Unravelling the mystery: FTIR-ATR and inelastic neutron scattering (INS) spectroscopies applied to the analysis of burned human skeletal remains

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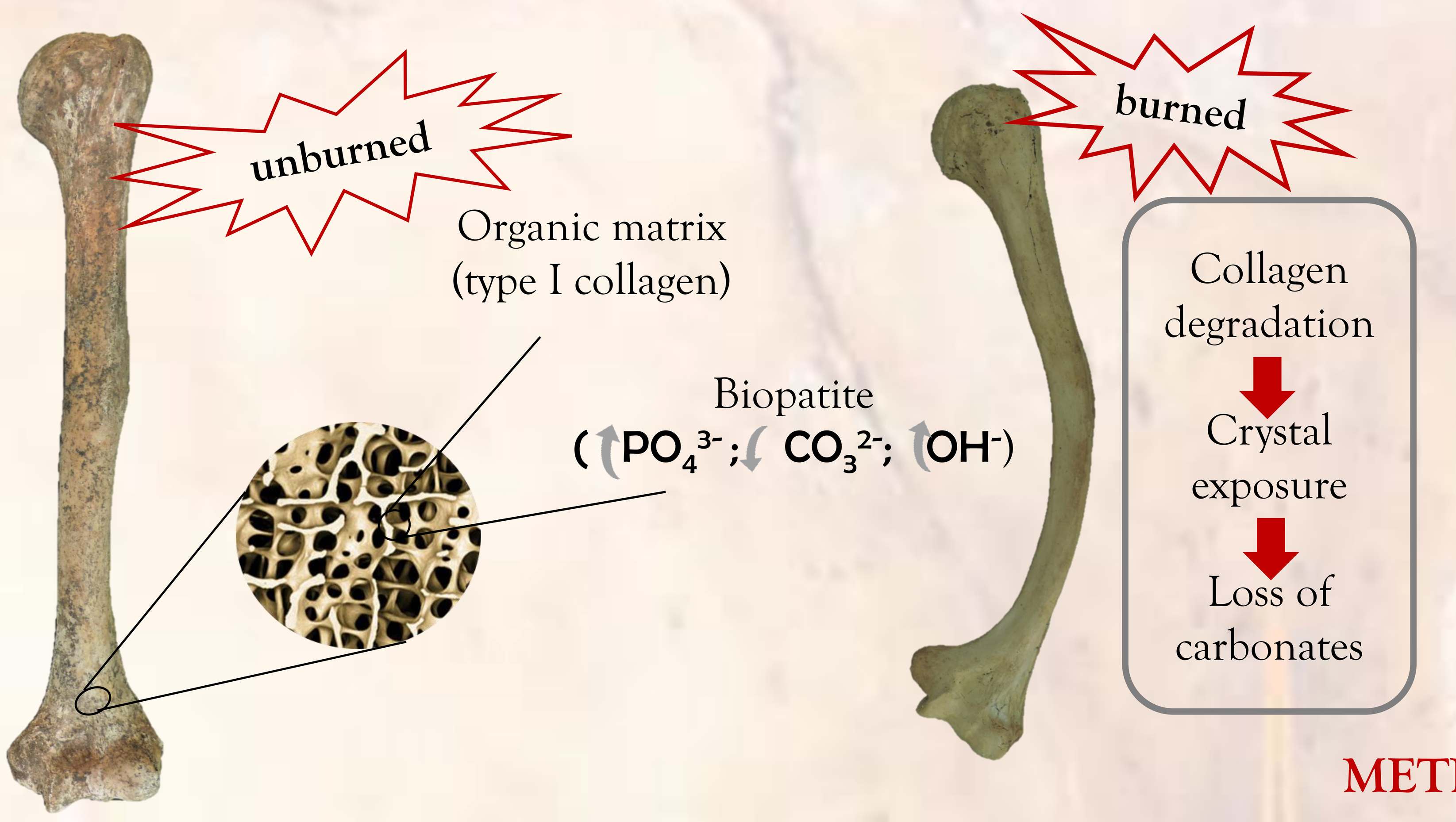
INTRODUCTION

