

Exploring hominin and non-hominin primate dental fossil remains with neutron microtomography

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Fossil dental remains usually represent the most common evidence testifying the life of extinct taxa in a given region at a given moment. In parallel with results from research on developmental biology and quantitative genetics, advances in comparative structural morphology of fossil and living primate dental remains show that a significant amount of valuable information lies "safely" stored inside tooth crowns and roots. In response to the potentially conflicting requirements of safeguard vs. fruition/exploitation of the fossil record, the available computed microtomography technologies based on X-ray microfocus sources (X- μ CT) and Synchrotron Radiation (SR- μ CT) allow nowadays the subtle quantification at the micron and sub-micron scale of the meso-/microstructural signature imprinted in the mineralized tissues through high-resolution "virtual histology". Nonetheless, depending on the degree of alterations undergone during fossilization, tooth tissues do not systematically provide a distinct structural signal, thus preventing the extraction of essential paleobiological information.

The extent of such problems and the investigative limitations in signal retrieving are well illustrated here by two examples from chrono-geographic distinct contexts: three highly mineralized jaw fragments attributed to *Homo erectus* from Java, Indonesia, and a cercopithecoid maxilla from the Sterkfontein Cave, South Africa, still fully embedded in a breccia rock. These specimens were first unsuccessfully examined by industrial X- μ CT and then detailed by neutron microtomography (n- μ CT) at the FRM-II Antares facility with a spatial resolution ranging from 20.5 to 75.0 μ m.

Our results show that, even when X- μ CT fails to show any contrast between the tooth tissue components, the inner morphology of even highly mineralized remains can still be recognized, extracted and imaged in 3D by n- μ CT. For the first time, this method allowed us to satisfactorily quantify the internal signature of precious fossil specimens and thus to (re)assess their taxonomic identity, which is crucial in paleobiological research. Following fossilization, alterations capable to variably alter, or even hide, the inner structural morphology of the remains quite commonly characterize any fossil assemblage. Our analytical experience demonstrates that, besides phase-contrast SR- μ CT, neutron microtomography, whose absorption profile differs from X-rays by being more strongly attenuated by organic than mineral materials, represents an effective investigative tool for imaging fossil remains at a better contrast resolution despite the usual hazy appearance of their structural signal.