Project outline "The Pan-European correlation of the epicontinental Triassic"

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Introduction

The epicontinental Triassic successions in Europe show much similarity in the overall pattern of evolution, which is mainly due to similar basin evolution and climatic conditions. In the various parts of Europe, the relative timing of basin extension, the environments of sedimentary infill (marine, lacustrine, fluvial), impact upon biota, and synchronicity of lithological boundaries are often hotly debated. The standard model of these epicontinental successions is in the Central European Basin (CEB), where the tripartite Triassic system (Buntsandstein, Muschelkalk, Keuper) was originally defined by Friedrich von Alberti (1834), the so-called "Germanic Triassic". Whilst this standard model is commonly applied in large parts of Central and Southwestern Europe, it cannot be used, for instance, in Western Europe, where a bi-partite division into the Sherwood Sandstone and Mercia Mudstone groups is normally applied, or north of the Mid-North Sea High, where fluvial-sandstone to lacustrine mudstone successions are common in the Middle and Upper Triassic.

This project group aims to improve the understanding of the epicontinental Triassic in Europe on a number of fronts.

Better correlation to the Triassic stage boundaries

With the establishment of Triassic stage boundaries proposed by the task forces of the STS by 2008, it is necessary to better understand the mapping of these stage boundaries into the European epicontinental Triassic. This is likely to be possible only by an approach that uses integrated stratigraphic tools.

The best understood part of the European epicontinental Triassic is the Germanic Triassic, where the continental Buntsandstein can be dated and correlated using conchostracans, sporomorphs and partly vertebrates. Additionally, the marine-influenced Upper Buntsandstein can be correlated by bivalves and in places ammonoids and holothurians. The correlation of the overlying marine Muschelkalk is based on conodonts and in part ammonoids, bivalves, brachiopods, echinoderms and sporomorphs. In the mainly continental Keuper, conchostracans, sporomorphs, bivalves as well as ostracods and vertebrates are useful for correlation. Close to the Triassic-Jurassic boundary, conodonts occur in the Penarth Group (United Kingdom). Thus, in terms of biostratigraphy, the Germanic Triassic and its lateral equivalents can be correlated, in places in detail, with parts of the marine Triassic stages, but in other places rather poorly (e.g. Kozur, 1999, Bachmann & Kozur, 2004). Extending this knowledge, gained from many years of study on the CEB, to other parts of Europe is an important aim of this project group.

In the last decade, a considerable number of magnetostratigraphic studies have been carried out in the Triassic, which has lead to a working model for the magnetic field polarity for most of the Triassic (Muttoni et al., 2004). Through the correlation of this stage-related biomagnetostratigraphy it is now possible to correlate the Triassic stages into the European epicontinental successions through the use of magnetostratigraphy (e.g. Nawrocki, 1997, Hounslow & McIntosh, 2003, Szurlies et al., 2003, Szurlies, 2004, Hounslow et al., 2004, Dinarès-Turell et al., 2005).

Stable isotope stratigraphy also appears to provide markers for isochronous correlation, such as at the Permian-Triassic boundary (e.g. Hiete, 2004) and the Triassic-Jurassic boundary (Hesselbo et al., 2002), both based on stable organic carbon isotopes. This clearly has the potential for development, if other synchronous "biological/climatic events" can be found both in marine and terrestrial environments. Hence, a detailed correlation of the entire epicontinental succession, including the fossil-free intervals, requires the stratigraphic evaluation of many tools including biostratigraphy, magnetostratigraphy, stable isotope stratigraphy and perhaps other isochronous event markers such as impact ejecta horizons and microspherules (e.g. Walkden et al., 2003, Bachmann & Kozur, 2004).

