Some applications of X-ray Synchrotron microtomography for non-destructive 3D studies of paleontological specimens

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Among the numerous applications of the X-ray Synchrotron microtomography, paleontology is a recent newcomer.
Studies of external morphological characters are not sufficient for paleontologists to extract all the important data about fossil organisms. Observations of internal structures become more and more necessary, but they have to be non-destructive in most of the cases. Conventional microtomography allows numerous investigations. But the best microtomographic images are obtained using a third generation synchrotron, as the ESRF, which provides a lot of supplementary information. Firstly, beam intensity allows very high spatial resolutions and exceptional contrast when compared with industrial microtomographs. Secondly, monochromaticity permits to avoid beam hardening that is frequently strong for paleontological samples. Thirdly, coherence leads to new imaging techniques: phase contrast radiography, phase contrast microtomography and holotomography. These methods appear to be successful for fossils presenting high mineralization or low densities contrasts. Figure 1 shows some examples, at different scales, of applications of X-ray synchrotron microtomography in paleontology.

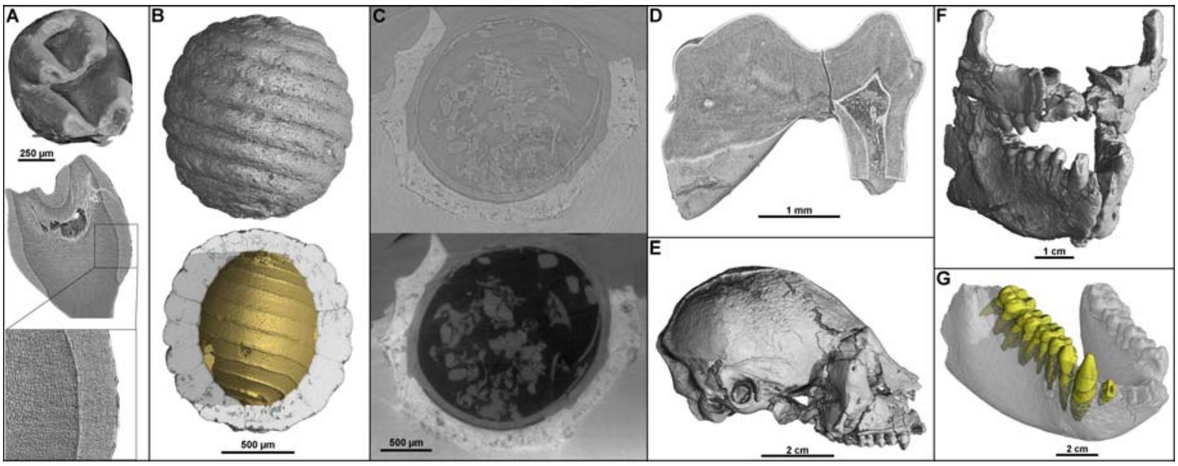

Figure 1: **A**: Rodent molar. Phase contrast reveals enamel and dentine microstructure. **B**: Fossil charophyte algae showing a virtual 3D cast of the gyrogonite. **C**: Comparison between absorption and holotomography on a fossil charophyte. **D**: Fossil primate molar. Phase contrast enhance the enamel-dentin junction. **E**: Fossil skull of a South-American primate. **F**: Virtual 3D reconstruction of the jaws of an Asiatic fossil primate. **G**: Mandible of an ancestor of modern orang-utans from Thailand. Right teeth have been virtually pulled off.