PalC

Pre-screening of anthropogenic lime carbonates for ^{14}C dating

DURATION
15/12/2020-15/03/2023

BUDGET
174.300 €

PROJECT DESCRIPTION

Mortars, or more generally anthropogenic lime carbonates, have been used for many centuries to build elements of architecture. The oldest known use of mortar dates from the Neolithic period. The production process of lime mortars consists of heating geological limestone (CaCO3) to produce quicklime (CaO) which is then blended with water to form slaked quicklime (Ca(OH)2) and mixed with aggregates (sand) to create the mortar. The hardening is due to a carbonation reaction: atmospheric CO2 is incorporated to the mortar and gives rise to the formation of calcium carbonate (CaCO3), then called anthropogenic lime carbonates. This carbonation process theoretically allows radiocarbon dating of the mortars since the quantity of 14C absorbed is relative the 14C quantity in atmosphere at a certain time. Radiocarbon dating of homogeneous mortars, which have fully carbonated and don't contain any geogenic carbonates (such as unburnt fragments of the geological limestone), calcareous impurities coming from the aggregates (carbonate grains such as shells) or secondary carbonate formation, can be reliable and gives often good agreements with historical dates. However, more often mortars are very heterogeneous and the radiocarbon dates obtained don't correspond to the expectations. The current procedure used for CO2 extraction before dating is generally based on stepwise acid hydrolysis. It is assumed that the different carbonate sources dissolve at different rates although empirically this assumption seems not always valid.

The main objective of PALc is to verify the reliability of the radiocarbon dating of anthropogenic lime carbonates by developing a pre-screening method. The research project will help understanding the sample compositions and how it is related to the obtention of a reliable 14C date.

The methodological approach of PALc consists of a meticulous process starting from the sampling to the precise description of the samples using multiple analytical techniques to the radiocarbon dating. To achieve this goal, a careful characterisation of the samples will be linked to the way that radiocarbon results match the presumed historical dates or the 14C date obtained on organic materials present inside the mortar (charcoal, plant fibres, animal hair). The analytical methods that will be used are complementary for obtaining a wide range of parameters characteristic of each samples. They consist of petrographic analyses using polarized transmitted light, Infrared and Raman spectroscopies, thermogravimetric analyses, cathodoluminescence and if necessary scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy. A wide variety of samples will be processed to obtain a range of parameters suitable for pre-screening any type of samples in the final protocol. They will be composed of diverse types of lime binders (air-hardening and hydraulic), aggregates and admixtures and will present a diversity of physical properties and different states of conservation. Their provenances and ages will also be diverse (from ancient Rome to Middle Ages in Belgium, Italy, France and Turkey). The characterisation protocol will be set up to determine if a sample is suitable for dating or not using the stepwise acid hydrolysis. This pre-screening protocol will be implemented to be the most concise and rapid by selecting the more appropriate tools and parameters determinant for a successful dating of the samples.

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Eventually, this protocol will result in cost and time saving for radiocarbon dating. The development of a pre-screening technique to identify mortars suitable for radiocarbon dating will be beneficial for both heritage scientists and archaeologists or art historians since 14C analyses will only be performed on potentially datable mortars providing therefore more confidence in the obtained results. On another level, improving accuracy of 14C dating of lime-based mortars and renders found in monuments and archaeological remains will contribute to the cultural and touristic valorisation of these historic sites.

The results of the project will be shared with the scientific community at conferences and in the literature. They will also be very significant in term of future capacities and skills at KIK/IRPA for the monuments and the radiocarbon laboratories. It will allow them to be more efficient with higher quality results.

CONTACT INFORMATION

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