen was part of a mortar joint. The sampling depth was >1-3 cm from the surface of the wall. The mixture contained grey pozzolana, red pozzolana as aggregate, and white inclusions.

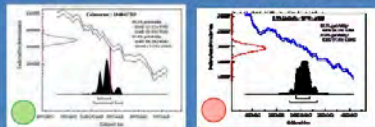
In order to perform the test, the specimen was split in two parts and each part was analysed separately using different preparation techniques, in different laboratories.

The first part comprising the bulk mortar (green) was sent to Aarhus University in Denmark for the  $H_3PO_4$  sequential hydrolysis described in Heinemeier et al. 2010. Sequential dissolution (5  $CO_2$  fractions) was applied to 2 pieces of the same part.

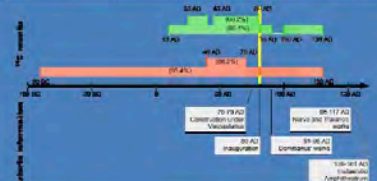
The second part (red) was crushed in order to isolate some lime lumps. These were sent to the the University of Salerno (Italy) where the lumps were dissolved in  $H_3PO_4$  according to the typical procedure for carbonates as described in Pesce et al. 2009.



## RESULTS



Preparation technique	$\delta^{13}C$ (‰)	Radiocarbon age (BP)	Calibrated age	Confidence level (partial data, %)	Confidence level (%)
Bulk mortar (no. 2, 5 $CO_2$ fractions each piece)	-	1940 ± 17	25 AD - 40 AD	15.4	68.2
			45 AD - 60 AD	54.6	95.4
			100 AD - 130 AD	8.9	
Lime lumps (no. 1, 1 $CO_2$ fraction)	-12.9 ± 0.5	1979 ± 45	40 BC - 70 AD	-	88.2
			90 BC - 130 AD	-	95.4



## DISCUSSION

- A detailed architectural and archaeological knowledge of both, building and sampling point allow a more precise evaluation of the radiocarbon results.
- Both results include the historically known construction time of the building (70-79 AD) within the confidence level 95.4%. However, only the result of the bulk mortars includes the construction time within the confidence level 68.2%.
- The bulk mortar samples show a narrower uncertainty, compared to the result obtained with the lime lumps technique. This is due to a combined calibration of 5 measured  $CO_2$  fractions from 2 samples that was not available for the lime lumps.

## CONCLUSIONS

Success of the radiocarbon dating of lime mortars, is based on a number of factors including the knowledge of the context in which the samples are collected and the laboratory procedure that follows the sampling work.

Different preparation techniques lead to similar radiocarbon ages (although with some differences).

Sequential dissolution of a few bulk mortar samples lead to similar radiocarbon ages as the total dissolution of a single lime lump. However, a combined calibration of five measurements lead to a narrower time span for the bulk mortar.

## ACKNOWLEDGMENTS

Authors are grateful to R. Rea and A. Dellino of the Soprintendenza Speciale per i Beni Archeologici di Roma for their supervision during sample collection. Authors are also grateful to the Aarhus AMS Centre of the Department of Physics and Astronomy, Aarhus University and to the Center for Dating and Diagnostics (CEDAD) of the University of Salerno for their help in the radiocarbon dating of mortar.

## CONTACT DETAILS

Rita Vecchiattini - Department of Sciences of Architecture, University of Genoa, Strada 33, Agostino, 07 10123, Genova, Italy, E: [rvecchiattini@unige.it](mailto:rvecchiattini@unige.it)  
 Alf Lindroos - Abo Akademi University, Donkylintorget 3, 20500 Åbo, Finland, E: [alf.lindroos@abo.fi](mailto:alf.lindroos@abo.fi)  
 Giovanni Luca Pesce - Department of Architecture and Built Environment, Northumbria University, Leazes Park, Newcastle upon Tyne NE1 8ST, United Kingdom, E: [Giovanni.Pesce@northumbria.ac.uk](mailto:Giovanni.Pesce@northumbria.ac.uk)  
 Jan Heinemeier - Abo Akademi University, Donkylintorget 3, 20500 Åbo, Finland, E: [jan.heinemeier@abo.fi](mailto:jan.heinemeier@abo.fi)  
 Lynne Lancaster - College of Arts and Sciences, Ohio University, 2518 U.S. Nat. Highway, USA, E: [lancaster@ohio.edu](mailto:lancaster@ohio.edu)  
 Heinemeier Jan - Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, building 1522, 8000 Aarhus C, Denmark, E: [jah@fyf.au.dk](mailto:jah@fyf.au.dk)

## BIBLIOGRAPHIC REFERENCES

- Heinemeier, J., Ringbom, A., Lindroos, A., Swerbjornsdottir, A. E., 2010. Successful AMS dating of non-hydraulic lime mortars from the medieval church of the Åland island, Finland. *Radiocarbon* 52 (1), 171-204.
- Pesce, G., Quarta, G., Calcagnile, L., D'Elia, M., Cavaciocchi, P., Lastrico, C., Guastella, R., 2009. Radiocarbon dating of lumps from aerial lime mortars and plasters: methodological issues and results from the S. Nicolo' di Capodimonte church (Cernusco, Genoa - Italy). *Radiocarbon* 51 (2), 367-372.

Lynne Lancasters poster över vår forskning kring Colosseum.





Sedan 1994 har projektet analyserat murbruk i olika delar av Europa:

Ytterligare kan här nämnas Jordanien, Turkiet, Danmark, Norge, Slovakien och Tyskland.

Murbruk baserade på kalksten, marmor, pozzolana och snäckskal.

Både i klassisk och medeltids arkeologi.



Mark van Strydonck, Bryssel, Royal Institute of Cultural Heritage, där han ledde.  
The *Radiocarbon Dating Laboratory*. En av de främsta internationella gestalterna inom metodutvecklingen. Vi träffades bl.a. vid en konferens 2009 på Hawaii. Följande år ordnade jag bl.a. en internationell konferens om vår forskning i Åbo och på Åland där Strydonck deltog. Därefter inbjöd han till en konferens på Mallorca.





Från konferensen i Mallorca: Mark van Strydonck och Jan Heinemeier, Som ni kanske märker har fysikern Heinemeier, Aarhus, vid sidan av Strydonck, varit våra främsta samarbetspartner och stöttepelare genom åren.







ÅR och John Hale,  
på randen av  
Vesuvius  
krater, där det  
pyrde och  
ångade.

Man undrar hur  
rinnande  
lava kan ha  
påverkat  
murbruks-  
dateringen av  
Pompeji och  
Herculaneum





Herculaneum, de underjordiska badinrättningarna bekräftar förekomsten av kontamination från vulkanutbrott. Alltför gamla dateringar.



