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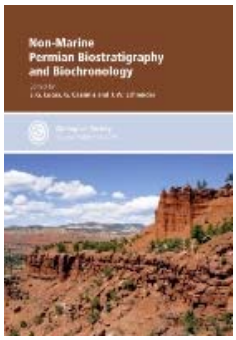
Non-Marine Permian Biostratigraphy and Biochronology, edited by S.G. Lucas, G. Cassinis & J.W. Schneider, 2006. Geological Society Special Publication 265. The Geological Society of London, The Geological Society Publishing House, Unit 7, Brassmill Enterprise Centre, Brassmill Lane, Bath, BA1 3JN, United Kingdom. Hardback, 344 pages. Price GBP 85.00. ISBN 978-1-86239-206-9.



Permian continental strata are known from many regions across the world. Despite they have been studied for about two centuries, each new research project devoted to the Permian brings a number of new, intriguing results. It is therefore not surprising that the interest into these strata remains high. Why is exploration of the Permian continental world so attractive? The answer is quite simple: because the strata of this Period are so different from older and younger strata; often they are red! In fact, the traditional name of the European Lower-Middle Permian is Rotliegendes, which means "red bed". To be more serious, a huge supercontinent (Pangea), which included all large continental blocks, dominated the Permian Earth. This created a very specific situation, because non-marine deposits accumulated within very large areas, and terrestrial life became diversified and dispersed over the landmasses rapidly.

The Permian stratigraphy is changing rapidly since the 1990s. The two-fold subdivision was replaced by three units, and a number of global stages were re-established with the Global Stratotypes Sections and Points (GSSPs). An absolute duration of this Period was also established: the Permian lasted 48 Ma (299-251 Ma). These important achievements have become possible thanks to the ongoing activity of the International Commission on Stratigraphy (ICS). At the same time, many regional-scale studies of the non-marine Permian strata and fossils have been carried out in Europe, North and South America, Africa, Arabia, East Asia, Iran, Russia, and Australia. Thus, it is a right time to summarize the new knowledge, so as to form the basis for further developments. Such an attempt is represented in this volume.

The book is essentially a synthesis of information. But of what kind? It embraces the results of some selected (!) research projects, which enriches our knowledge of the continental Permian deposits and fossils. However, this is not a comprehensive overview of the non-marine Permian (except few chapters). The volume consists of an introduction, 14 research papers, and an index. The introduction is a brief contribution by Lucas et al., who give a historical background and clarify the present state of research on the non-marine Permian. The contents of the 14 chapters is briefly explained in the introduction. The most strange for me is the lack of any explanation of the ICS activities (except very few citations), whereas more detailed information is given on the so-called SGCS (Standard Global Chronostratigraphic Scale). The relationship between the ICS international chronostratigraphic chart adopted in 2004 and the SGCS remains unclear. It looks whether they are the same. Figure 1, which presents the Permian chronostratigraphy, does not contain any indication of which stages are formal (i.e., established with GSSP) and which are not, and also introduces two regional units (Wolfcampian and Leonardian) to the global chart.

Another critical note must be made about Figure 2, where "the most important continental Permo-Carboniferous basins" are shown. Where is the Western Caucasus with the thickest Early Permian molasse?! Why do the authors name the Cisuralian “Orenburg region”?! And why is

most Africa so "empty"? Moreover, the abbreviation "SP" shown on a map somewhere in the North Sea is not explained in the caption and it is easy to muddle it with another abbreviation "Sp", which refers to the "Spain Basins". It would have been much more reader-friendly if the introduction had included a correlation chart for the Permian deposits, like that just published by Menning et al. (2006). This would help the reader to understand the relationships between the various regional units that are commonly used in the Permian non-marine stratigraphy. On the other hand, the introduction provides a very helpful synopsis comprising the stratigraphic usefulness of micro- and macrofloras, charophytes, ostracodes, conchostracans, insects, bivalves, fishes, tetrapod footprints and body fossils.

The first chapter is devoted to the polarity time scale for the Permian/Triassic transition. A number of polarity intervals is recognized. It seems that the so-called Illawara Reversal, which occurred in the Guadalupian, was a remarkable event, because it marked the beginning of the geomagnetic-field reversals after a 50-Ma-long constant polarity. This contribution focuses on the Siberian Traps. Long-term eruptions are postulated, and these are presented as the likely cause of the spectacular Permian/Triassic mass extinction, which devastated the Earth's biota. Surprisingly, hypothesized short-duration eruptions have also been used as evidence, for a volcanism-triggered extinction (Erwin, 2006)! It thus must be deduced that further discussions on this subject are required.

Rössler describes the petrified Permian forests found in the pyroclastic horizon at Chemnitz (Germany) and in the alluvial deposits at Tocantins (Brazil). These are great examples of the World Paleontological Heritage Sites. Both local floras were dominated by tree ferns. Some similarity between the assemblages can be explained with broad phytogeographic connections that may have been possible as a result of the assembly of the various continental blocks into the unique supercontinent Pangea.

The paper by Lucas, who examines the global Permian tetrapod-based biostratigraphy, is of a great importance. Ten faunachrons, namely Coyotean, Seymouran, Mitchellcreekian, Redtankian, Littlecrotonian, Kapteinskraalian, Gamkan, Hoedemakeran, Steilkransian, and Platbergian, are outlined and formally described. The author underlines that both the Carboniferous/Permian and the Permian/Triassic boundaries do not correspond with the boundaries of the land-vertebrate faunachrons.

