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

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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 cavea, 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 altered its original structures and finishes, in particular at ground level.

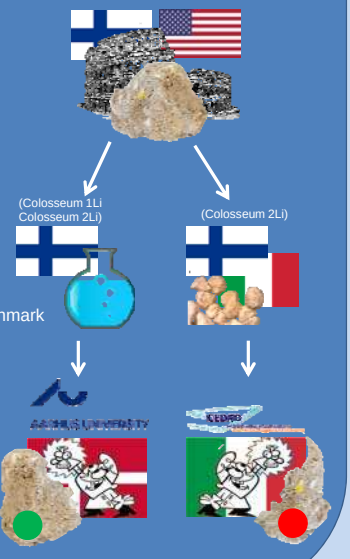
SAMPLING AND SAMPLES

Sampling work was carried out in 2001 as a part of the Åbo 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 Århus 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 Salento (Italy) where the lumps were dissolved in H_3PO_4 according to the typical procedure for carbonates as described in Pesce et al. 2009.

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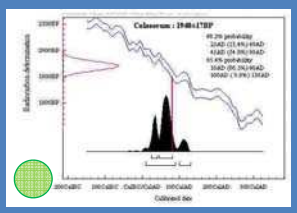
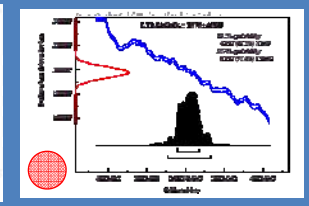
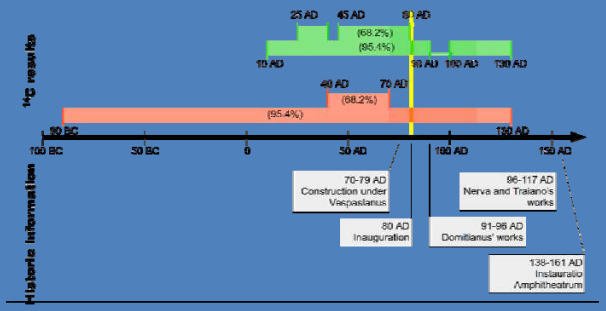
RESULTS





Preparation technique	$\delta^{13}C$ (‰)	Radiocarbon age (BP)	Calibrated age	Confidence level (partial data; %)	Confidence level (%)
Bulk mortar (n=2; 5 CO_2 fraction each piece)	-	1940±17	25 AD – 40 AD	13.4	68.2
			45 AD – 80 AD	54.8	
			10 AD – 90 AD	86.5	95.4
			100 AD - 130 AD	8.9	
Lime lumps (n=1; 1 CO_2 fraction)	-12.9±0.5	1979±45	40 BC – 70AD	-	68.2
			90 BC – 130 AD	-	95.4



DISCUSSION

- A detailed architectonic 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.

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