2010 internationell murbrukskonferens i Åbo och på Åland  
Entusiastiska simmare på Kökar,

Jan Heinemeier

John Hale

Pia Sonck

Alf Lindroos

ÅR

Gregory Hodgins





- ▶ Konferens i Bordeaux, Jan Heinemeier, Gerard Barrett, Danuta Michalska, Irka Hajdas, Alf Lindroos





# 14C Archaeology conference, 2014, Ghent,



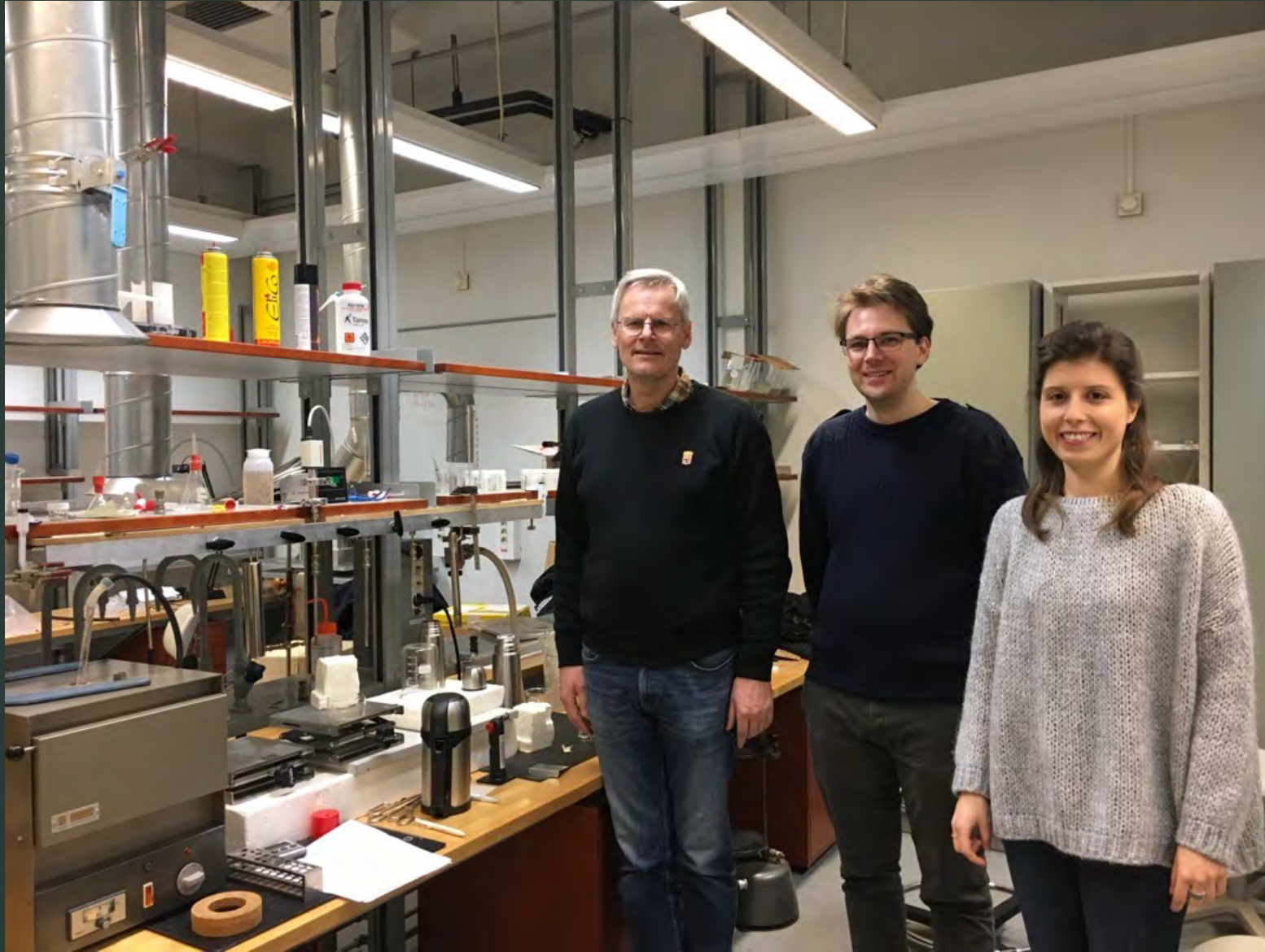


# Konferensmöte i Bartsgårda



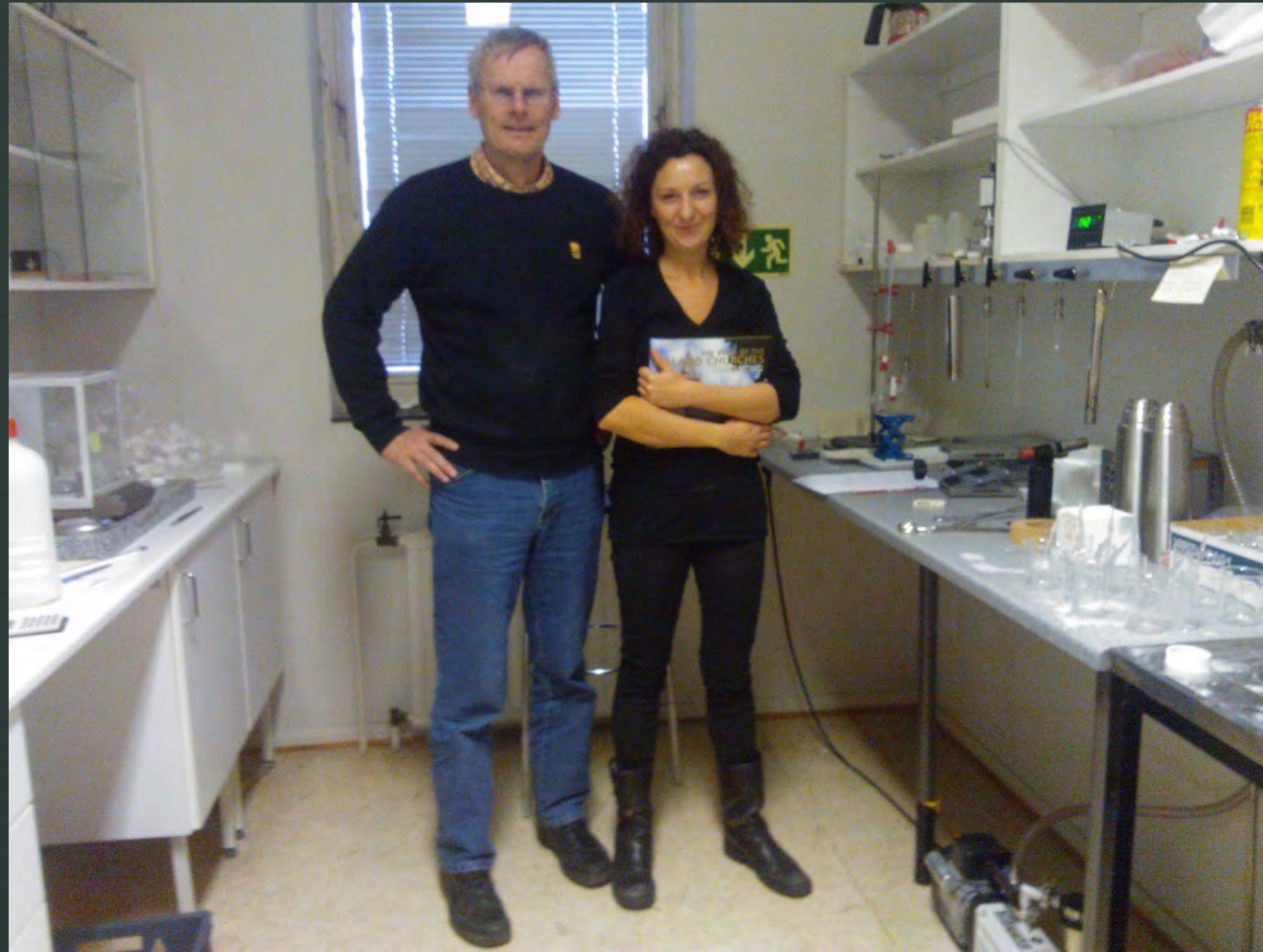


# Alf Lindroos lär ut murbruksdateringens grunder åt ➤ Thomas Daugbjerg (Århus) och Giulia Tirelli (Modena).





Alf Lindroos och Martha Caroselli, Modena, Italien, som också hon lärde sig murbruksdateringens grunder under några månaders vistelse i Åbo



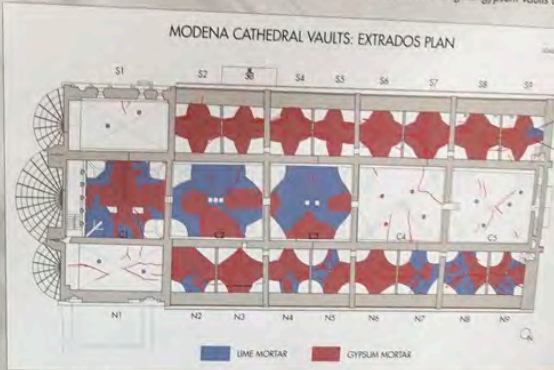


# Universitetet i Modena, med professor Stefano Lugli, är viktiga samarbetspartners i Italien. Martha Caroselli har kunnat utreda hela kronologin kring restaureringen efter brand i katedralen i Modena

The cathedral was built between the 12th and the 13th century, but the vaults were progressively added to the main framework during the 15th century. After the last damaging anti-seismic reinforcement project had the opportunity to investigate the building materials and clarify the chronology of the construction phases. The vaults were built using original lime vaults (fig.1).

Results of the research are:  
 - Original construction of the vaults  
 - Restoration portions built after the main earthquakes  
 - Main restoration works to the earthquake chronology in the historic catalogue (Rovida et al. 2011) (tab.1).

Episodio	PGA	Magnitudo
Modena	0.222	4.30
Appennino modenese	0.187	3.98
Bologna	0.055	3.57
Appennino Tosco-emiliano	0.025	3.80
Spillanforti	0.091	4.72
Modena	0.172	4.25
Modena	0.111	3.25
Bologna	0.028	3.78
Valle della Staffora	0.012	3.74
Modena	0.144	4.30
Liguria orientale	0.072	3.43



## RESULTS

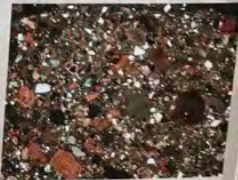
47 samples were collected from the vaults extrados: 25 samples of mortar (lime and gypsum) and 18 samples of bricks. We present the first results from the vault S9. The research is still ongoing.