Integration of lithostratigraphic and cyclostratigraphic schemes

A speciality of the Triassic of the CEB is the confusingly large number of often synonymous or homologous lithostratigraphical terms, which have proliferated in more than 150 years of research. Another characteristic is the frequent use of unconformities and marker beds for lithostratigraphic subdivisions and correlations, which result in a mixture of lithostratigraphy and allostratigraphy. The introduction of wireline logs to basin-wide correlation has opened up the possibility for an integrated high-resolution log- and lithostratigraphic framework for the epicontinental Triassic (e.g. van Adrichem Boogaert & Kouwe, 1994, Geluk & Röhling, 1997, Bourquin et al. 1998, Michelsen & Clausen, 2002, Szurlies et al., 2003). Furthermore, such correlation within the CEB is supported by numerous marker beds, which seem to provide quasi-isochronous horizons (e.g. Szurlies et al., 2003, Szurlies, 2004, Lutz et al., 2005). The Triassic of the CEB is indicated by a distinct cyclicity of varying magnitude, which is considered to reflect water depth and climatic variations in the CEB due to tectonic activity or solar-induced Milankovitch cycles (e.g. Aigner & Bachmann, 1992, Clemmensen et al., 1994, Goggin and Jacquin, 1998). These offer a promising tool for correlation of the epicontinental Triassic, but also potentially for improving the global Triassic time scale (e.g. Bachmann & Kozur, 2004). The challenge here is to attempt to correlate these base-level cycles (sequences) and cyclostratigraphic units into other parts of the CEB as well as to basins outside of it, to see if it is possible that they may be linked to a set of European-wide tectono-stratigraphic or climatic events which drive the cycles. For this, a combination of lithostratigraphy and (wireline) log stratigraphy is most promising, in that it provides a robust high-resolution lithostratigraphic framework, which additionally can be supported by prominent quasi-isochronous marker beds. Other biomagnetostratigraphic constraints are required to validate this.

A first stage in this process would be to establish key transects (E-W, N-S) by linking the different lithostratigraphic nomenclatures in the separate basins using all available methods (e.g., biostratigraphy, magnetostratigraphy, lithostratigraphy, cyclostratigraphy, log-stratigraphy, chemostratigraphy) resulting in a robust and detailed high-resolution stratigraphic correlation framework for the European epicontinental Triassic.

Triassic palaeoclimate, environmental and biotic change

The sedimentary record of the epicontinental Triassic is modulated by climatic, tectonic, environmental and biotic changes. The interplay between these factors can be better understood within a framework that attempts to link them to a chronostratigraphic and cyclostratigraphic scale. It is then possible to separate European-wide change in these factors from local and regional events, and so better understand the causal events of climatic and biotic changes. This is illustrated by the many studies, which attempt to understand the timing and nature of events at the Permian-Triassic (e.g. Bachmann & Kozur, 2004, Hiete, 2004) and Triassic-Jurassic boundaries (Hesselbo et al., 2002). There are without doubt similar major environmental and biotic changes, which have a story to tell at or near other boundaries in the Triassic (e.g. near Olenekian/Anisian, Norian/Rhaetian boundaries).

Forums for collaboration

The work of the project group will be aided by a number of forums, which provide for dissemination of information, discussion, learning of new concepts and ideas and development of means by which collaborative efforts can improve research outcomes. The project group forums will include:

1. A forum for earth scientists who are interested in the epicontinental Triassic.
2. The opportunity to visit the different parts of the European epicontinental Triassic on annual field workshops and through this to bring together Triassic researchers and to encourage them to start cooperation.
3. The support of studies of the European epicontinental Triassic using a multidisciplinary approach.
5. An information forum in Albertiana.
6. The installation of a Website.

Field workshops

In 2004 and 2005, two field workshops took place, which formed the precursors of this project group. These were held in the United Kingdom and in Germany, respectively, to evaluate the relationships between the Triassic lithostratigraphies of the different European regions.

The initial **“Field workshop on the British Triassic”** was held during August 10-17, 2004, lead by Mark W. Hounslow, Peter Turner and Ramues Gallois. It brought together 12 geoscientists from 4 European countries (**Fig. 1**) to examine the similarity and differences between the Triassic basin evolution and succession development between the British and German Triassic. A north-south transect was examined from the Triassic successions of NW England, to those Triassic successions in SW England. This transect gave the opportunity for examination of most of the UK Triassic from near to the Permian-Triassic boundary to the Triassic-Jurassic boundary, and also the different styles of basin development, from those basins formed in Palaeozoic-age basement to those formed on Variscan basement.

