DFG Forschergruppe 1670

Transalpine Mobilität und Kulturtransfer

ARCHAEOBIOCENTER LMU

LMU SAPM Staatssammlung für Anthropologie und Paläoanatomie München

TRANSALPINE MOBILITY AND CULTURE TRANSFER. II.

Research Unit of the German Science Foundation (FOR 1670)

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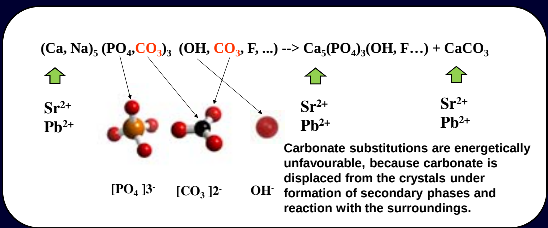
1 Mineralogical characterization of the research substrate

Archaeological skeletal material differs from native bone and teeth because of biological, chemical and physical deterioration (diagenesis, e.g. Berna et al. 2004). High temperature alteration prior to burial is a special feature of cremations which will also have its effect on diagenetic processes. In general, the biological apatite is thermodynamically unstable. An in-depth mineralogical characterization accompanying isotopic analyses is therefore indispensible.

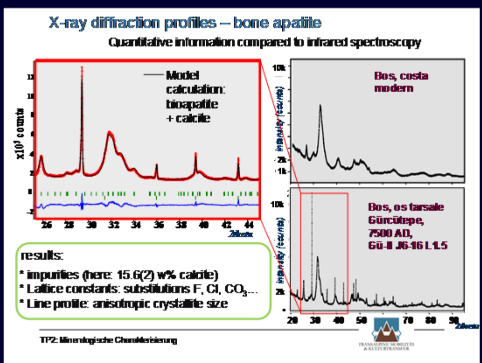


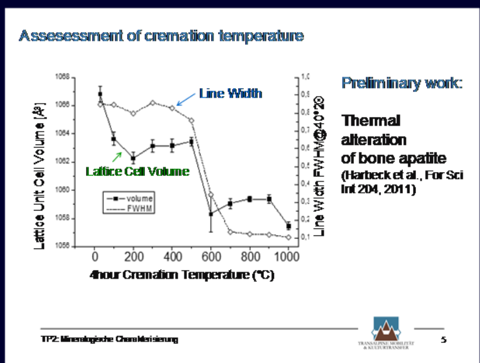
2 Establishment of a catalogue of criteria for the validation of isotopic ratios in the mineral phase of cremated and uncremated skeletal finds

While routine methods for the characterization of the integrity of biomolecules have long since been established, no such methods or criteria commonly agreed upon are available for the assessment of the integrity of the mineral phase of archaeological skeletons, whether cremated or not. Several markers have been suggested such as the splitting factor (SF) and crystallinity index (CI) (e.g. Hedges 2002, Lebon et al. 2008), but have also been questioned for good reasons (e.g. Pucéat et al. 2004, Trueman et al. 2008).

The establishment of a catalogue of criteria for the validation of isotopic ratios measured in bone and tooth mineral is therefore urgently needed and constitutes the major goal of subproject 02. Bioarchaeological and synthetic references will be investigated by a variety of mineralogical and crystallographical methods. Mineralogical alterations through cremation will be calibrated by analogue experiments.

3 Preliminary results

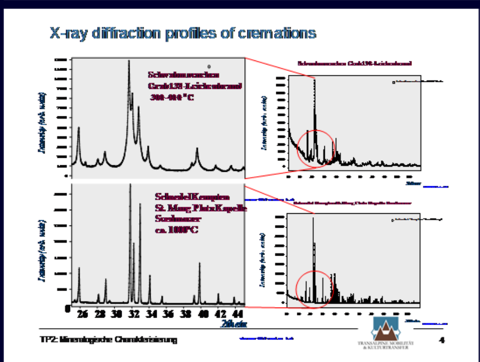




Experimentally cremated bone

Change in the crystal lattice unit cell volume as well as dependence of the line width (full width at half maximum) on cremation temperature. Note that crystal changes are already evident at 100°C.

Postulated solid state reactions generating pyrophosphates and β-tricalciumphosphates were not observed by us (see also Shipman et al. 1984).



The term „crystallinity“ is only poorly defined by the CI since the line width is both a function of the crystal size and lattice microstrains resulting e.g. from internal defects, variable chemical compositions, and external parameters such as the composite bone structure involving collagen. Both cremation and diagenesis lead to a continuous variation in line width in our experiments. A crystallographic investigation beyond the classical parameters such as SF and CI is indispensable. With regard to the structural state of bioapatite (lattice constants, anisotropic line widths, differentiation between crystal size and microstrain), the detection of secondary authigenic minerals, and both the bulk and the microchemistry of skeletal finds, an extensive mineralogical characterization of the research substrate is necessary.

Methods applied in the course of the project are X-ray diffraction with quantitative profile analysis infrared spectrometry, X-ray fluorescence accompanied by polarized microscopy, Fourier Transform Infrared Spectrometry, and electron beam analysis.

4 Systematic experimental work currently performed

includes the assessment of crystallographic parameters of the bioapatit with a focus on regularly detectable secondary phases,
and the assessment of the effects of pyrothermal alterations by the establishment of realistic time/temperature profiles with regard to prehistoric cremation practices, variation of oxygen fugacity, experimental cremation of bones of different mammalian taxa, and of bones with different biomechanical properties with regard to mineral/collagen/pore space parameters.
Results will be correlated with isotopic ratios, time of thermal exposure, diagenetic features, and soil parameters.

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