## METHODS

**Petrographic characterization** of lime mortar was performed to determine the aggregate composition, the presence of underburned and unburned fragments and "lime lumps" (Elsen 2006). Image analysis of thin sections was also carried out to evaluate the aggregate/binder ratio and the aggregate grain size (Carò e Di Giulio 2004; Lugli et al. 2007).  
**Carbon dating using sequential dissolution** (Lindroos et al. 2018) and **optically stimulated luminescence** of the sand aggregate (Lindroos et al. 2018) were carried out for dating lime mortar.  
**Optically stimulated luminescence** for dating bricks.

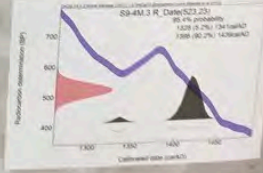
## RESULTS: PETROGRAPHIC ANALYSIS

Sample S9-4M is a lime-based mortar with underburned particles up to 3 mm in size. Lime lumps are scarce and small (< 1 mm). The aggregate/binder ratio is 2.2. The aggregate grain size is very fine to medium, poorly sorted. The sand composition is: micritic limestone and sparry calcite, quartz, calcite, siltstone, rare fossil fragments, ophiolite fragments, biotite, iron oxide and/or hydroxide. The provenance is probably from the Po river (fig.2).



## RESULTS: ABSOLUTE DATING

The results are listed in tab.2. The petrographic analysis revealed the presence of the carbonate sand and the unburned limestone fragments possibly yielding an OSL age older than expected. Nevertheless, the sequential dissolution has succeeded in providing a radiocarbon age of the bulk mortar (1328-1341 AD (5.2%) and 1396-1439 AD (90.2%)) in agreement with the expected age from the historic documents (1404-1433 AD, Baracchi 1988, fig.3). The OSL age is too old (1140 BC ± 720 and 960 AD ± 200) in comparison with the expected age (1404-1433 AD) and probably means that only few quartz grains were completely bleached. The mortar sand appears to be unsuitable for OSL dating. The TL analysis on bricks indicate that bricks manufactured in the 13th century were re-used in the lime and gypsum portion of the vault in the 15th century.

