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Computed tomography in palaeontology – case studies from Triassic to Cretaceous ammonites

A. Lukeneder (1), S. Lukeneder (1), and C. Gusenbauer (2)

(1) Natural History Museum Vienna, Geology and Paleontology, Vienna, Austria (alexander.lukeneder@nhm-wien.ac.at), (2) Upper Austria University of Applied Sciences, Campus Wels, Stelzhamerstrasse 23, 4600 Wels, Austria

Case studies on computed tomography on ammonites, ammonite mass-occurrences and trace fossils, deposited during the Upper Triassic (approx. 225 mya) of Turkey and during the Lower Cretaceous of Italy (approx. 130 mya), are presented. X-ray computed tomography is known in palaeontology as providing data for 3D visualization and geometrical modelling techniques. Computed tomography down to a few microns (or even below) of spatial resolution are increasingly employed for geoscientific investigations, using an equally variable range of processing techniques and software packages. Additionally internal structures are visualized without destruction of fossils, as computed tomography is a non-destructive method.

Experimental
The scans were made at the Upper Austria University of Applied Science in Wels with a dual source industrial 3D computed tomography device (RayScan 250 E), equipped with a 225 kV microfocus and a 450 kV minifocus X-ray tube as well as a 2048x2048 pixel flat panel detector (cone beam reconstruction). The spatial resolution (down to 5 μm) is determined by the size of each volumetric pixel (voxel) of the data set. For each fossil part the optimal voxel size and tube voltage were set according to the specimen dimensions.

Case study 1: Triassic ammonites from Turkey (FWF Project P22109-B17)
A case study in computed tomography on the ammonite genus Orthoceltites is presented. The latter studies are essential for palaeontology and systematic investigations. Ammonite shells and filled phragmocones (secondary calcite) from the Orthoceltites beds possess the same mass-density as the matrix in which the ammonite specimens are embedded. The almost identical mass-density of the embedding matrix (about 2.8 g/cm3), the ammonite shell (secondary calcite, about 2.6-2.8 g/cm3) and the infilled matrix (about 2.8 g/cm3) avoids their visualization. It is therefore not possible to visualize the ammonites by computed tomography. In few cases ammonite shells, body chambers and secondary formed calcite fissures can bee observed in computed tomographic images and movies. Future work will be done on the possibilities of computed tomography in such dense Mesozoic limestones.

Case study 2: Cretaceous ammonites and trace fossils from Italy (FWF Project P 20018-N10)
This case is somehow different compared with the Triassic case study above. We used the same methods and equipment as within the Triassic samples. The only differences are the sediments and the material of ammonites and trace fossils. Within marly-limestones from the Lower Cretaceous numerous ammonites (e.g., Dissimilites, Lytoceras; Lower Barremian) and trace fossils (Halimedides; Lower Barremian are preserved as limonitic steinkerns or limonitic fillings. These dens estructures can be visualized by computed tomography. New morphological details as spines on ammonite shells, shape and position of suture lines, and the exact structure of trace fossils can be shown.