Roscher & Schneider attempt to re-evaluate the Pennsylvanian-Permian climatic conditions in Central Europe. The climate was generally dry, but five wet phases, related to the Gondwanan glaciation, are recognized. The closure of the Rheic Ocean was responsible in part for the aridization, whereas the mountain chains formed during the Hercynian orogeny did not form an orographic barrier. Arguments for four seasons in the equatorial belt, and for a monsoon system are put forward. It is important that the authors' conclusions are supported by their own paleotectonic and paleoclimatic reconstructions. It would of of special interest to test whether the recovered plate-tectonic interactions are consistent with the reconstructions proposed by Stampfli & Borel (2002) and Torsvik & Cocks (2004).

Hunt & Lucas identify five archetype vertebate ichnofacies (the four Permian ones are *Chelichnus*, *Batrachichnus*, *Brontopodus*, and *Characichichnos*) of the Permian non-marine environments of North America and the rest world, while Gand & Durand deal with the tetrapod footprints of the French basins.

Lucas & Hunt (in a second joint contribution to this volume) reconstruct some biostratigraphic developments based on tetrapod footprints. Only two units are outlined. The first embraces the Early Permian, and the second the Middle-Late Permian. One must think that the authors' conclusion about the higher resolution of biozonation based on tetrapod body fossils in comparison with that based on footprints is not unexpected. I believe that this conclusion is very important because it demonstrates the true stratigraphic utility of footprints evaluated with recent data.

Werneburg & Schneider revise the amphibian Pennsylvanian-Cisuralian biozonation of Europe. Nine zones are defined formally, which provides a good basis for interregional correlations. It is an excellent decision of the authors to distinguish between the First and Last Appearance Dates (FAD and LAD), and the First and Last Occurrence Dates (FOD and LOD);

the latter terms are often mentioned as First and Last Occurrence Levels (FOL and LOL). Three particular examples of correlations with these revised biozones are given. In general, this is a very impressive paper!

Štamberg summarizes the state-of-the art regarding the actinopterygian fishes from the Bohemian basins (Czech Republic). The data are plotted for each individual basin, and also summarized in Table 5. Co-occurrence with discosauriscid amphibians suggests that the latter ate actinopterygians.

Then, several contributions are devoted to the regional stratigraphy and paleontology of the non-marine Permian. The Carboniferous and the Triassic are also mentioned here and there.

Virgili et al. pay attention to the tectono-sedimentary evolution of south-western Europe. This is a very informative review, which particularly supports the idea of transformation of Pangea B to Pangea A around the Middle Permian.

Arche & López-Gómez deal with the basins of central and northeastern Iberia, where the Permian/Triassic transition is marked by two barren intervals that are related to the activity in two large igneous provinces, namely Emeishan and Siberia.

Durand records an older age of the beginning of the French Buntsandstein sedimentary cycle in the Provence (south-eastern France), which is compared with data from other European regions. It is suggested that the arid conditions started in the Dienerian-Smithian. Does it mean some gradual changes across the Permian/Triassic transition? At least, it appears so.

Hmich et al. evaluate the biostratigraphic potential of Carboniferous-Permian faunas (insects, tetropods, tetrapod tracks) from the Moroccan basins. Paleobotanical data are extensively dealt with in this contribution. A trend to aridization interrupted by wet phases is reconstructed. Such climatic changes forced the terrestrial fauna to adapt or to become extinct. The taxa that adapted to the droughts radiated during the late Cisuralian - early Lopingian.

The last contribution, authored by Schneider & Werneburg, is devoted to one of the most interesting topics, namely insect-based biostratigraphy. Examination of available data permits to delineate and to define formally 11 spiloblattinid biozones. I can only dream how efficient it would be to carry out a similar investigation for the famous Uralian localities of the Permian insects, where rich collections were obtained in the mid-20th century.

The organization of a book should be well structured. Contributions on similar subjects should be presented in one section of the book, but here, for instance, a contribution on tetrapods is followed by one dealing with the climate, which contribution is followed, in turn, by one again about tetrapods. The technical presentation is fine, however: the volume is richly illustrated, although most of the figures are black-and-white. Numerous Permian non-marine strata are so spectacular that the black-and-white reproductions are a bit disappointing. It would have added much to the value of the book if it had contained at least some colorful outcrop photos, like the one on the front cover. The index at the end of the volume is rather complete and, therefore, useful.

I like to detail what I dreamed to find in this volume and what I have not found. First, this is a synthesis of the Permian paleotectonics, which is essential for understanding many of the conclusions presented in this volume. Second, these are discussions of diversity changes, extinctions, and turnovers among the continental faunas and floras. Third, these are more regional evidences from South America, Asia, Australia, and Antarctica. Fourth, this is an overview of the stratigraphic and paleontological studies that are required now. It is good to read about what has just been done, but it is not less important to know what should be done now.

This volume has one very attractive aspect. Many contributions contain formal descriptions of biostratigraphic units, which are made very accurately and according to the widely-accepted rules. Bioevents are selected carefully and the biostratigraphic horizons are as important as the lithostratigraphic units. Nothing is oversimplified or abridged in these descriptions. This makes the book a very helpful tool explaining the "classical" biostratigraphic approaches.

In general, I have found this volume full of numerous interesting and useful information. It provides a valuable basis for further thoughts and discussions, and, consequently, the editors have carried out their main task very successfully. Thus, , I strongly recommend this book to all specialists in Permian stratigraphy, paleontology, paleogeography, and paleotectonics.

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