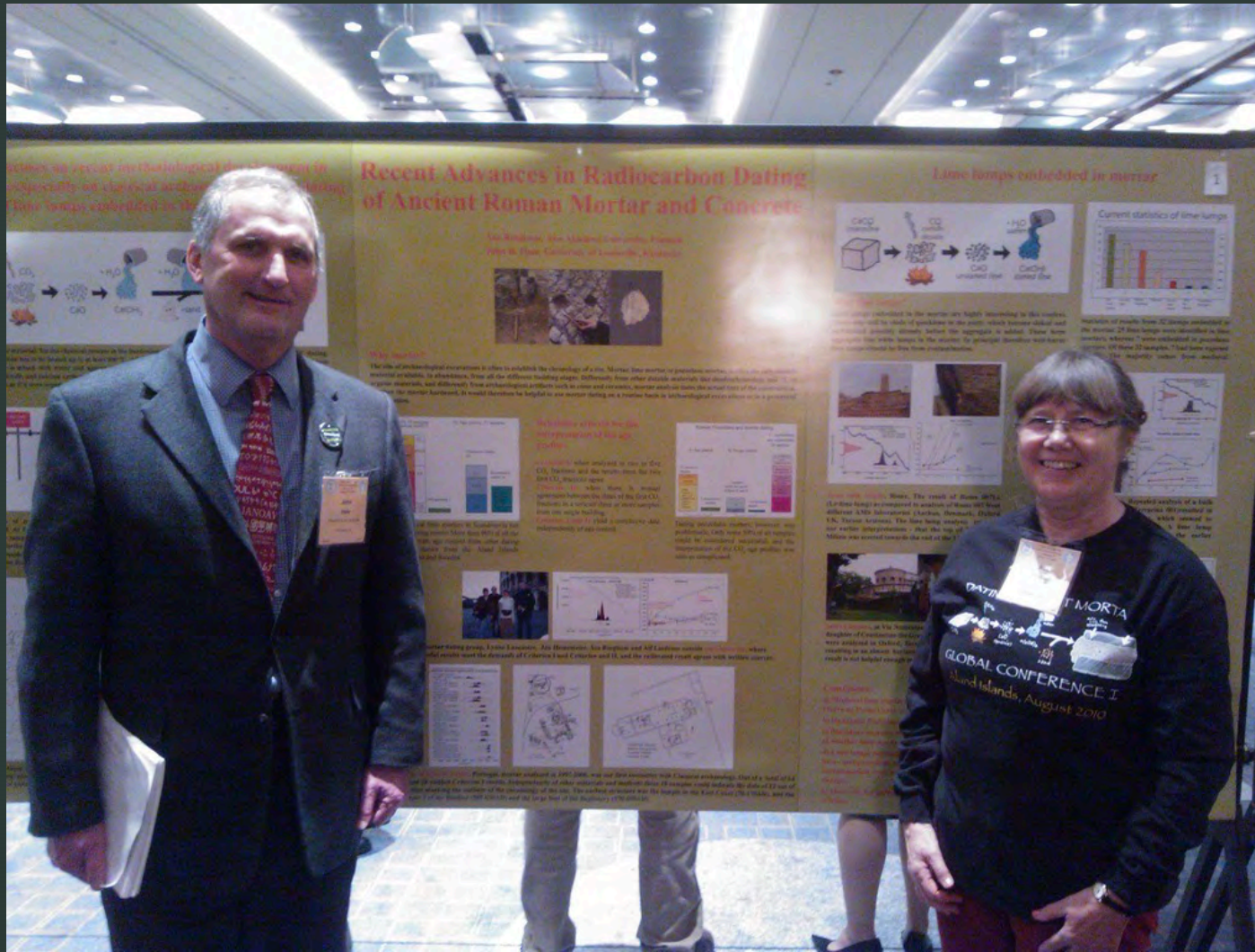


Sample	Location	Expected age	Absolute dating technique	Dates	Notes	Commentary
S9-12A	Brick		TL	1288 AD ± 80	90% V20 Brick A	
S9-12B	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12C	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12D	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12E	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12F	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12G	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12H	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12I	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12J	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12K	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12L	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12M	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12N	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12O	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12P	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12Q	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12R	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12S	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12T	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12U	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12V	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12W	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12X	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12Y	Brick		TL	1300 AD ± 80	90% V20 Brick A	
S9-12Z	Brick		TL	1300 AD ± 80	90% V20 Brick A	

**CONCLUSION**  
 Our data suggest that the vault S9 was originally built in 1404-1433 AD using lime mortar and older bricks (1245 AD ± 65), and was subsequently partially reconstructed with gypsum mortars and re-used bricks (1285 AD ± 80, 1250 AD ± 80). As gypsum mortar can not be directly dated, unfortunately, the re-use of older bricks do not allow to pinpoint the timing of the vault reconstruction and the possible triggering earthquake.

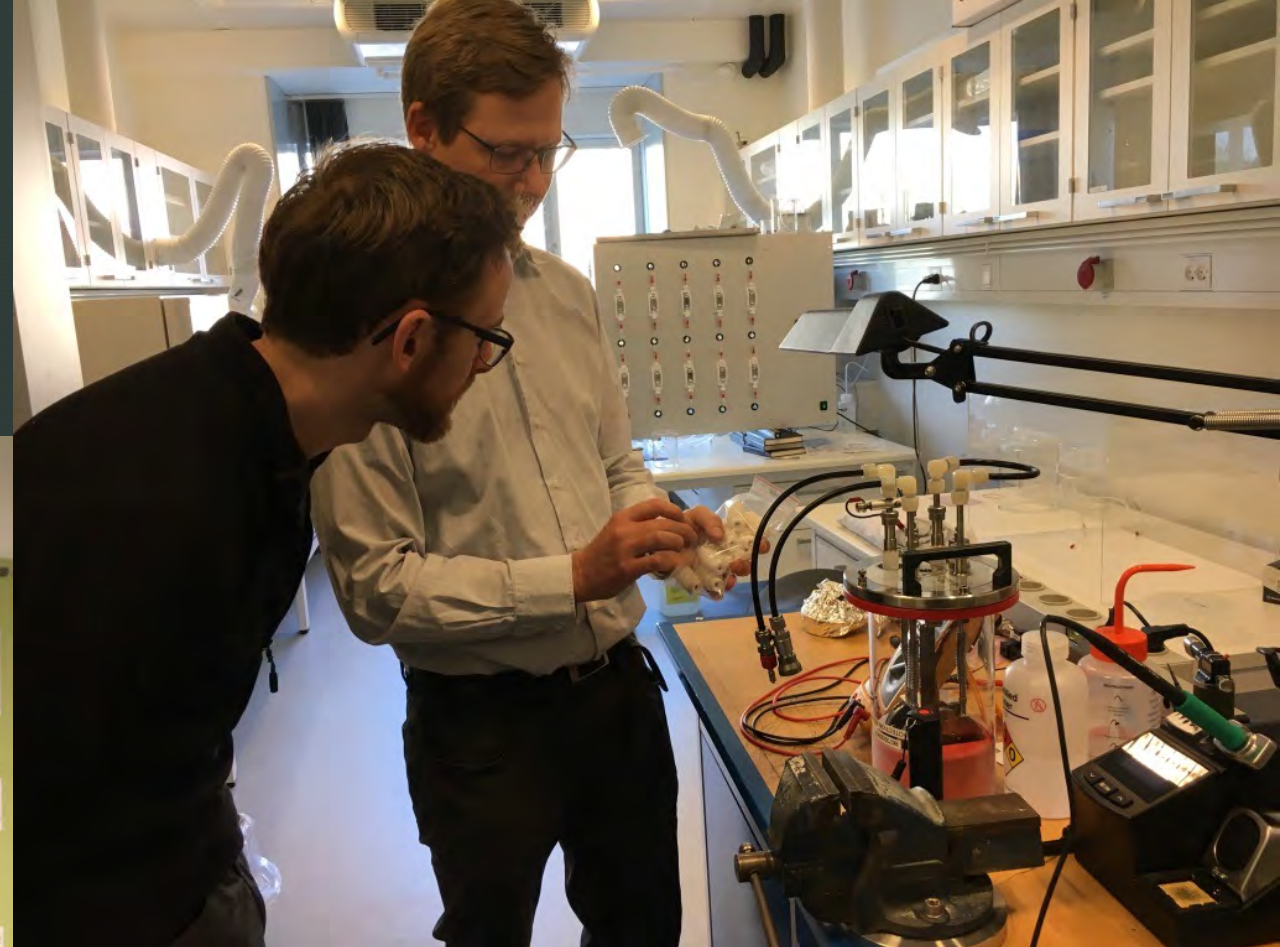


# John R. Hale och ÅR, vid American Institute of Archaeology konferens i Chicago 1997, där vi vann första pris...





# Möte i Aarhus, Samma poster som i Chicago



### WHEN DID THE MORTAR HARDEN?

A new method for dating buildings with other structures through AMS radiocarbon analysis.