The second **“Field Workshop on the Triassic of Germany and surrounding countries”** took place in July 14-20, 2005, lead by Gerhard H. Bachmann, Gerhard Beutler and Michael Szurlies. This workshop was attended by 24 geoscientists from 6 countries (**Fig. 2**) to discuss the relationships between the German Triassic and its relationships to the successions in the neighbouring countries.

The venue and starting point was Halle (Saale). **Fig. 3** shows a geological map of Thüringen (Thuringia) and Sachsen-Anhalt with the some 20 outcrops visited. There, on a total distance of some 120 km, a complete overview from the Zechstein-Buntsandstein boundary, including the continental Permian/Triassic boundary (Stop 1, 10), to the Triassic-Jurassic boundary (Stop 21) could be given. Examples of most relevant Buntsandstein, Muschelkalk and Keuper formations as well as the stages within, were visited and discussed.

To consolidate the activities of the project group, the series of annual workshops has been continued with a **“Field Workshop on the Triassic of eastern France”**

Figure 1: Participants of the field workshop on the British Triassic at the Bristol Channel.

Figure 2: Participants of the field workshop on the German Triassic in the Steudnitz outcrop.

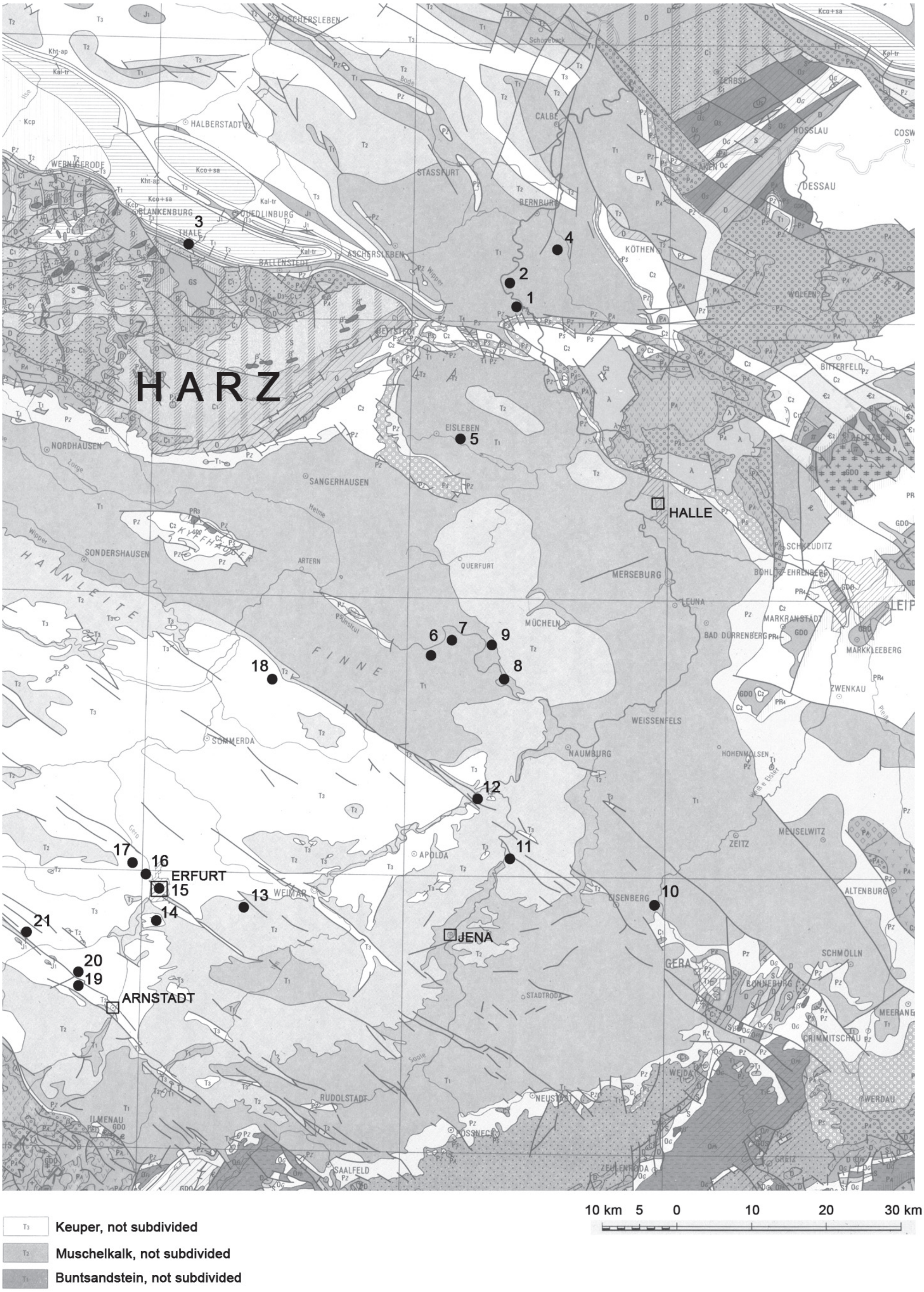

Figure 3: Geological map (without Cenozoic) with Stops 1-21 of field workshop on the German Triassic.

Stop 1	Nelben near Könnern (Uppermost Zechstein / Lower Buntsandstein: Fulda Fm – Calvörde Fm, PTB)
Stop 2	Beesenlaublingen (Lower Buntsandstein: Bernburg Fm)
Stop 3	Thale (Lower Buntsandstein: Calvörde Fm), optional
Stop 4	Baalberge (Middle Buntsandstein: Volpriehausen Fm)