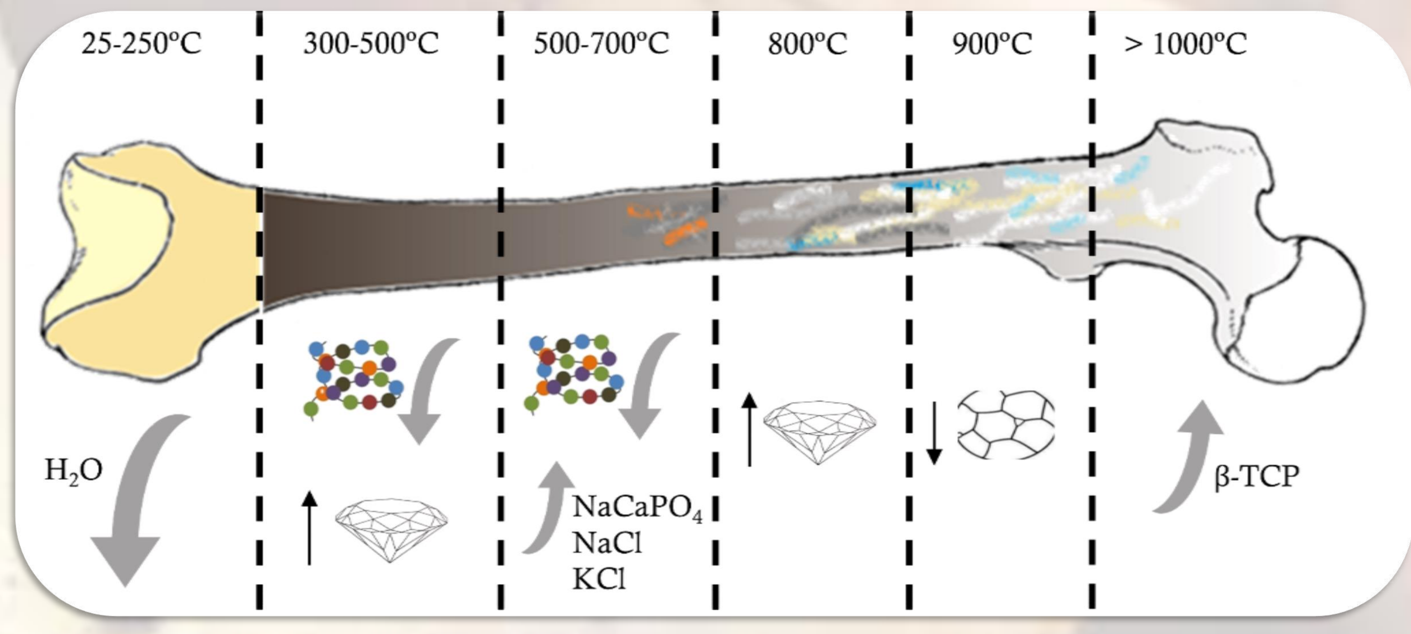
Burned human skeletal remains can be found in forensic (terrorist attacks, fires, attempts to conceal the corpse in case of homicides) or archaeological contexts (funerary practices of past populations).



The problem here is that heat causes numerous changes in bones and teeth that complicate bioanthropological analyses.

Vibrational spectroscopy techniques have been shown to be very useful for understanding and quantifying heat-induced changes in bone´s composition and structure.

In the present work, FTIR-ATR and INS spectroscopies were applied in order to identify markers that will hopefully allow to relate heat-induced bone diagenesis to the pre-burned conditions of the remains.