This is an account of an interdisciplinary team in the process of developing the method of dating ancient mortar. If visible, such a method is a great step forward for studying the architecture and engineering of the Roman Empire and other ancient civilisations. For the first time buildings without diagnostic archaeological artefacts could be dated as isolated chunks of building debris. Such a method has been sought for over 30 years.

#### The method - Lime is the key

When hardening the mortar absorbs the carbon dioxide of the atmosphere (1). As mortar then contains a sample of atmospheric carbon, which can be subjected to radiocarbon dating, usually the ratio of  $^{14}\text{C}$  to normal carbon in plant and animal tissues reflect the roughly constant atmospheric concentration. But after an organism dies, radioactive decay reduces the original amount of  $^{14}\text{C}$  by half every 5,730 years. However, with mortar the presence of fossil carbon complicates the endeavor. Particles of unburned limestone (calcium carbonate) that survived the heating constitute one source of contamination. Recrystallization of calcium in the mortar causes another type of contamination.

#### Implementations and results

##### Step 1 - Testing the method against firmly dated structures in Medieval Åland.

The results from Trøen's Church and other buildings demonstrate the accuracy to detect the mortar's relative to other methods based on a separation system with known  $^{14}\text{C}$  fraction. The  $^{14}\text{C}$  data points from mortar radiocarbon dating correlate with archaeological dates.

##### Step 2 - Going international, testing other types of mortar and other chronologies, Roman mortars and pozzolana.

The method was used on finely dated structures in the Mediterranean and the territory of the Roman Empire. One big challenge was to see how the mortar samples were affected by the presence of lime. The ratio and amount of the carbonate cause a relative contamination which can be removed by the use of a separation system. The method was used on Roman mortars and pozzolana. The results show that the method is applicable to a wide range of mortars and pozzolana. The method was used on Roman mortars and pozzolana. The results show that the method is applicable to a wide range of mortars and pozzolana.

##### Step 3 - Profiles of mortar and successive $\text{CO}_2$ fractions.

Some studies on the preservation of the mortar, ancient Roman mortar in particular. The results show that the method is applicable to a wide range of mortars and pozzolana. The results show that the method is applicable to a wide range of mortars and pozzolana.

#### So far our project has demonstrated that:

- The method is applicable to a wide range of mortars and pozzolana.
- The method is applicable to a wide range of mortars and pozzolana.
- The method is applicable to a wide range of mortars and pozzolana.

#### Results from individual samples in Tiberis

Results from individual samples in Tiberis. The results show that the method is applicable to a wide range of mortars and pozzolana. The results show that the method is applicable to a wide range of mortars and pozzolana.



## Ny viktig kontakt med Gerard Barrett, från Chrono laboratoriet i Belfast



# Konferens i Mallorca 2012, arrangerad av Mark Van Strydonck.







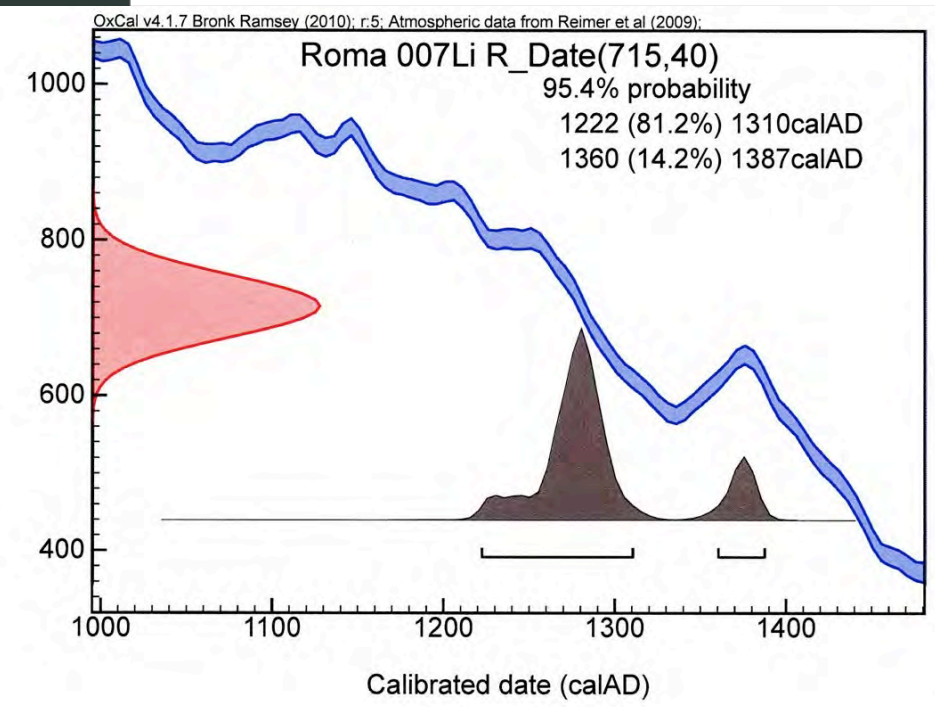
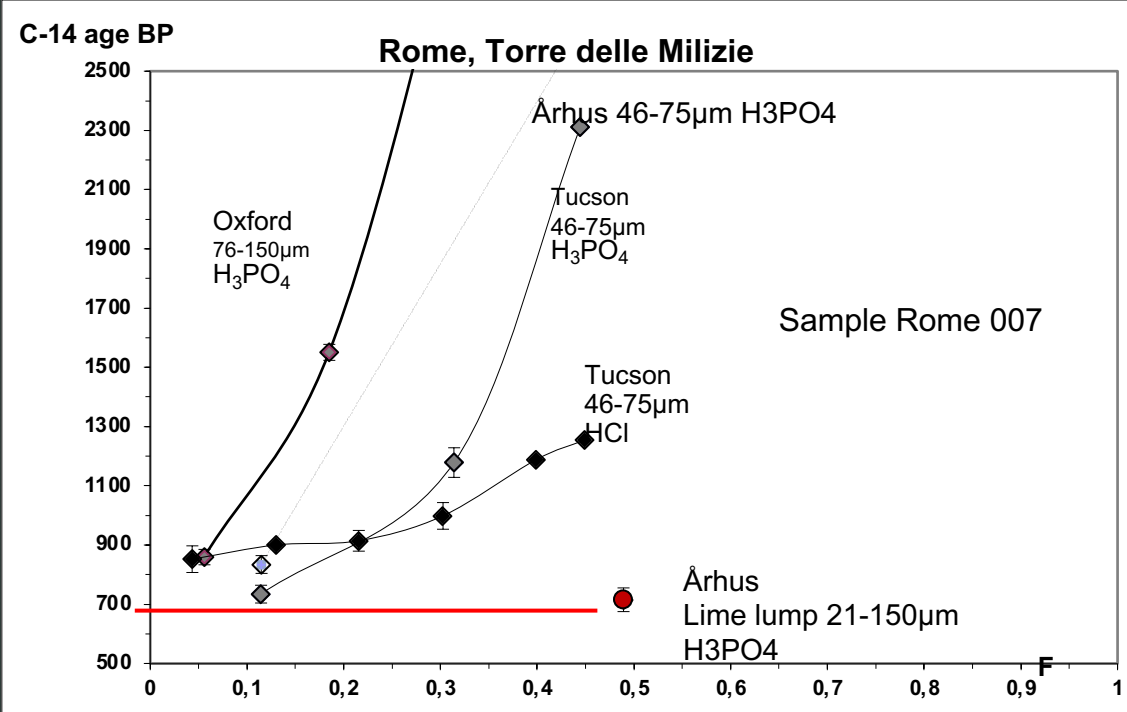


