^{14}C dating of fire damaged mortars from medieval Finland

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What is a ^{14}C profile of a mortar?

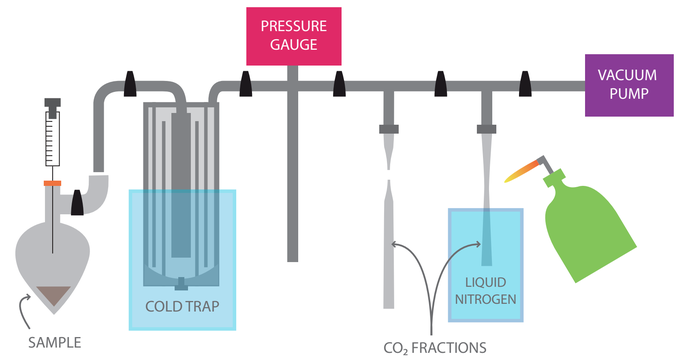

Figure 1. CO_2 line for extracting CO_2 fractions during acid hydrolysis. Usually five fractions per sample are dated to form a ^{14}C profile.

What does a reliable ^{14}C profile look like (85% H_3PO_4)?

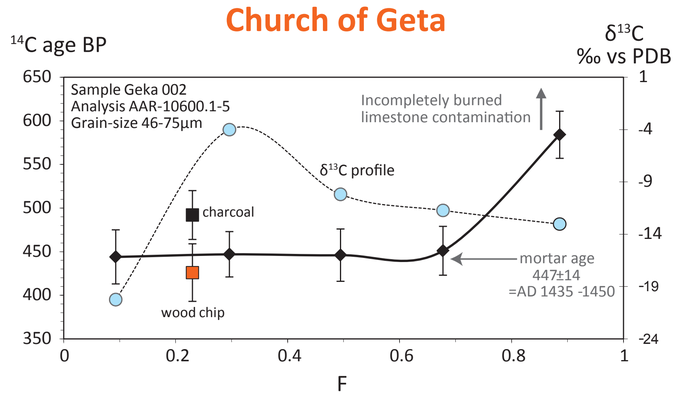

Figure 2. A reliable mortar dating profile with age control from enclosed wood chip and charcoal.

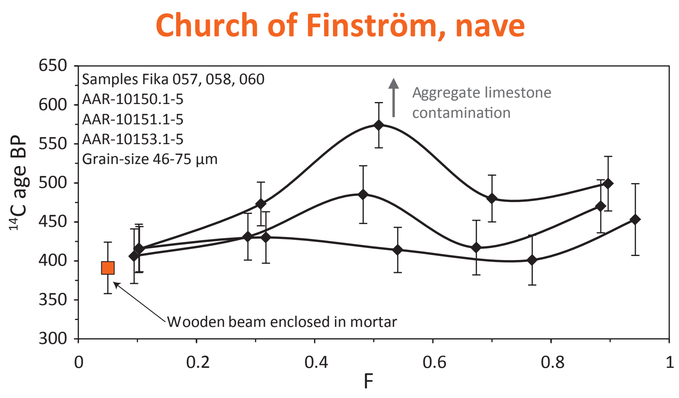

Figure 3. Reliable mortar dating profiles with "bumps" indicating limestone contamination

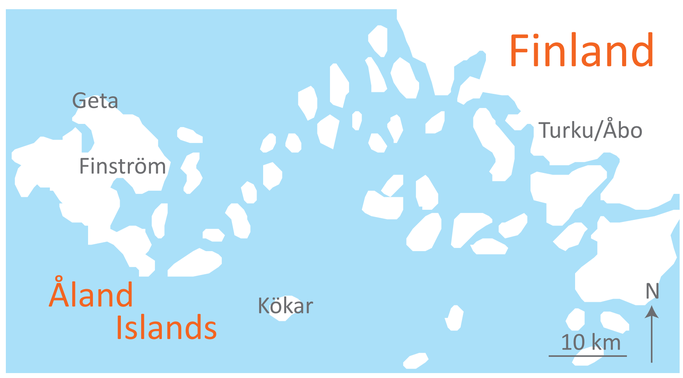

Figure 4. Map of SW Finland.

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What kind of temperatures cause decarbonization?

