The effects of pedal geometry and morphology on track depth: taking a step towards using fossil tracks as palaeopenetrometers through finite element analysis and physical experimentation

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A vertebrate track is the resultant deformation caused by the interaction of an animal and a substrate. The final morphology (before burial) is determined by three factors; substrate properties, pedal morphology, and forces applied. Through computer simulation employing finite element analysis, it is shown that the relative length of the foot perimeter affects track depth even when pressure and substrate properties are kept constant. In cohesive substrates, an increased perimeter allows more sediment to move laterally and upwards, rather than be forced down beneath the load, resulting in a shallower track. Non-cohesive substrates (*e.g.* sand) behave differently, shearing more readily at the edge of the foot, and causing those indenters with a relatively larger perimeter to indent more deeply. The implications of this are that two tracks made by similar sized animals may be different depths due purely to the shape of the feet. This means that employing fossil vertebrate tracks as palaeopenetrometers (gauges of palaeo-substrate consistency) must take into account the pedal morphology and geometry. Secondly, conclusions of neoichological experiments conducted using one type of substrate, may not be directly relatable to fossil tracks imprinted in other substrates, particularly when considering the full three-dimensional track volume.

Distribution of planktonic foraminifera across the Cenomanian Turonian Boundary Event [CTBE] in the Rehkogelgraben section (Upper Austria)

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The sediments of the Ultrahelvetic Zone of the Eastern Alps (Upper Austria) were deposited on the distal European continental margin of the Tethys. The Rehkogelgraben section (~40 Km east of Salzburg) comprises a 5 m thick succession of Upper Cenomanian marl–limestone cycles overlain by a black shale interval composed of three black shale layers and carbonate–free claystones, followed by Lower Turonian white to light grey marly limestones with thin marl layers. The stratigraphic position of the black shale intervals is shown to be coeval with the global "Cenomanian Turonian Boundary Event" (CTBE) by the extinction of *Rotalipora* spp. and the first appearance of *Helvetoglobotruncana helvetica*. As this work was based on an analysis of ~40 thin sections, it has not been possible to identify all of the detailed faunal changes normally recorded at this level. The data do, however, complement the foraminiferal analysis of the processable marl samples within the succession (Wagreich *et al.*, 2008). Many of the thin sections from immediately above the CTBE are crowded with calcispheres, and this is a feature of many other successions in Europe and the Middle East.