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Programme, Abstracts, and Field Guides

24.09. – 29.09.2012
Museum für Naturkunde Berlin

Edited by Florian Witzmann & Martin Aberhan

museum für naturkunde

Leibniz-Gemeinschaft

HUMBOLDT-UNIVERSITÄT ZU BERLIN

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Ever since the first giant bones of sauropods were found scientists worldwide investigate the development of gigantism and the lifestyle of these enormous animals. Analysis and interpretation of sauropod gigantism is essential for understanding the evolutionary constraints and their consequences on the development of the earth's geological and biological history. Quantitative information on the sauropods' weight is, among other attributes, of major interest.

In many localities worldwide dinosaurs left their tracks in sediments, which can today be observed to date as fossil footprints. Based on the geometry of those footprints and using soil mechanical approaches the stress state applied to the subsoil by the dinosaurs via its foot may be reverse-calculated using inverse analysis. The geometry of the footprint (i.e. vertical displacements) is strongly influenced by the stress applied and the characteristics of the subsoil. The value of the applied stress depends on the dinosaur's weight (i.e. static component) as well as on the acceleration the dinosaurs foot received when coming into contact with the subsoil (i.e. dynamic component). Biomechanical aspects have to be taken into account when dealing with this problem.

Therefore, the aim of the present investigation is to apply and to verify a soil mechanical concept to predict the weight of an extant, living animal, to validate the engineering methods. Based on the footprint geometry and the soil mechanical properties of the subsoil the Finite Element Method (FEM) is adopted to achieve this aim.
Certain similarities may be found between sauropods and elephants locomotion. Thus in this study an elephant with known weight is walking on a prepared sand bed to produce footprints. The geometry (i.e. vertical displacements) of the footprint is used to reverse-calculate the elephants weight. The following work steps are performed:
- The footprints are scanned using Laser Scanners to derive 3D geometry diagrams of deformation.
- Experimental investigations are carried out to determine soil parameters needed as input values for the numerical simulation.
- Locomotion sequences of the elephant walk are studied in detail by Digital Image Correlation (DIC) method.
- Inverse Analysis using numerical simulation by FEM code PLAXIS including Hardening Soil Model (i.e. stress dependent stiffness values are taken into account) is carried out.

The predicted weight of the elephant and the estimated weight of the elephant derived via numerical simulation are compared. We summarize the outcome with regard to the influence of dynamic components (arising from the forward speed) and several weight distributions during the elephant walk. As a result we discuss the applicability of the above introduced soil mechanical concept for the prediction of sauropods weight by inverse analysis.

S25 – A remarkable carpal construction in *Prosantorhinus germanicus* (Rhinocerotidae, Mammalia) from Sandelzhausen (Bavaria, Germany)

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The famous Miocene locality Sandelzhausen has an age of around 16 Ma and belongs stratigraphically to the Neogene mammal zone MN5 respectively the upper freshwater molasse. The highly diverse fossil assemblage consists of plants, invertebrates and vertebrates with a dominance of mammals. Within the large number of specimens the remains can mainly be assigned to rhinos. Among the first findings in 1959 was a well-preserved rhino lower jaw. Within the excavation history of two large periods the number of teeth, skulls and postcranial remains of three different rhino taxa grew to a tremendous size (e.g., more than 1800 teeth). The largest and rarest species is *Lartetotherium sansaniense*. A second species is *Plesiaceratherium fahlbuschi* of which Sandelzhausen provided the type specimen. *Prosantorhinus germanicus* is the third species and most numerous in remains. Compared to the other species this rhino has relatively short limbs and the whole posture is reconstructed as hippo-like. Following this and supported by findings from limnic sediments, the members of the whole tribe (Teleoceratini) are very often described as semi-aquatic in their mode of life. A large project focuses on the postcranial skeleton to answer the question if adaptations are visible to support such a semi-aquatic mode of life hypothesis. A first look at the carpal bones reveals two different morphotypes of the intermedium and the carpale IV. Some of these two bones are showing a palmar located contact facet. Such a palmar articulation has not been observed in the other species from Sandelzhausen or their extant relatives. The intermedium is the carpal bone between the ulnare and the radiale in the proximal row of carpals, and the carpale IV belongs to the distal row of carpals. A palmar contact facet between intermedium and carpale IV would mean a restriction of movement between the proximal and distal row of carpals. In cursorial ungulates a movement restriction shows an adaptation to a higher speed or to a difficult habitat (e.g., mountainous regions), and therefore reduces the danger of injuries. This restricted carpal movement would point to a more cursorial locomotion in *Prosantorhinus germanicus* which would be in contrast to the predicted semi-aquatic mode of life. Another interpretation lies within an extreme form of sexual dimorphism. Since male rhinos are much heavier than females, the restricted carpal movement may have supported the larger body weight and prevented injuries of the forelimb. Further investigations are needed to shed more light on the ecology of these fossil rhinos.