# Konferenz i Zürich 2022



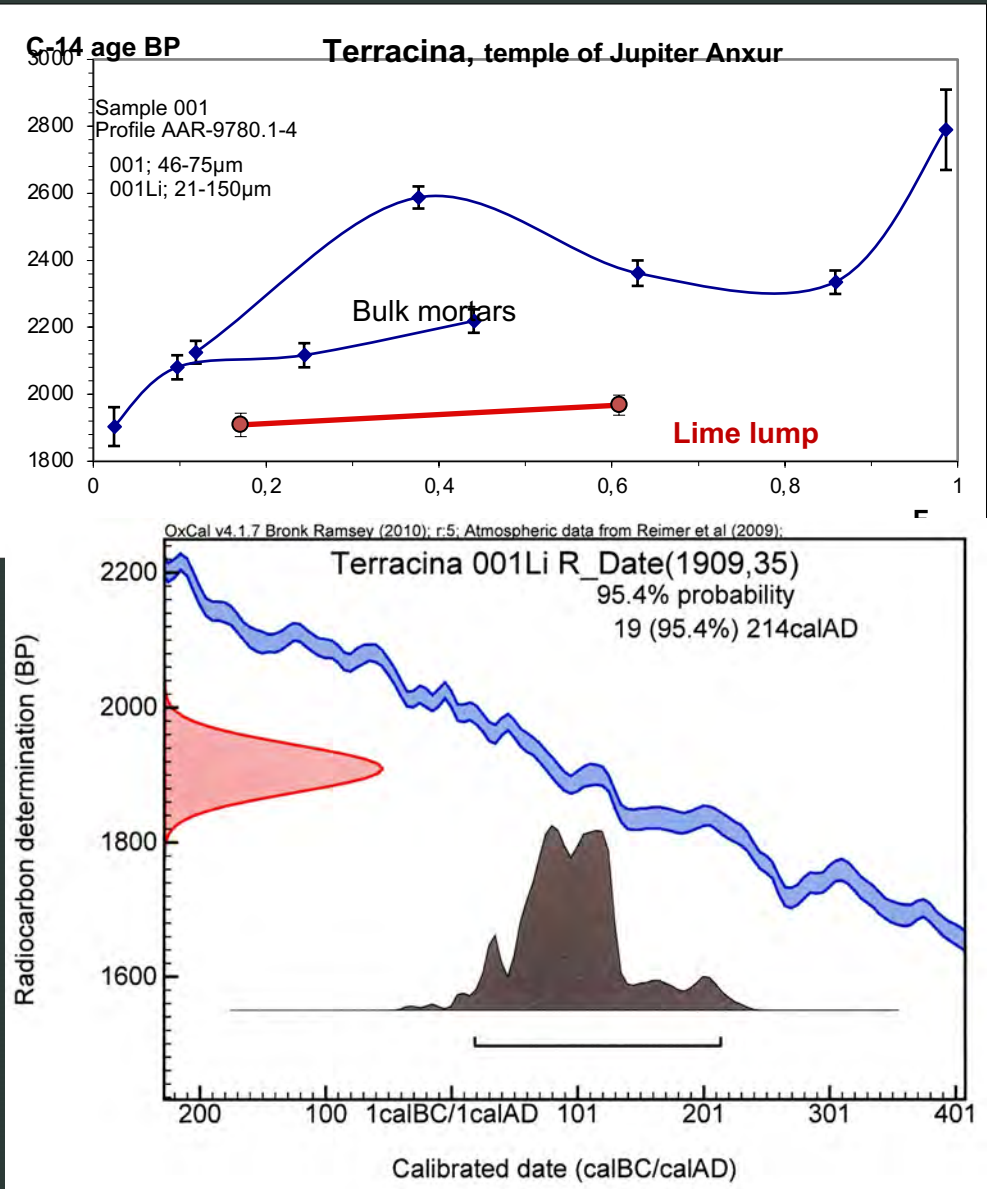


Torre delle Milizie, hör till de första proverna Lynne och jag tog i Rom. Notera att analys av kalkklumpar, i rött, bekräftar tidigare tolkning, baserad både  $H_3PO_4$  och HCl hydrolyys