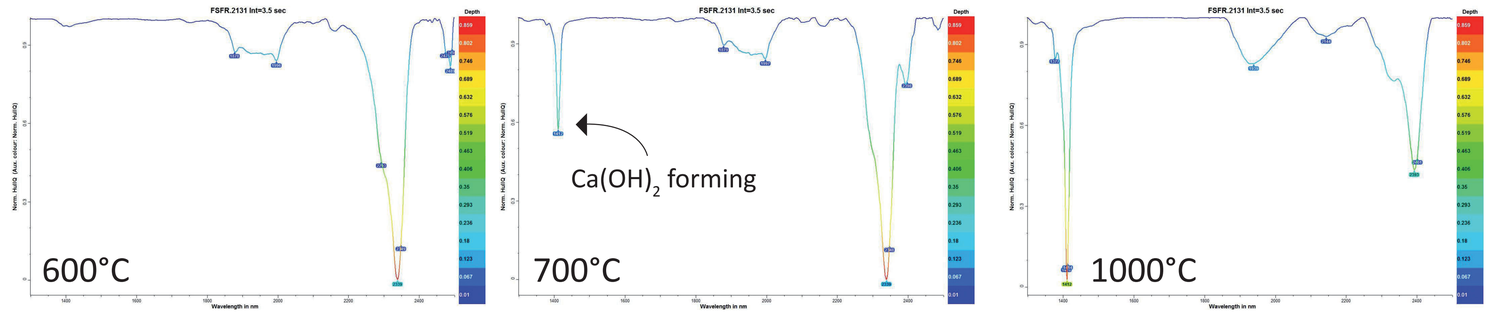

Figure 5. IR reflexion profiles showing that the transformation of $CaCO_3$ to $Ca(OH)_2$ starts between 600 and 700°C. Measured from powders with an ASD TerraSpec Portable Mineral/Soil Spectrometer.

What does a ^{14}C profile from a fire damaged mortar look like?

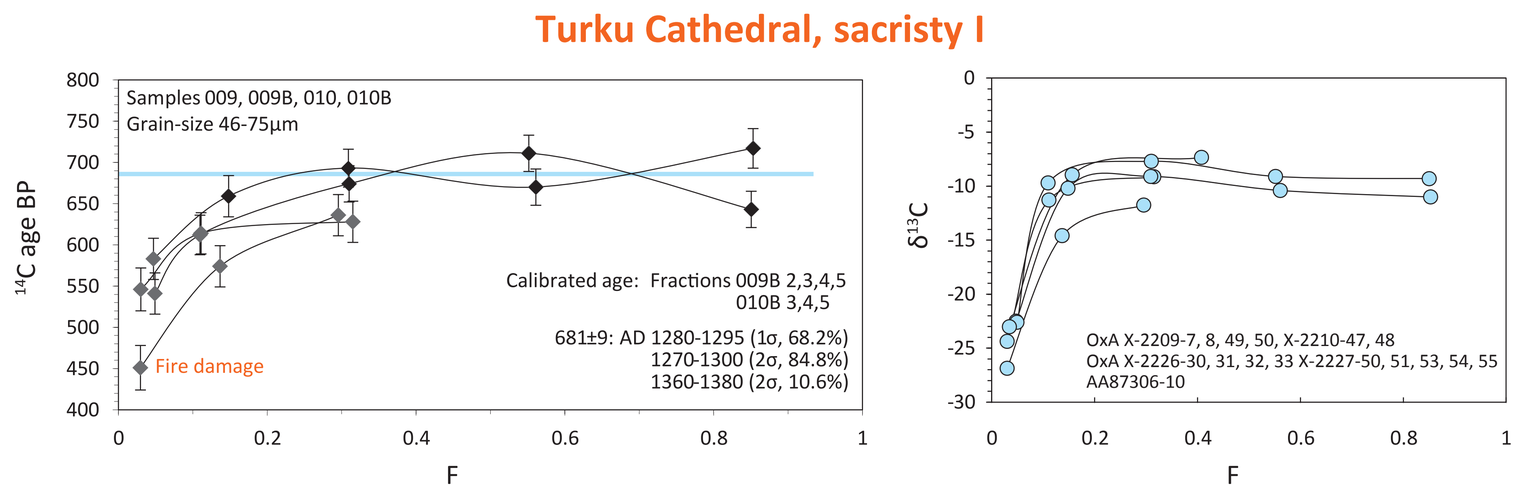

Figure 6. Mortars from the oldest part of Turku Cathedral that have burned >16 times. A) ^{14}C profile. B) δ^{13}C profile. The most easily soluble carbonate is younger than the bulk. Is it formed after the fire? It has very low delta values.

Is this a fire damaged mortar?