S1 – The role of hot spots in the break-up of Pangaea and the opening of the Atlantic Ocean

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It is generally acknowledged that mantle plumes played a significant role in the process of fragmentation of the Pangaea supercontinent during late Triassic – early Cretaceous times, although the importance of their contribution is often underestimated. I show that long-lived thermal anomalies in the mantle not only triggered the break-up of central Pangaea but also influenced considerably the tectonic evolution of the Atlantic Ocean from the Early Jurassic onward.

A major point of controversy in modern geology is the role of far-field and "active" forces for rift initiation. Most authors distinguish two end-members in modelling of continental break-up: active rifting, associated with asthenosphere upwelling due to thermal or compositional anomalies (mantle plumes), or passive rifting associated with a regional tensional stress field. Although people generally agree that both mechanisms may contribute to the onset of rifting, it is still unclear if active rifting by itself can drive the rupture of continents. A common line of thought assumes that the lithosphere only breaks passively, although this process may in turn destabilize the lower lithosphere, leading to small-scale convective upwelling of asthenosphere, thereby active rifting may only take place in the late syn-rift or post-rift phase.

The possibility that active rifting represents a viable mechanism for the break-up of a continent is suggested from the observation that active spreading pulses along mid-ocean ridges often cause deformation in the nearby continental margins. These phenomena were first described by Bott in the 1990's, who showed that anomalous hot and low-density upper mantle zones beneath oceanic ridges, forming ocean floor swells, determine a substantial increase in the compressional deviatoric stress field in the oceanic area and in the adjacent continental margins (up to 90 MPa). The existence of post-break-up contractional deformation along passive margins, associated with horizontal compression, has been discussed in many papers, in particular for the northern and central Atlantic regions during the Cenozoic. For instance, I have recently showed that the inversion of the Mesozoic rift structures of the Atlas region, leading to the formation of the Atlas orogen, occurred during the Oligocene – early Miocene and was accompanied by higher spreading rates in the central Atlantic, possibly driven by the Azores mantle plume. Similarly, it was suggested that the rapid northward motion of India during the late Cretaceous – Eocene was driven by the force exerted by the Reunion plume head.

I will outline a new paradigm for the driving forces of plate tectonics, in which divergent flows in the asthenosphere, associated with mantle heterogeneities, are driving mechanisms as well. In this model plates are moved by the combined action of drag stresses exerted on the base of the lithosphere and far-field boundary forces (slab pull and ridge push).

S6 – The rise of Mesozoic marine reptiles and a review of the developmental record

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Today, the percentage of marine reptiles among the total sauropsid species richness is very low, with only 90 out of ca. 20,000 (0.45 %) living in the oceans. Among the five different lineages (turtles, sea snakes, crocodylians, iguana, and birds, of which the latter three are predominantly semi-aquatic) only the sea snakes (Hydrophiidae) are speciose. In contrast, in the Mesozoic the oceans were inhabited by an immense diversity of secondary marine reptiles, including ichthyosaurs, mosasaurs and sauropterygians, all three successful radiations. With their appearance in the fossil record shortly after the most catastrophic mass extinction event in Earth history, the sauropterygians and ichthyosaurs quickly radiated and evolved diverse morphologies, ecologies and life histories. Besides the anatomical study of adaptation to the aquatic environment, it is becoming increasingly important to also look at the physiological, metabolic and life history aspects the organisms experienced. These aspects can be addressed for example with bone histological studies. One key aspect to elucidate phylogenetic relationships and functional constraints is the study of how the early development of the different organisms is affected by the profound changes in environment. Do juveniles have similar lifestyles as the adults? Do they occupy the same or different habitats?