Diagenetic screening of bone samples; tools to aid taphonomic and archaeometric investigations

Summary

Chapter one Outline and Scope of this thesis, gives a brief account of the aims and scopes of the study. Chapter two General Introduction, gives an overview of the topic of study for the LeCHE research training network: dairy farming – its effects in the past and the present, and how we can study this. The last part of this chapter describes the role of the current project within the network and gives a short overview of bone diagenesis and the issues under study.

In Chapter three What happened here? Bone histology as a tool in decoding the post-mortem histories of archaeological bone from Castricum, the Netherlands, a case-study is presented involving histological analyses of bone samples from the Roman period site of Castricum in the Netherlands. The study demonstrated the relationship between diagenetic alterations observed at histological scale, and known taphonomic events and fluctuations in the burial environment. This supports previous work concluding that histology could be applied in reconstructing taphonomic histories, important both for understanding site formation processes and for assessing suitability of skeletal material for biomolecular and biochemical analyses.

Chapter four Testing an alternative high-throughput tool for investigating bone diagenesis: FTIR in attenuated total reflection (ATR) mode, reports the testing of a type of Fourier transform infrared spectrometry (FTIR) not widely applied in archaeology: FTIR with an attenuated total reflection unit (FTIR-ATR). The study compares the results of analyses on the same material, both modern and archaeological, using the more commonly applied FTIR-method, and FTIR-ATR. The results suggest that FTIR-ATR is the preferred method as the same data can be obtained in a faster, simpler manner, involving less methodological issues.

Chapter five Are teeth better? A histological investigation of diagenesis in a set of archaeological bone-tooth pairs and the implications for sample selection in biomolecular studies, describes the histological and biomolecular preservation of bone-tooth pairs from a multi-period cemetery in Eindhoven, the Netherlands. Since a common assumption is that dental tissues preserve better in the archaeological record than bone, the objective was to investigate the differences/similarities in diagenetic alterations of femur and tooth from the same individual. The results show that, in general, the same processes that occur in bone occur in teeth, but, the teeth are overall better preserved. However, this seems to vary with type of burial environment. The study furthermore shows that bone preservation at histological scale can function as proxy for the preservation of teeth and the biomolecules they contain (collagen and DNA).

Chapter six Recipe for success? Testing a simple multi-proxy screening approach for genetic assay of archaeological skeletal material, describes the development of a simple, multi-proxy screening protocol involving histology, FTIR-ATR and bone UV autofluorescence. This protocol has then been applied to a large set of samples also designated for ancient DNA analyses. The relationship between the parameters obtained by the screening protocol, and DNA recovery rate, quality and quantity was investigated. A range of interesting observations were made. Notably, the assemblage analysed displayed no correlation between bioerosion and DNA recovery rate whereas non-biological decay processes seemed to be of greater importance both for recovery rate and DNA quality. A fluorescence index based on the extent of ‘fresh’ UV auto-fluorescence was found to be an efficient screening method.

Chapter seven Death, decay, discovery – and then what? Investigating potential post-excavation effects on the preservation of bone and biomolecules, details a study aimed to improve understanding of post-excavation effects on archaeological skeletal material. This is an important but little addressed issue in archaeology and cultural heritage management. The histological, chemical and molecular level of preservation of four cattle bone assemblages from the same location (medieval city centre of York) from different burial environments and excavation campaigns (30 years ago and recently) was described and compared. No alterations could be ascribed to post-excavation effects, but it was demonstrated that the combination of analytical techniques applied detected subtle differences in preservation caused by variable environmental conditions. Hence, this type of approach could be used to further investigate post-excavation effects in other assemblages and contexts.

Chapter eight Histological atlas of dental diagenesis, includes an atlas with micrographs illustrating a
range of diagenetic phenomena observed in a set of archaeological teeth, including biological, physical and chemical decay of dentine, cementum and enamel.

Chapter nine *Synthesis*, provides a short synthesis of the thesis, summarizing the main questions and conclusions.