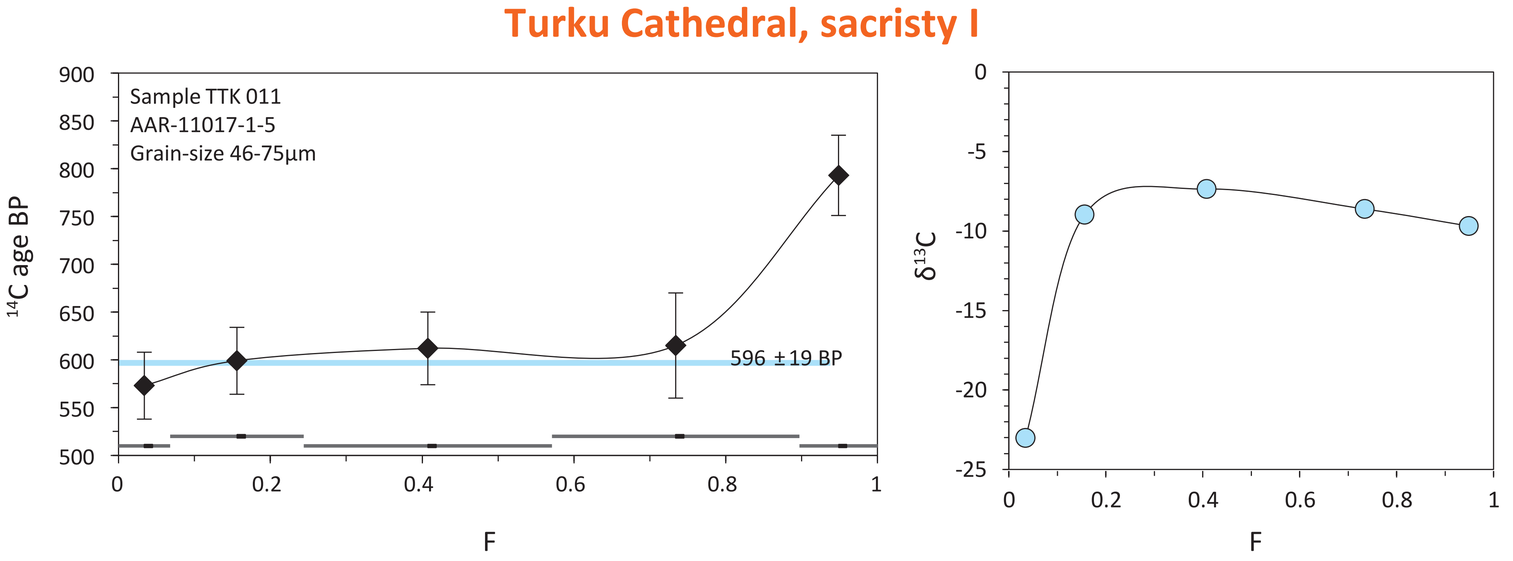

Figure 7. A slightly younger mortar than those in Fig. 6, but still from the same building unit. A) ^{14}C profile. B) δ^{13}C profile.

Probably yes! The Novgorodians burned the cathedral in 1318 and it was rebuilt. There is probably a later fire damage since the δ^{13}C value is -23 for the first CO_2 fraction.

Do fire damaged mortars need another kind of hydrolysis?

Yes, we think so. In our preliminary experiments we have results indicating that diluted HCl dissolves most contaminants before the binder carbonate is exhausted.

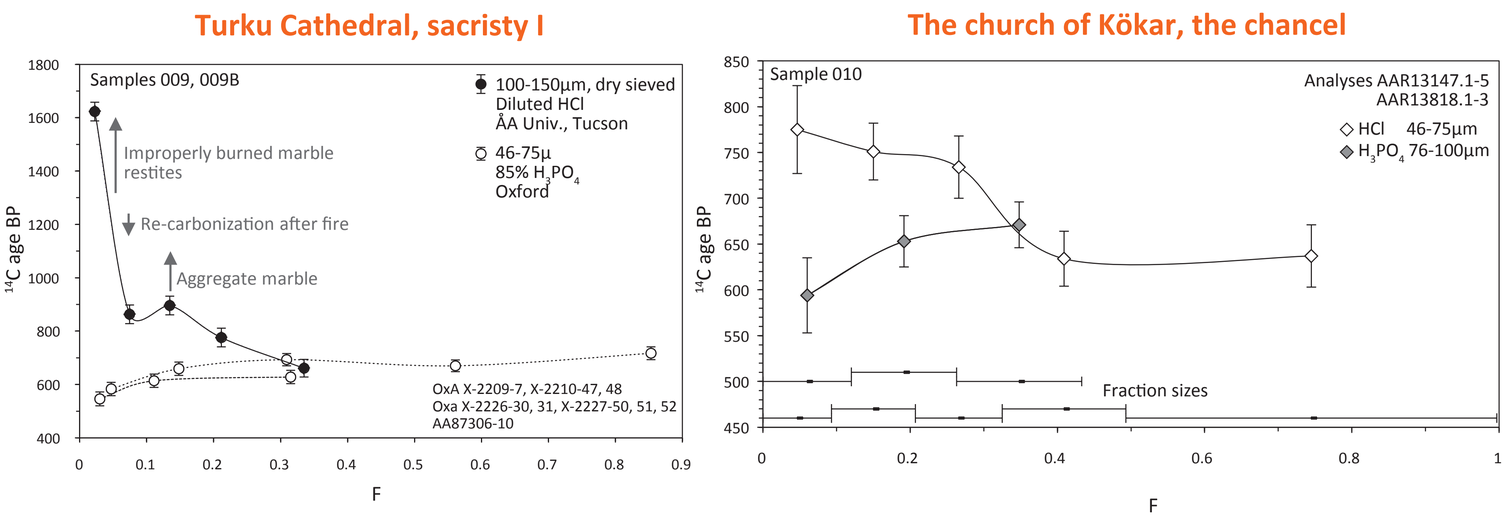

Figure 8. ^{14}C profiles produced by using H_3PO_4 and diluted HCl hydroslysis. The profiles converge at the correct ^{14}C age around 30-40% dissolution. A) Turku Cathedral. B) The church of Kökar, Åland Islands (no documented fire).