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Reconstruction of paleoenvironments by analyzing spatial shell orientation

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Fossils, especially their mass-occurrences, can be exploited as useful source of information about the depositional conditions. Particularly abundant fossils with elongated shape such as belemnites are useful indicators to draw conclusions about influencing factors (e.g. paleocurrents) of paleoenvironments. Orthocone cephalopods, gastropods, bivalves, foraminifers, vertebrate bones and others have been used so far in field-based spatial orientation studies (Flügel 2004). Normal coiled (planispiral) cephalopods can also provide such depositional information. A new method for reconstructing spatial shell orientation in 3D is presented here. A roughly 225 million-year-old (Carnian, Triassic) monospecific mass-occurrence of the ammonoid *Kasimlarceltites krystyni* from the Taurus Mountains in Turkey (project FWF P22109-B17; Lukeneder et al. 2012), embedded in limestone, is used for this pilot study.

The most obvious method for digitization of the ammonoids, μ-computed tomography (CT), was not successful in this case due to the lack of density differences between the ammonoids (i.e. secondary calcite shells) and the embedding source rock (carbonate). Therefore we had to come back to the classic method of grinding, which, despite its invasive character, cannot always be disregarded, particularly if digital recording methods are not applicable and samples are large enough to sacrifice parts. A 150x170x140 mm block of the ammonoid bearing limestone bed has been grinded to 70 slices, with a distance of 2mm between each slice. By using a semi-automatic region growing algorithm of the 3D visualization software Amira, the ammonoids were segmented, and a 3D model of this mass-occurrence reconstructed. We used landmarks as well as trigonometric and vector-based calculations to compute the diameters and the spatial orientation of each ammonoid. For the diameters, the longest distance (longitudinal axis) of each shell (landmark a & b) and the orthogonal distance from this cord to one side of the shell (transverse axis) was measured (landmark s & c). Spatial orientation was characterized by dip and dip direction of the longitudinal axis, as well as by strike and azimuth of a plane defined by both axes. The exact spatial orientation data was determined for a sample of 699 ammonoids within the bed and statistically analyzed. The results provide a hint on the geodynamic processes (paleocurrents), depositional conditions (allochthonous or autochthonous) and other general information about the ancient environment. The method can be adapted for other mass-occurring fossils and thus represents a good template for studies of topographical paleoenvironmental factors.

References:

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