Geophysical Research Abstracts
Vol. 12, EGU2010-2155, 2010
EGU General Assembly 2010

The development of the Middle Triassic tectonical controlled Germanic Basin of Central Europe and the palaeoenvironmental related distribution of marine and terrestrial reptiles

Cajus G. Diedrich
PaleoLogic, Geology/Palaeontology, Halle/Westph., Germany (cdiedri@gmx.net)

Nine Middle Triassic paleogeographical maps comprising the uppermost Upper Bunter, Lower to Middle Muschelkalk and Upper Muschelkalk to Lower Keuper time frame (Diedrich 2008b) show the marine ingression and regression cycle of the Middle Triassic Germanic Basin (Diedrich 2010c). For bathymetrical and palaeoenvironmental interpretations especially reptiles and their footprints are used. This Germanic Basin as analogon for the Arabian Gulf (Knaust 1997), north of the Tethys, was under marine and finally terrestrial influenced sediments in a time frame (after Kozur and Bachmann 2008) between 247.2 My (Myophoria Fm, Aegean, Lower Anisian) to 237.9 My (Grabfeld Fm, Longobardian, Lower Ladinian). In a duration of 9.3 My the Germanic Basin was filled up mainly with marine carbonates and at the end by siliciclastics influenced by the northern Tethys through the Silesian, Carpathian and later the Burgundian Gates which connected the Germanic Basin to the Northern Tethys. With the marine ingression from the East via the Silesian Gate (Poland) a ten to hundred kilometers extended intertidal flat to sabkha facies belt surrounded first only the central and then the Western Germanic Basin (Winterswijk, Netherlands). Those intertidal zones were used mainly by two different small reptiles as their primary habitat. Hereby they left Millions of the small tom medium sized footprints of the ichnogenera Rhynchosauroides and Procolophonichnium (Diedrich 2005, 2008a). Larger terrestrial and beach and sabkha adapted reptiles were Tanystrophaeus antiquus and unknown archosaurs, which are recorded only by their footprints. At the beginning of the ingression at the uppermost Bunter a shallow marine invertebrate fauna and coastal reptiles appeared in the Germanic Basin which must have originated mainly from the Northern Tethys. Especially all marine reptiles immigrated from the Tethys which is proven not only by assamblaged Tethyan cephalopod Ceratite species (cf. Diedrich 2008a). The coastal intertidal zones appeared with mud cracked biolaminate and sabkha dolomites ("Biolaminate and Sabkha facies") and expanded further west and south within the Lower Muschelkalk Winterswijk Fm (Aegean/Bithynian boundary), Osnabrück Fm, and Jena Fm (Bithynian to Pelsonian) (Diedrich and Trostheide 2007, Diedrich 2008a). The intertidal zones changed their extensions several times in the Lower Muschalkalk due to the less eustatically and more tectonically controlled very shallow relief cratonic basin morphology and were more stable in the western part of the flat carbonate ramp basin (Winterswijk, Netherlands) and in coastal zones in general. In the Germanic Basin centre (Rüdersdorf to Gogolin, Germany/Poland) the conditions were all that time under very shallow carbonate sand barr (Oolithtic, Terebratula or Shell bioclastic facies) or shallow subtidal ("Wellenkalk facies") conditions, whereas even extended seagrass meadows in shallow carbonate facies types are indirectly proven by invertebrate communities, especially snails. Those algae attracted especially placodontids which were the "Triassic seacows" feeding on such algae (Diedrich, 2010a), which immigrated with Paraplacodus, Placodus and Cyamodus already with the first Lower Muschelkalk ingression sequence. Also other reptiles such as nothosaurs Nothosaurus (small species), Cymatosaurus, the pachypleurosaurids Dactylosaurus, Neusticosaurus or Serpianosaurus must have originated from the tethys and were shallow marine and even lagoonary adapted paraxial swimming smaller marine reptiles. This "Lower Muschelkalk" time was highly tectonically active represented by several seismic layers (slumps, sigmoidal shocked layers, etc.) (cf. Schwarz 1975, Rüffer 1996, Knaust 2000, Diedrich 2008a), which were also reaching the intertidal beach zones, possibly even with tsunamite hazard events (Diedrich 2008b, 2009b). Such tsunamis or quick floodings due to storm events must have had hazardous impacts on marine reptiles or fishes, and the beach inhabiting terrestrial reptiles, which could have been killed by high amounts which explains the presence of many skeletons, bonebeds, and footprint preservations in the Germanic Basin biolaminate and lagoonal facies. With a high seismic peak during the Middle Muschelkalk