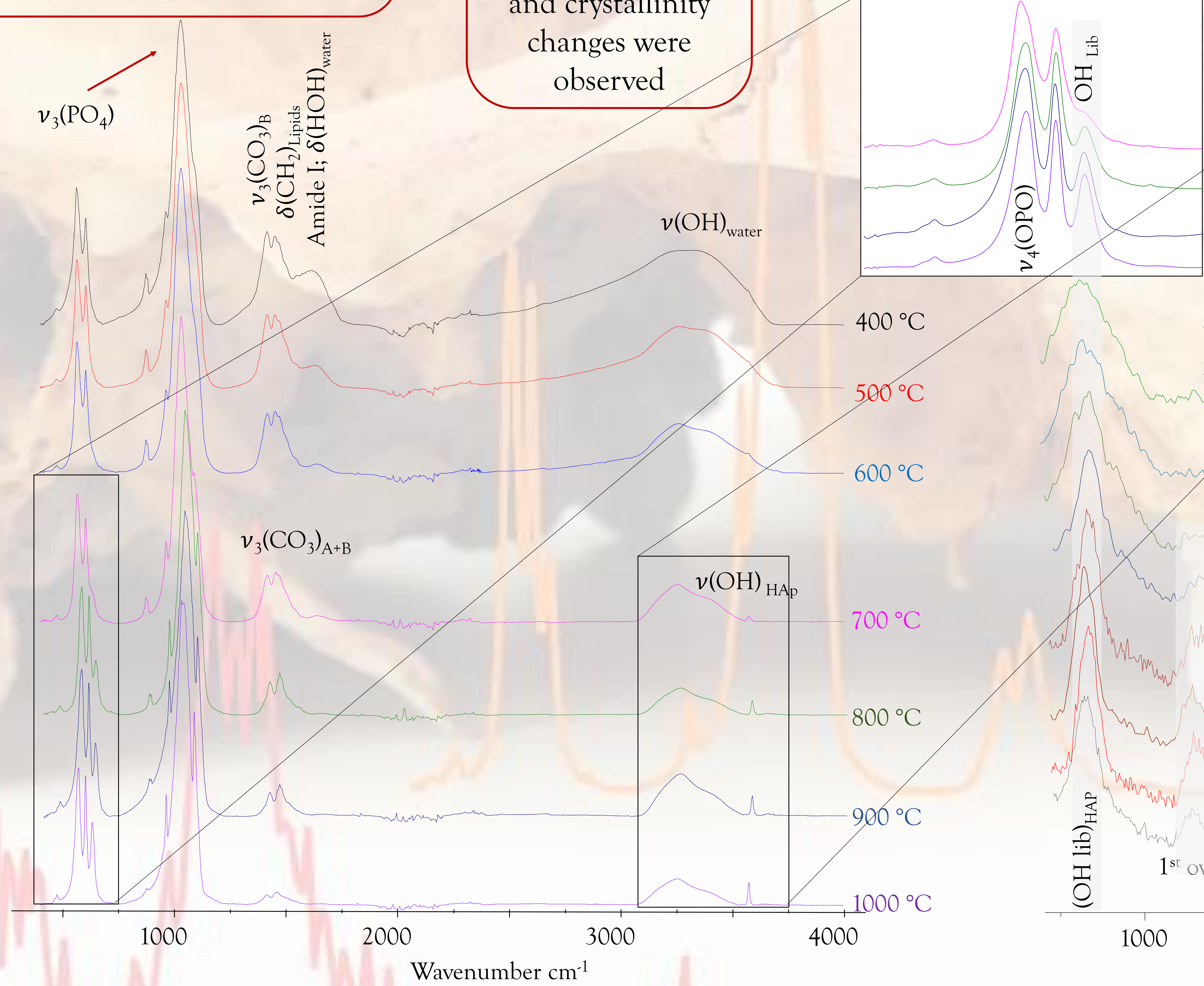
METHODOLOGY

7 sections from the diaphysis of a femur was sectioned and burned under controlled conditions in an electric oven: 400, 500, 600, 700, 800, 900 and 1000 °C, for 120 minutes, at a heating rate of 6 – 10 °C/min.

RESULTS & DISCUSSION

The combined application of the optical and neutron spectroscopic techniques allowed access to the whole vibrational profile of the burned human bone samples.