Stop 5	Unterrissdorf (Lower Buntsandstein: Bernburg Fm)
Stop 6	Grosswangen (Lower / Middle Buntsandstein: Bernburg Fm – Volpriehausen Fm)
Stop 7	Nebra (Middle Buntsandstein: Hardegsen Fm – Solling Fm)
Stop 8	Glockenseck near Laucha (Upper Buntsandstein: Röt Fm)
Stop 9	Karsdorf (Upper Buntsandstein, Lower Muschelkalk: Röt Fm, Jena Fm)
Stop 10	Caaschwitz (Upper Zechstein / Lower Buntsandstein: Leine Fm – Fulda Fm, Calvörde Fm, PTB)
Stop 11	Steudnitz (Lower / Middle Muschelkalk: Jena Fm – Karlstadt Fm)
Stop 12	Krähenhütte near Bad Sulza (Middle Muschelkalk / Upper Muschelkalk: Diemel Fm – Trochitenkalk Fm)
Stop 13	Troistedt (Upper Muschelkalk: Meissner Fm)
Stop 14	Erfurt, Egstedter Trift (Lower Keuper: Erfurt Fm)
Stop 15	Erfurt, Petersberg (Middle Keuper: Weser Fm)
Stop 16	Erfurt-Gispersleben (Middle Keuper: Stuttgart Fm – Weser Fm)
Stop 17	Schwellenburg (Middle Keuper: Weser Fm)
Stop 18	Groß Monra (Middle Keuper: Stuttgart Fm)
Stop 19	Wachsenburg near Arnstadt (Middle Keuper: Weser Fm – Arnstadt Fm)
Stop 20	Burg Gleichen near Arnstadt (Middle Keuper: Arnstadt Fm)
Stop 21	Grosser Seeberg near Gotha (Upper Keuper / Liassic: Exter Fm – Liassic)

taking place in **October 2-7, 2006**. This field trip was organized by Sylvie Bourquin (CNRS, University Rennes 1, France).

We look forward to hearing from all interested colleagues who are willing to participate in this project group. We hope to stimulate discussion and further investigation of the above-mentioned aspects by the community of Triassic workers. Please contact Michael Szurlies if you are interested in the project group.

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