Karlstadt Fm (Pelsonian/Illyrian boundary) in the intertidal zones up to 19 tectonically shocked biolaminate layers (locality Bernburg, Central Germany, Diedrich 2009b) prove the beginning of the Alpine tectonics and its raise (fold belt structure: Müller et al. 1964), but also the opening of the Carpathian Gate (graben structure: Szulc 1998), from which the epicenters were estimated by two main slickenside directions. Those can be found all over the Germanic Basin "Lower Muschelkalk" sediments (Szulc 1998, Föhlisch 2007, Diedrich 2009b). This time period of the Pelsonian/Illyrian boundary gave even such extended intertidal zones, that reptiles left Millions of tracks all over those biolaminate facies types, allowing those to migrate and distribute East (Bohemian Island) - West (Rhenisch Massif, London-Brabant Massif) due to "intertidal flat bridges". Therefore chirotherid archosaur trackmakers left Chirotherium, Isochirotherium and Brachychirotherium trackways quite abundantly not anymore in the typical Bunter red sandstone facies; now they appeared in the new environments, the intertidal biolaminates such as well documented at Bernburg (Central Germany, Diedrich 2009b), but also on other Middle Triassic coast east of the Massif Central (Demathieu 1985) or the Alps (e.g. Avanzini 2002). The only surviving marine reptiles were smaller lagoonal adapted pachypleurosaurs such as the common Anarosaurus and smaller sized Nothosaurus. Placodontids disappeared with the loss of the palaeoenvironment of the macroalgae meadows and seem to have migrated to the Carpathian gate and northern Tethys, where those habitats were still present. The dramatical habitat change with terrestrial territory loss, and marginal marine beach zone extensions seem to be also the reason for the beginning of the dinosaur raise in the world. Within the Middle Muschelkalk Heilbronn and Diemel Formations a massive sea level fall caused a new extension of intertidal zones and sabkhas, but also halite and gypsum evaporates ("Domolite-evaporate facies") in the basin center including the southern Germanic Basin branch (region Tübingen/Stuttgart, Southwestern Germany). The "Middle Muschelkalk" shallow relief and lagoon to intertidal dominated period changed again drastically within a new tectonic active "Upper Muschelkalk" time and strong "ingression" of the northern Tethys into the Germanic Basin within the Illyrian time (Bad Sulza Fm, Trochitenkalk Fm). A shallow marine, with shallow water carbonates filled Germanic Basin developed again, but this time with different consequences onto the former coastal zones, in which intertidal biolaminated and sabkhas disappeared as a result of steeper coastal morphologies. Whereas in the first ingression a shallow marine reptile fauna was present (Nothosaur-Pachypleurosaur taphocoenosis, Lower Bad Sulza Fm, Diedrich in prep.). The fauna changed with the main transgression within the Upper Bad Sulza Fm to a Placodontid-Pistosaur taphocoenosis with more open marine adapted forms (Diedrich in prep.). At those time also crinoid bioherms developed massively all over the central and southern Germanic Basin in front of the costs at the "steeper coast margins" (which were still hot high angled), as a "crinoid belt" (e.g. Aigner and Bachmann 1991), which was responsible for massive crinoidal limestones (= "Trochitenkalk facies"). In this period again "Triassic seacows" seem to have populated well the entire Germanic Basin, and here again seagrass meadow areas documented by benthic invertebrate palaeocommunities (Diedrich 2009a, 2010a). The marine macroplants must have built extended meadows on the shallow marine and oxygen-rich seafloor conditions of the "Tonplatten facies" on which many different invertebrates settled in- or epifaunistic. This tectonical deepening controlled situation continued with the Meißner Fm and aequivalent Formations and its cephalopod Ceratite rich "Tonplatten facies", whereas the "maximum flooding" (if the term can be used here in a cratonic and tectonically controlled basin: cf. definition of marine cycles in: Aigner and Bachmann 1991) was in the compressus biozone (ceratite biozone, middle Meißner Fm, Anisian/Ladinian boundary, cf. Diedrich 2009a). The high stand is underlined by now full adapted marine reptiles such as nothosaurs (Nothosaurus mirabilis, Simosaurus gaillardodti), pistosaurs (Pistosaurus longaevus) and especially the open marine ichtyosaurs (Shastasaurus, Mixosaurus, Omphtalmosaurus) support the full marine and highest water level conditions. The "regression" or better suggested here "basin uplifting" started in the upper Meißner Fm with a reducing carbonate sedimentation which was overtaken slowly by terrestrial sediments already within the Warburg/Erfurt Formations (Fassanian/Longobardian boundary, Lower Ladinian). The fresh water and clay mineral influence caused a reduction of the marine benthic community biodiversity and the development of brackish lagoons, in which some invertebrate faunas and dominantly small marine reptiles pachypleurosaurs lived. At that time all placodontid reptiles disappeared, which must have been the chain reaction of the macroalgae loss and environmental changes. A change of terrestrial influence and periodic marine influence is documented in repeating intercalated massive dolomites (Alberti-Bed, Anthraconit-Bed and others) and clay layers of the Lower Keuper Erfurt and especially Grabfeld Fm (Longobardian). In this final period the Lower Keuper Germanic Basin was less and less marine influenced, finally dominated at that time on the limnic influenced costs by large amphibians such as Mastodonsaurus, Gerrhothorax or Plagiosuchus, which were found especially at southern German and Central german sites (Schoch and Wild 1999, Diedrich 2010b), including the famous southern