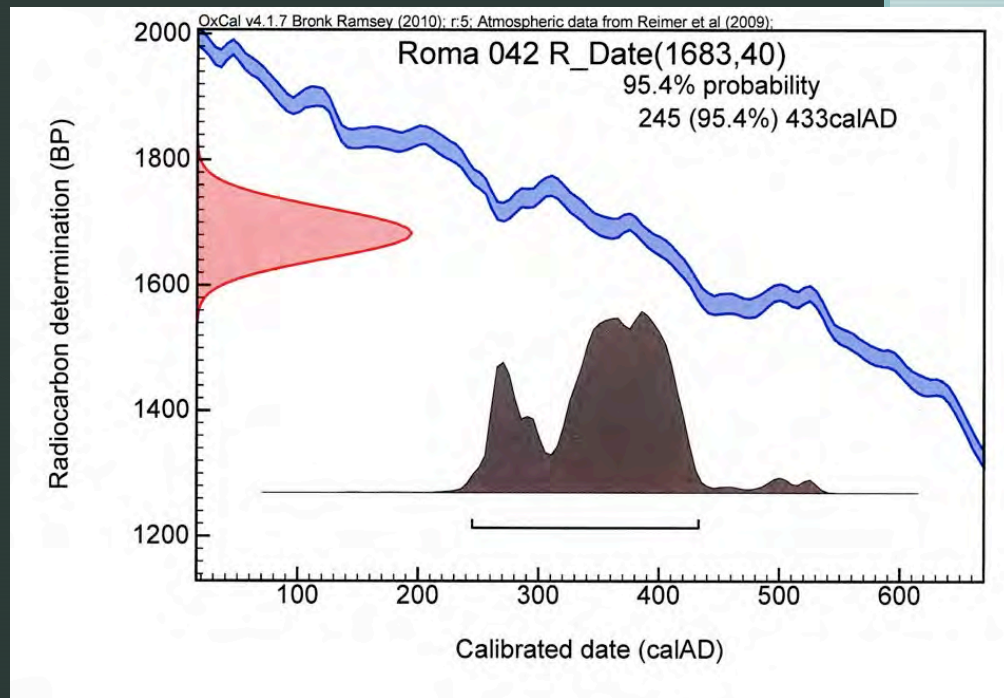
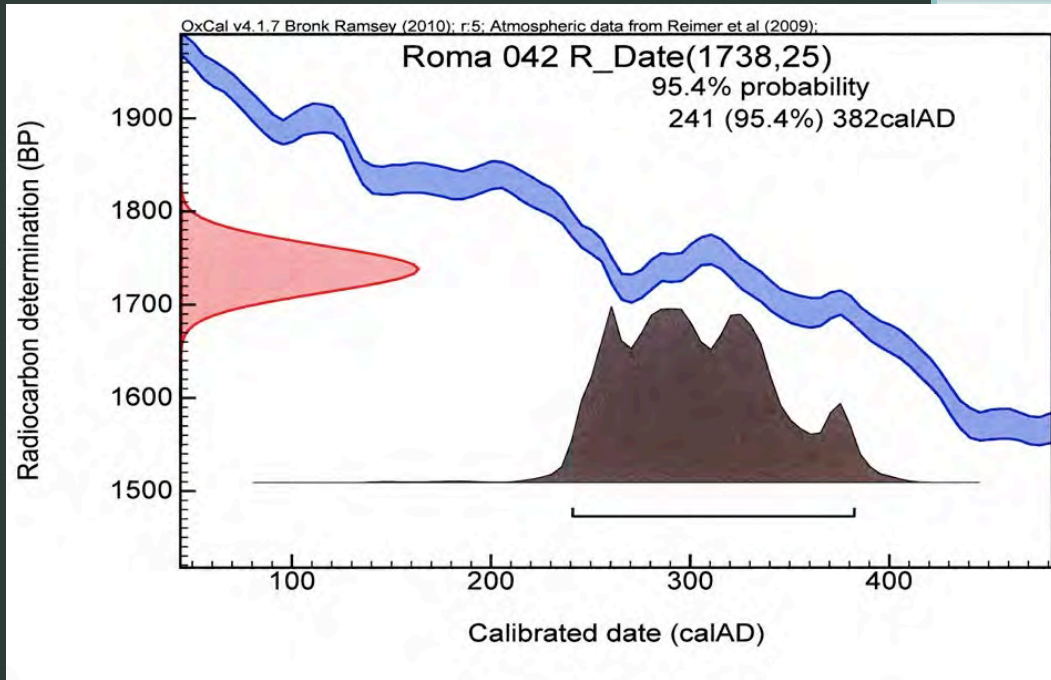
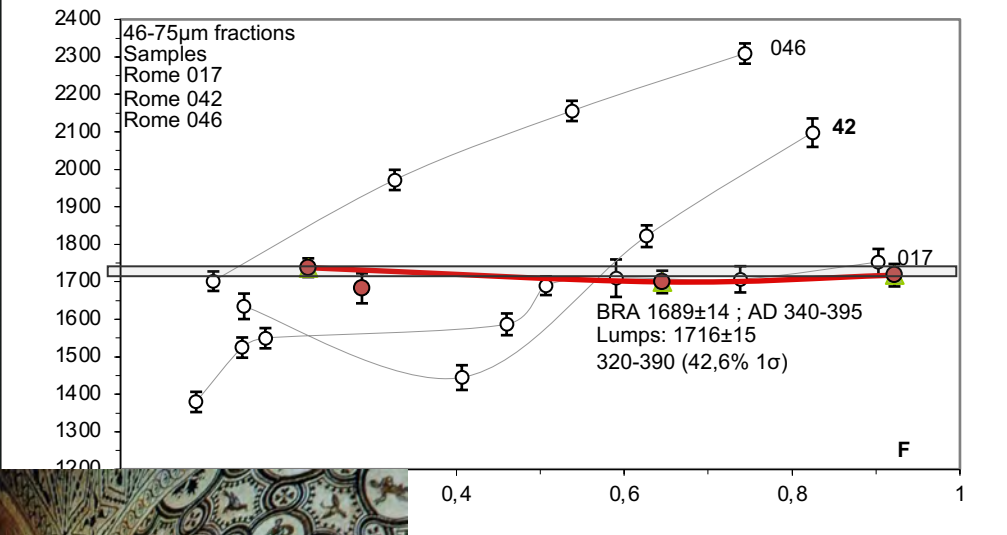
# Terracina, viktigt! Vi upptäcker potentialen i analys av kalkklumpar!





C-14 age BP

### Santa Costanza



Santa Costanza, Via Nomentana, Rom.  
Analys av kalkklumpar markerade i rött.  
Samma prover analyserade i sekvens och i hydrolysis,  
Ger ständigt samma svar,  
Costanza var dotter till Konstantin den Store, 300-tal!





Mortar gangsters i  
Bartsgårda 2006.  
Längst till vänster  
Fiona Broch från  
Daterings laboratoriet  
i Oxford, där chefen heter  
Christopher Ramsay,



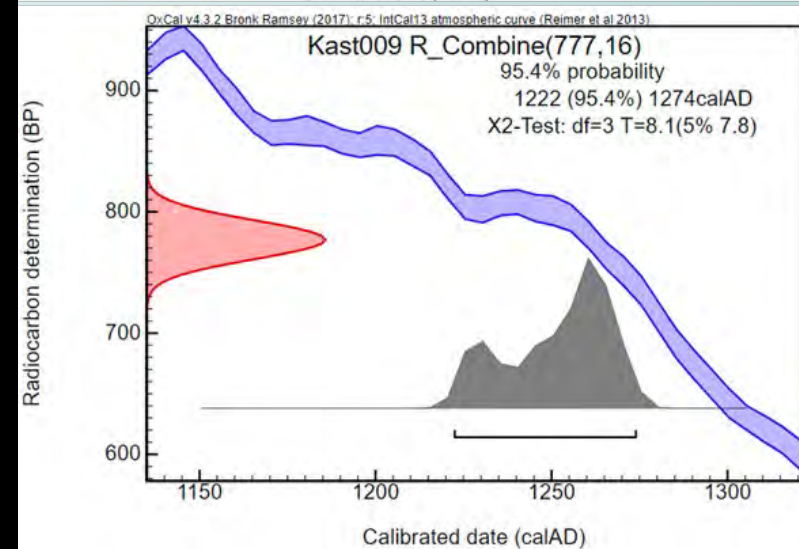
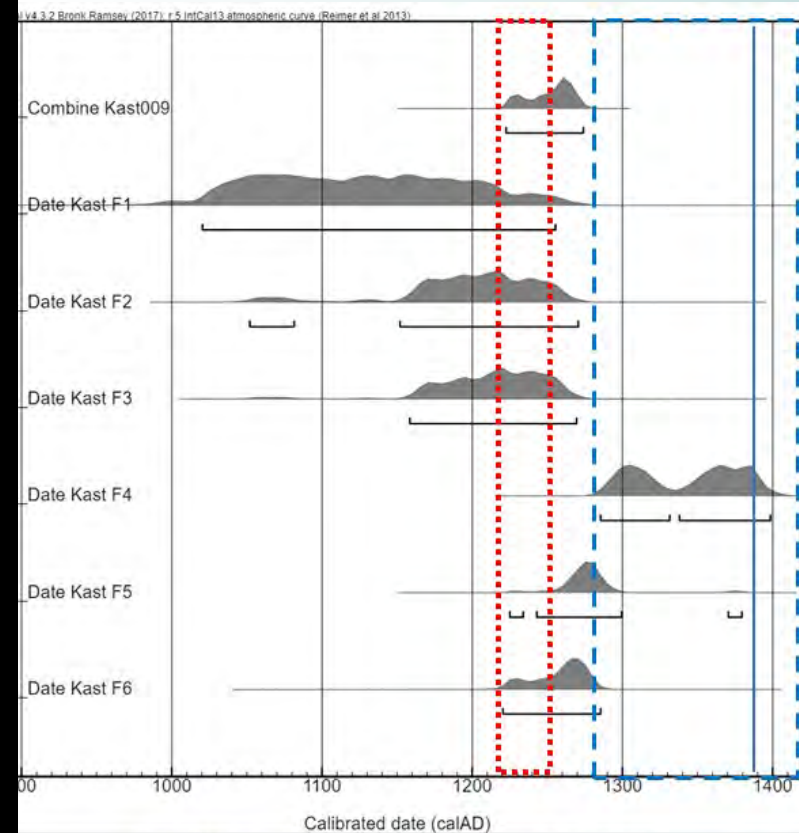


