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Impact of the Burial Environment on Archaeological Bone Preservation. The Example of the Neolithic Lacustrine Sites 19 and 21 of Chalain, France

Ina Reiche (ina.reiche@culture.gouv.fr)[1], **Alix Peaudecerf** (alix.peaudecerf@obs.ujf-grenoble.fr)[2], **Colette Vignaud** (colette.vignaud@culture.gouv.fr)[1], **Michel Menu** (michel.menu@culture.gouv.fr)[1] & **Laurent Charlet** (laurent.charlet@obs.ujf-grenoble.fr)[2]

[1] Centre de Recherche et de Restauration des Musées de France, CNRS-UMR 171, 6 rue des Pyramides, F-75041 PARIS Cedex 01, France
[2] University of Grenoble, L.G.I.T., BP 53, F-38041 Grenoble cedex 9, France

For archaeological purposes as dating or determination of ancient diets and climatic conditions, it is important to evaluate bone preservation as these objects are often the unique witnesses of ancient populations. Lacustrine archaeological sites are generally characterised by an exceptional preservation of archaeological remains, especially of organic material. Therefore, the Neolithic lake site of Chalain, France, presents a large amount of archaeological bone remains that permit to study the elemental and structural changes during early diagenesis.

Bone consists of an intimate mixture of an organic fraction, mainly collagen, and an inorganic phase composed of poorly crystallised carbonate-hydroxyapatite. Within the Neolithic site, these objects have been buried for about 5000 to 6000 years. During this period, the bones were subjected to divers alteration processes as dissolution, hydrolysis, recrystallisation, reorganisation of the organic matrix, ion diffusion and precipitation of secondary minerals as well as biological degradation as a function of the close environmental conditions (Quattropani et al. 1999; Reiche I. et al. 1999). So we chose to study the impact of soil environmental conditions on the bone preservation by analysing simultaneously bone, water and sediment composition. Proton induced X-ray and gamma-ray emission (PIXE/PIGE) allows precise elemental analysis as well as depth profiling of the archaeological bone samples. Scanning electron microscopy SEM-EDX was used for the identification of secondary precipitates within the bone structure whereas X-ray and electron diffraction provide structural information. More precisely, observation and analysis using TEM-EDX give morphological, elemental and micro-structural localised information for individual crystals which is complementary to infrared spectroscopy and X-ray diffraction (XRD) giving global molecular and crystallographic characterisation. ICP-AES and capillary ion chromatography enables major, minor and trace element analysis of pore water and XRD, the characterisation of the lake sediments. This comparative study of the state of preservation of several archaeological bone samples in parallel with their environmental pore water and sediment reveals elemental and structural changes during early diagenesis of archaeological bones even under exceptionally favourable burial conditions. The uptake of trace elements is shown to be dependent on the pore water chemical composition. The dissolution-recrystallisation processes, shown by TEM observation (fig. 1), is attributed to the slight super-saturation with respect to relatively well crystallised hydroxyapatite, to the microbiological activity and to the acid-base conditions of the direct soil environment.

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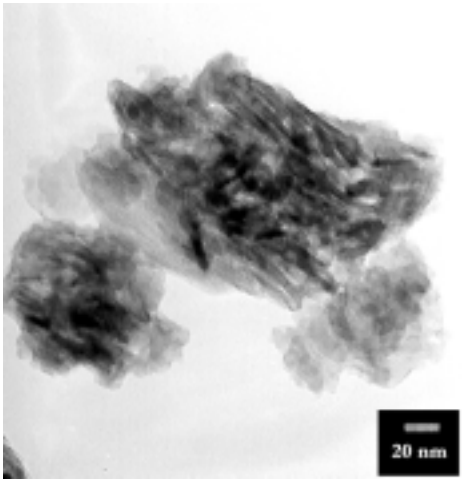

Figure 1: TEM micrograph of a deer bone from the subaquatic station 21 of the Neolithic lacustrine site of Chalain showing 40-80 nm needle shaped apatite crystals formed during dissolution-reprecipitation processes, possibly caused by micro-organisms (Susini et al., 1988).