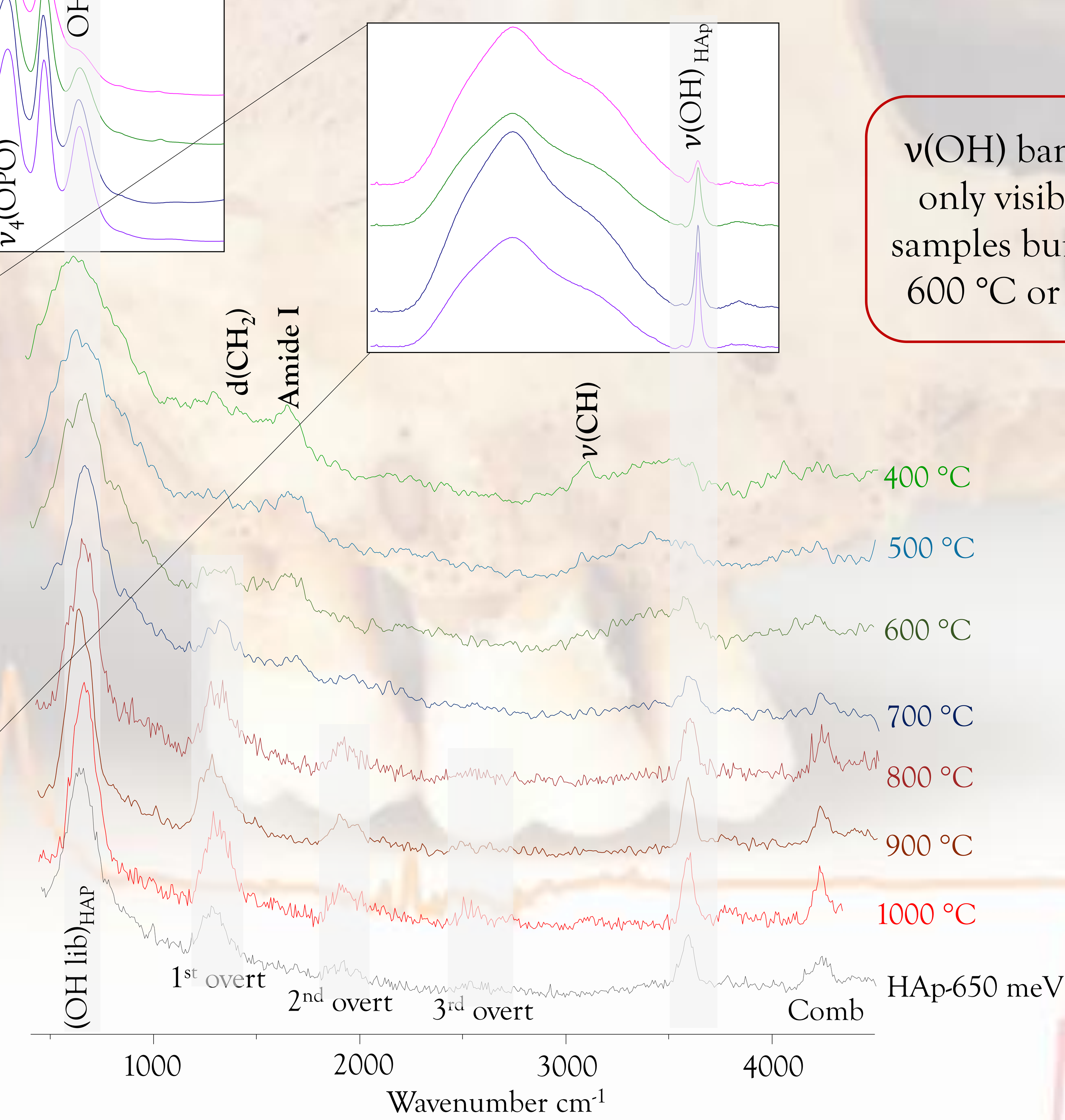
As the temperature increase, there is a progressive loss of carbonate content and crystallinity changes were observed



FTIR-ATR spectra of human femur burned from 400 to 1000 ºC.

> 700 ºC both OH libration and stretching signals of hydroxyapatite are visible

ν(OH) band was only visible for samples burned at 600 °C or above



INS spectra (measured in MAPS) of human femurs burned at different temperatures (400 to 1000 ºC). The spectra were recorded with 5240 cm^{-1} incident energy. The spectrum of reference calcium hydroxyapatite (HAp, SRM2910b from NIST) is also shown for comparison.

CONCLUSIONS

The good quality INS data currently obtained allowed us to validate the information retrieved from the FTIR spectra.

The knowledge presently gathered, coupled to the macroscopic information obtained from bone analysis (before and after burning), is expected to lead to a quantitative correlation between the bone's crystalline structure and heat-induced changes.

As mentioned, this approach will have a high impact in both archaeological and forensic sciences.

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