Efter de viktiga analysresultaten från kalkklumpar i Rom, beslöt vi oss för att också testa kalkklumpar inbäddade i medeltida murbruk från Finland. Med en sannolikhet på 95,4 % uppfördes Kastelholms slott någon gång mellan åren **1222 och 1274.**

Artikel om Kastelholm publicerad i *Journal of Archaeological Science*, Paula Reimers.

Tidigare forskning hävdar att Kastelholm uppfördes efter 1388, då det för första gången nämns i skriftliga källor. Graciela Ponce-Antón med i provtagningen, skolad vid Åbo Akademi.

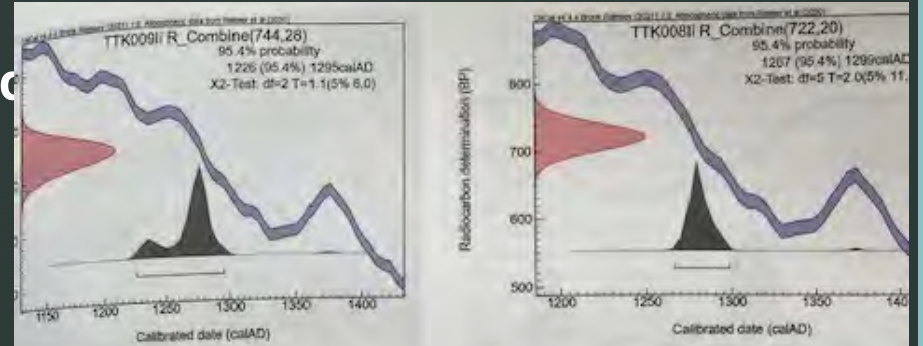
Observera att många prover, överensstämmer sinsemellan, vilket ökar tillförlitligheten



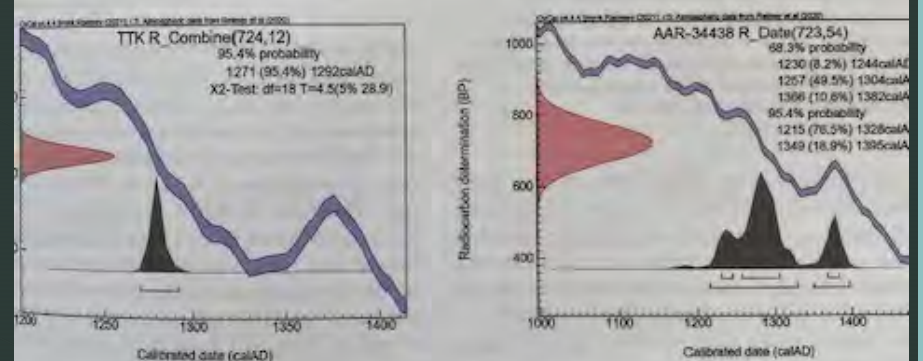
Vi testar kalkklumpar Kastelholm, Kuretornet, fönsternischen där murbruksproverna togs



# Ramped Pyrolysis Radiocarbon Dating of Lime Lumps : The earliest Mortar Construction phase of Turku Cathedral, Finland, 14 september 2022, Publicerat i Journal of Archeological Science, författare: Gerard Barrett, Evelyn Keaveney, Lindroos, Alf, Donnelly Colm, Schroeder-Daugbjerg, Thomas,, Åsa Ringbom,



preliminära resultat från murbrukdatering (RPO-metoden), tillämpad i Åbo domkyrkas sakristia, som utgör stenkyrkans äldsta skede.  
 preliminary calibrated results from the RPO-method implemented on limelumps embedded in the mortar, dating the earliest stage of the stone church.



ensam kalibrering av de preliminära resultaten från murbrukdatering av Åbo domkyrkas äldsta skede: Den första sakristian i sten. Vid en sannolikhet på 95,4 procent anges åldern 1271–1292 e.Kr.  
 individual calibration of the preliminary results from the RPO-method on mortar from the earliest building stage of Turku Cathedral, the first stone sacristy. A probability of 95,4 % yields the date range 1271–1292 AD.

147e. TTK 008W. En träflisa TTK 008W innesluten i mur från Åbo domkyrkas första stensakristia (TTK008) analyserades i januari 2022 vid dateringslaboratoriet i Århus (AAR:34438). Den bekräftar resultaten från murbruksanalys från samma sakristia. Efter kalibrering, vid en sannolikhet på 76,5 procent, anges åldern 1215–1328 e.Kr. vilket stämmer överens med dateringen av omgivande murbruksprov (TTK008Li).  
 A wooden splint (TTK 008W) analyzed in the Dating Laboratory in Aarhus in January 2022 (AAR:34438). The splint was embedded in one of the mortar samples from the sacristy, TTK008Li. As a result, the calibrated date range of the splint (1215–1328 AD) confirms the age of the surrounding mortar sample.

...tiden före den första stenkyrkan på platsen. Det senaste resultatet från <sup>14</sup>C-analys av obrända ben från den första sakristian, från det så kallade "under skeletter", påträffat i januari 2022 vid dateringslaboratoriet i Århus (AAR:34438). Den bekräftar resultaten från murbruksanalys från samma sakristia. Efter kalibrering, vid en sannolikhet på 76,5 procent, anges åldern 1215–1328 e.Kr. vilket stämmer överens med dateringen av omgivande murbruksprov (TTK008Li).  
 ...the time before the first stone church on the site. The latest result from the <sup>14</sup>C analysis of unburnt bones from the first stone sacristy, from the so-called "under skeletons", found in January 2022 at the Dating Laboratory in Aarhus (AAR:34438). It confirms the results from the mortar analysis from the same sacristy. After calibration, with a probability of 76,5 %, the age of the splint (1215–1328 AD) confirms the age of the surrounding mortar sample.