German “Grenzbonebed” (Fassanian/Longobardian boundary) (Reif 1982, Hagdorn 1990). This bonebed already contains a strongly reduced marine reptile fauna with pachypleurosaurs and giant lagoon-adapted nothosaurs (N. giganteus, S. gaillardoti) and few marine hypersaline adapted shells such as Costatoria costata (cf. Hagdorn et al. 2009). The absence of cephalopod ceratites and rare nautilid presence are the last proves for the periodic restricted lagoon situations- being comparable in its facies and reptile fauna to the lagoon of the Northern Tethys Monte San Giorgio, Switzerland/Italy (e.g. De Zanche and Farabegoli 1988, Furrer 1995) to which the Germanic Basin was connected through the Burgundian Gate, France. The marine influence and marine sediment fill of the Germanic Basin stopped finally at the beginning of the Middle Keuper (lower Upper Triassic), diachronously more earlier in northern Germany (Warburg/Erfurt Fm, cf.: Kozur and Bachmann 2008, Diedrich 2010b) as in southern Germany (cf. Hagdorn et al. 2009) indicating a periodic marine influence from the Northern Tethys through the Burgundian Gate. At the final tectonical stage (last seismits in the Grabfeld Fm, Longobardian: cf. Bachmann and Aref 2005) no intertidal flats nor biolamnintes developed anymore in a low relief Germanic Basin morphology, which reason can be explained be the carbonate reduction, strong terrigenous clay input, and brakish-lagoonary conditions, in which cyanobacterial mats of the low-relief intertidal zones could not develop.

References

Aigner, T. and Bachmann, G.H. 1991. Sequence Stratigraphy of the German Muschelkalk. In: Hagdorn, H. and Seilacher, A. (Eds.): Muschelkalk. Schöntaler Symposium. 15-18. Goldschneck-Verlag, Stuttgart.

Avanzini, M. 2002. Dinosauromorph tracks from the Middle Triassic (Anisian) of the Southern Alps (Valle di Non-Italy). Bolletino della Società Paleontologica Italiana, 41 (1), 37-40.

Bachmann, G.H. and Aref, M.A.M., 2005. A seismite in Triassic gypsum deposits (Grabfeld Formation, Ladinian), Southwest Germany. Sedimentary Geology 180, 75-89.

De Zanche, V. and Farabegoli, E. 1988. Anisian paleogeographic evolution in the Central-Western Southern Alps. Memoirs Scientifique Geologique 40, 399-411.

Demathieu, G.R. 1985. Trace fossil assemblages in Middle Triassic marginal marine deposits, eastern border of the Massif Central, France. Societe Economie Paléontologie et Mineralogie, Special Publications, 35, 53-66.

Diedrich, C. 2005. Actuopalaeontological trackway experiments with Iguana on intertidal flat carbonates of the Arabian Gulf - a comparison to fossil Rhynchosauroides tracks of Triassic carbonate tidal flat megatracksites in the European Germanic Basin. Senckenbergiana maritime, 35 (2), 203-220.

Diedrich, C. 2008a. Millions of reptile tracks - Early to Middle Triassic carbonate tidal flat migration bridges of Central Europe. Palaeogeography, Palaeoclimatology, Palaeoecology, 259, 410-423.

Diedrich, C. 2008b. Palaeogeographic evolution of the marine Middle Triassic marine Germanic Basin changements – with emphasis on the carbonate tidal flat and shallow marine habitats of reptiles in Central Pangaea. Global and Planetary Change, 65 (2009), 27-55.

Diedrich, C. 2009a. The vertebrates of the Anisian/Ladinian boundary (Middle Triassic) from Bissendorf (NW Germany) and their contribution to the anatomy, palaeoecology, and palaeobiogeography of the Germanic Basin reptiles. Palaeogeography, Palaeoclimatology, Palaeoecology, 273 (2009), 1-16.

Diedrich, C. 2009b. Die Saurierspuren-Grabung im basalen Mittleren Muschelkalk (Anis, Mitteltrias) von Bernburg (Sachsen-Anhalt). Archäologie in Sachsen-Anhalt, Sonderband 2009, 1-62.

