Palaeogeography, Palaeoclimatology, Palaeoecology 416 (2014) 1–3

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

Preface

# Bone and enamel diagenesis: From the crystal to the environment — A tribute to Jean-François Saliège

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Fossil bones and teeth are valuable archives that record information about the life history and habitat of an animal or human being as well as about past climate and environment. This information is embedded in the biogeochemical composition of "living" mineralized tissues during their genesis, but they may be altered after death and during fossilisation, i.e. in the processes collectively understood by the term diagenesis. Only chemical signatures from well-preserved bio-proxies can be interpreted with confidence to reconstruct the life history, environment and climatic conditions during the lifetime of the animal or human being. This is also of uttermost importance if dates are obtained from fossil skeletal remains. Obviously, all buried materials and fossils are altered in one way or another as this is a prerequisite for their preservation in the fossil record. The real question then becomes to ensure whether the biogenic substrate is being analysed and thus avoiding false artefacts. In this respect, researchers must be confident that the targeted biogenic substrate remains pristine, or at least pristine enough to provide the information they are after. Understanding what processes ancient bones and teeth have undergone is extremely helpful in this regard.

Archaeologists, anthropologists, palaeontologists, geochemists, physicists and analytical chemists have been gathering about every four years since 1988 to discuss these questions during Bone Diagenesis meetings (Schwarcz et al., 1989). The first two International Bone Diagenesis workshops were held in Oxford (UK) in 1988 and 1993, and then in Paris (France) in 1996, Albarracín (Spain) in 2000, Cape Town (South Africa) in 2005, and Bonn (Germany) in 2009. Each Bone Diagenesis meeting was published in peer-review journals, i.e. Oxford 1988 in *Appl. Geochem.* 4(3) 1989; Oxford 1993 in *J. Archaeol. Sci.* 22(2) 1995; Paris 1996 in *Bull. Soc. Geol. Fr.* 168(5,6) 1997, 169(1,3) 1998; Albarracín 2000 in *Archaeometry* 44(3) 2002; Cape Town 2005 in *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 266(3–4) 2008; and Bonn 2009 in *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 310(1–2) 2011. Because it is always difficult to disentangle the biogenic from the diagenetic, papers on bone diagenesis can also be found in special issues dedicated to paleobiological and paleoenvironmental reconstructions, e.g. *J. Hum. Evol.* 15(5) 1985; *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 107(3–4) 1994 and *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 126(1–2) 1996. The 30 years of existence of the discipline is also punctuated by several books, i.e. Price (1989), Lambert and Grupe (1993), and Ambrose and Katzenberg (2001).

Each of the published volumes marked a step in the advance of our knowledge of bone diagenesis. Looking back at them, it is possible to see an evolution in the common themes that made the published papers a coherent set. The first three Bone Diagenesis meetings focused on dating and palaeodiet (Schwarcz et al., 1989), with an emphasis on palaeodietary reconstruction for the French session (Bocherens and Denys, 1997). The 2000 Albarracín meeting witnessed the arrival of studies focusing on the preservation of ancient DNA (Fernández-Jalvo et al., 2002). From the mid-2000s, the community tried to stress very strongly the need to understand the processes better — both regarding the processes of post-death changes, and also the recording of the natural variability in the archives during their mineralization. An emphasis was further given to experimental approaches (Lee-Thorp and Sealy, 2008), then to multiple isotopic systems (Tütken and Vennemann, 2011).

Recent scientific results and progress in this research field were presented and discussed by more than 60 international participants from 16 different countries during the 7th Bone Diagenesis meeting. This meeting was held in Lyon (France) from the 22nd to the 25th October 2013 (https://bd13.erudicio.com). The scientific programme of the 7th BD meeting was organized in six thematic sessions covering the following topics: (1) timing and quantification of diagenetic processes; (2) organic molecules; (3) dating; (4) bone diagenesis at the nanoscale; (5) diagenesis in the lab; and (6) advances in sample preparation and analytical techniques. A selection of fourteen papers covering most of the aspects discussed in the six sessions is presented in this special issue. One of the most salient features of the 7th BD meeting is the tremendous progress that has been made in instrumental techniques over the last few years. Thanks to new instrumentation, i.e. the synchrotron light source, accelerator particle (Albéric et al., 2014–in this issue and Heckel et al., 2014–in this issue), laser ablation techniques (Grün et al., 2014–in this issue and LeRoux et al., 2014–in this issue), and infra-red spectroscopic imaging (Lebon et al., 2014–in this issue), it is now possible to look at the structure and chemical composition of bone and teeth at the micro- and even at the nanoscale. Local heterogeneities in the preservation of such tissues can thus be detected

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http://dx.doi.org/10.1016/j.palaeo.2014.09.017

and used to select the best zones to extract meaningful information about the life of extinct human and animals. Furthermore, such new capabilities open up new vistas for determining ancient conditions where high resolution sequential information is required. This progress in instrumentation has also confirmed that modern bone and enamel tissues are highly hierarchical materials, and that a full understanding of their behaviour during diagenesis requires far better understanding of the interactions between the mineral phase, the organic matrix and the diagenetic fluids at different scales of observation. This theme permeated most of the sessions of the 7th BD meeting and is well-represented in this special issue.

We look forward to the new themes and topics that will undoubtedly emerge over the next four years, and which will be discussed at the next Bone Diagenesis meeting. It will be held once again in Oxford, 30 years after the first BD workshop, thus allowing to review progress in the discipline over the course of three decades.

Participants of the 7th Bone Diagenesis meeting, in front of the Institut Français de l'Education (Lyon, France).

This special issue is dedicated to our mentor and friend Jean-François Saliège who passed away in June 2012. Jean-François was a faithful participant of the Bone Diagenesis meetings (he did attend the Oxford, Paris, Albarracín and Bonn editions) but his discrete nature has always kept him away from the stage. He will be nevertheless remembered for his significant contribution to bone apatite dating in arid environments, and in Africa in particular, a continent that he loved so much. Jean-François helped us both during our PhDs and afterwards, including allowing us clandestine access to his laboratory to run samples on the mass spectrometer during weekends! We very much miss the long, lively discussions at the Epsilon's counter about matters related to labile carbonates, bone diagenesis, and life in general.

Jean-François Saliège (1943–2012) — Photo courtesy of A. M. Lézine.

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