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Palaeoclimatic and site-specific conditions in the early Permian fossil forest of Chemnitz—Sedimentological, geochemical and palaeobotanical evidence

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ABSTRACT

As significant indicators of deep-time palaeoclimate, a number of new palaeontological, pedological and geochemical characteristics are provided for the Chemnitz Fossil Lagerstätte to depict more precisely its environmental conditions. For the first time, several lines of evidence indicate that this fossil forest, instantaneously preserved by volcanic deposits, once received an annual precipitation of around 800–1100 mm, but grew on a nearly unweathered palaeosol. Although the composition of this rich and diverse T^0 assemblage suggests a hygrophilous, dense and multi-aged vegetation dominated by conservative lineages, the habitat was affected by environmental disturbances and pronounced seasonality. Repeated changes in local moisture availability are suggested by geochemical proxies, the co-occurrence to intergrowth of calcic and ferric glaebules in the palaeosol and developmental traits of perennial vegetational elements. Specific substrate adaptation is reflected by different root systems and cyclic growth interruptions recorded in the stems, branches and roots of long-lived woody plants. Many differentially adapted terrestrial animals complete the more comprehensive reconstruction of a late Sakmarian ecosystem and its climatic and preservational controls. Albeit spatially confined, this diverse *in-situ* record may contribute to understand wetland–dryland dynamics of sub-tropical Northern Hemisphere Pangaea.

1. Introduction

The most important witness of how ancient ecosystems react to climatic and environmental changes lies in the geological record. Of overall significance in this regard are fossil forests, especially if they represent *in-situ* records that reflect not only plant remains but also diverse animals, interactions between organisms and environmental characteristics. However, significant examples of such instantaneously preserved ecosystems are rare in the late Palaeozoic. Nevertheless, if thoroughly studied and understood they can provide a detailed picture of ancient living communities in the continental realm, and offer a high potential for understanding palaeoecological relationships (Césari et al., 2012; Gastaldo et al., 2004; Hinz et al., 2010; Opluštil et al., 2014; Wang et al., 2012). An ideal example with both a long study history (Cotta, 1832; Frenzel, 1759; Sterzel, 1875) and multi-focus ongoing research (Dietrich et al., 2013; Dunlop and Rößler, 2013; Feng et al., 2012; Matysová et al., 2010; Rößler et al., 2012a,b) is the Petrified Forest of Chemnitz. It represents an early Permian (latest Sakmarian) forest ecosystem developed on a distal braidplain and buried instantaneously by the deposition of volcanic ashes and flows. The rapid coverage by pyroclastics, due to a series of explosive volcanic eruptions, led to a three-dimensional record of the forest in growth position including its palaeosol, which classifies it as an outstanding T^0 assemblage (compare characteristics given in DiMichele and Falcon-Lang, 2011).

Historically, this fossil Lagerstätte has been well known since at least the early 18th century, due to prospecting activities for precious minerals. Although there exist some scientific descriptions from that time (Frenzel, 1759), the major motivation for collecting petrifactions was the utilisation as gemstones. The interest in its palaeobotanical significance has risen since the 19th century and continues today (e.g., Barthel, 1976; Cotta, 1832; Rößler, 2000, 2006; Sterzel, 1904). However, for a long time scientific descriptions were based on coincidental finds only, which occurred during construction works in the city of Chemnitz. On the basis of such material, research on specific fern or calamitean taxa has been carried out (Feng et al., 2012; Rößler, 2000; Rößler and Galtier, 2002a, b; Rößler and Noll, 2006, 2007, 2010). Additionally, during the last two decades geological research improved the general understanding of the basin development, its facies architecture, stratigraphic subdivision and interregional correlation (Eulenberger et al., 1995; Fischer, 1991; Schneider et al., 2012).

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