Diedrich, 2010a. Palaeoecology of Placodus gigas (Reptilia) and other placodontids - macroalgae feeder of the Middle Triassic in the Germanic Basin of Central Europe and comparison to convergent developed sirenia. Palaeogeography, Palaeoclimatology, Palaeoecology, (in review).

Diedrich, 2010b. The vertebrate fauna of the Lower Ladinian (Middle Triassic) from Lamerden (Germany) and contribution to the palaeoecology, anatomy and palaeogeography of the Germanic Basin reptiles. Palaeogeography, Palaeoclimatology, Palaeoecology, (in review).

Diedrich, 2010c. The palaeogeographic reconstructions of the Middle Triassic tectonical controlled carbonatic Germanic Basin of Central Europe - a northern Tethys connected cratonic marine Basin – coastal basin margin mappings by the use of reptile footprint rich intertidal and sabkha environments. Abstract, Fifth International Conference on the Geology of the Tethys Realm, Quena-Luxor,Egypt), 3-5.

Diedrich, in prep. The shallow marine fish and sauropterygian reptile vertebrate fauna of the Germanic Basin from the atavus/pulcher Bonebeds in the Bad Sulza Fm (Illyrian, Middle Triassic) of Bad Sulza (Central Germany).

Diedrich, C. and Trostheide, F. 2007. Auf den Spuren der terresten Muschelkalksaurier und aquatischen Sauropterygier vom obersten Röt bis zum Mittleren Muschelkalk (Unter-/Mitteltrias) von Sachsen-Anhalt.

Abhandlungen und Berichte für Naturkunde, 30, 5-56.
Föhlisch, K. 2007. Überlieferungen seismischer Aktivität im Unteren Muschelkalk. Beiträge zur Geologie Thüringens, N.F. 14, 55-83.
Furrer, H. 1995. The Kalkschieferzone (Upper Meride estone Ladinian) near Meride (Canton Ticino, Southern Switzerland) and the evolution of a Middle Triassic intraplatform basin. Eclogae geolicae Helvetiae, 88(3), 827-852.
Hagdorn, H. 1990. Das Muschelkalk/Keuper-Bonebed von Crailsheim. In: Weidert, W. K. (Ed.), Klassische Fundstellen der Paläontologie, Band 2. 78–88. Goldschneck-Verlag, Stuttgart.
Hagdorn, H., E. Nitsch, Aigner, T. and Simon, T. 2009. Field guide 6th international Triassic field workshop (Pan-European Correlation of the Triassic) Triassic of Southwest Germany. September 7-11, 2009, www.stratigraphie.de/perm-trias_workshops.html, 1-72.
Knaust, D. 1997. Die Karbonatrampe am SE-Rand des Persischen Golfes (Vereinigte Arabische Emirate) - rezentes Analogon für den Unteren Muschelkalk der Germanischen Trias? Greifswalder Geowissenschaftliche Beiträge, 5, 101-123.
Knaust, D. 2000. Signatures of tectonically controlled sedimentation in Lower Muschelkalk carbonates (Middle Triassic) of the Germanic Basin. Zentralblatt für Geologie und Paläontologie, I, 1998 (9-10), 893-924.
Kozur, H.W. and Bachmann, G.H. 2008. Updated correlation of the Germanic Triassic with the Tethyan scale and assigned numeric ages. Berichte der Geologischen Bundesanstalt Wien, 76, 53-58.
Reif, W.E. 1982. Muschelkal/Keuper bone-beds (Middle Triassic, SW-Germany) - storm condensation in a regressive cycle. In: Einsele, G. and Seilacher, A. (Eds.), Cyclic and Event Stratification. 299-325. Springer-Verlag, Berlin-Heidelberg-New York.
Müller, W. et al., 1964. Vulkanogene Lagen aus der Grenzbitumenzone (Mittlere Trias) des Monte San Giorgio in den Tessiner Kalkalpen. Eclogae geolicae Helvetiae, 57(2), 431-450.
Rüffer, T. 1996. Seismite im Unteren Muschelkalk westlich von Halle (Saale). Hallesches Jahrbuch für Geowissenschaften, B 18, 119-130.
Schoch, R. and Wild, R. 1999. Die Wirbeltiere des Muschelkalks unter besonderer Berücksichtigung Süddeutschlands. In: Hauschke, N. and Wilde, V. (Eds.), Trias eine ganz andere Welt. Europa im frühen Erdmittelalter. 331-342. Pfeil-Verlag, München.
Schwarz, U. 1975. Sedimentary structures and facies analysis of shallow marine carbonates (Lower Muschelkalk, Middle Triassic, SW-Germany). Contributions to Sedimentology, 3, 1-100.
Szulc, J. 1998. Anisian-Carnian evolution of the Germanic Basin and its eustatic, tectonic and climate controls. Zentralblatt für Geologie und Paläontologie, I, 7-8, 813-852.