Zbl. Geol. Paläont. Teil I	1998	Heft 11–12	1475–1495	Stuttgart, Februar 2000

High-resolution early Mesozoic Pangean climatic transect in lacustrine environments

EPICONTINENTAL TRIASSIC INTERNATIONAL SYMPOSIUM
Halle/S. Germany
September 21 – 23, 1998

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with 8 figures

Abstract: Analysis of 6700 m of core from the Newark rift basin in New Jersey, USA provides a high-resolution astronomically calibrated magnetic polarity time scale for the Late Triassic and Early Jurassic spanning about 33 million years. This time scale, and its application elsewhere, allows a significant simplification of the pattern of climate-sensitive facies in the early Mesozoic basins of the central and north Atlantic margins. Coals and deep-water lacustrine deposits were produced at the paleoequator (Richmond-type sequences), while strikingly cyclical lacustrine and playa deposits were produced 10° to the north and south (Newark-type lacustrine sequences). At 10–30 °N, eolian dunes, playas sediments and evaporites were deposited (Fundy-type sequences). Farther north, shallow-water lacustrine red beds were deposited (Fleming Fjord-type sequences), while yet farther north (~40°), perennial-lake black mudstones and coals again dominated in the humid temperate zone (Kap Stewart-type sequences). Central Pangea drifted north about 10° during the Late Triassic, and the vertical sequence of climate-sensitive facies in individual basins changed as the basins passed through different climate zones. This simple zonal climate pattern explains most first-order changes in overall lacustrine sequences seen in the rift zone. Lake-level cycles of Milankovitch origin change in a predicable way with the latitudinal shifts in climate and lacustrine style. Roughly 10 ky precessional cycles dominate within a few degrees of the equator, while ~20 ky precessional cycles are dominant northward to about 30 °N where ~40 ky obliquity cycles become evident in lake-level records.

Introduction

Stratigraphic correlation provides the framework for understanding ancient Earth systems. If stratigraphic resolution is poor, so will be the understanding of the system. Advances in paleoclimatology, especially aspects related to orbital forcing, have shown the permeating and persistent nature of relatively high-frequency (~10– ~20 ky) climate cycles throughout geological time. Given the poor resolution thought to be typical of interbasinal correlations in the early Mesozoic, outdated paleogeographic control, and high frequency climate change, it is hardly surprising that the lacustrine and related strata, preserved in numerous rift basins and rift-related basins from Svalbard to the Gulf of Mexico, have been depicted as

0340–5109/00/1998–1475 $ 5.25

displaying a baffling array of climate-sensitive lithologies. The seemingly conflicting associations of facies have prompted several ad hoc explanations invoking non-zonal climatic processes such as monsoons, the effects of topography, and global climate change (e.g. Manspeizer 1982, Parrish 1992).

Cyclostratigraphic and paleomagnetic analyses of 6700 m of core from the Newark basin collected by the Newark Basin Coring Project (NBCP – Olsen et al. 1996a) provide a high-resolution, astronomically calibrated, magnetic polarity time scale for the Late Triassic and Early Jurassic spanning about 32 million years (Kent et al. 1995, Olsen and Kent 1999). This time scale allows global correlations at intra-Neogene-level of resolution. In this paper we summarize our attempts to extend high-resolution correlations along a N-S transect from about 30 °N paleolatitude to the paleoequator along the axis of what would later become the Central and North Atlantic Oceans (Fig. 1). We use these correlations to place the basin sequences into a simple climatic scheme.

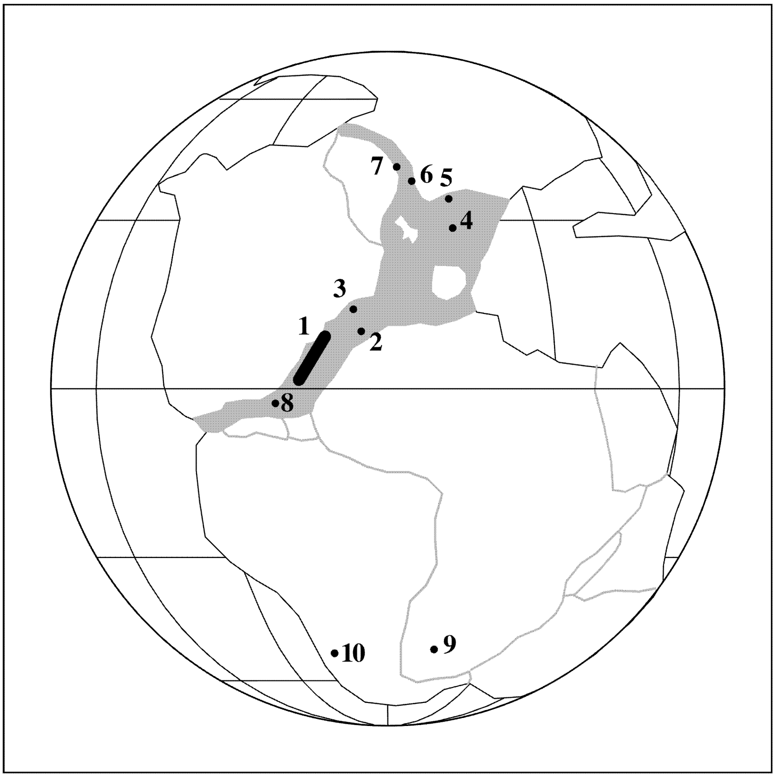

Fig. 1. Triassic-Early Jurassic zone of rifting (gray) in north-central Pangea. Reconstruction is modified from Olsen et al. 1996a and is for 210 my (Norian). Basins discussed in the text are: 1. Southern Newark Supergroup basins; 2. Argana basin; 3. Fundy basin; 4. Germanic basin; 5. Danish-Polish basin; 6. Haltenbanken; 7. Jameson Land basin; 8. South Georgia basin; 9. Karoo basin; 10. Ischigualasto basin.

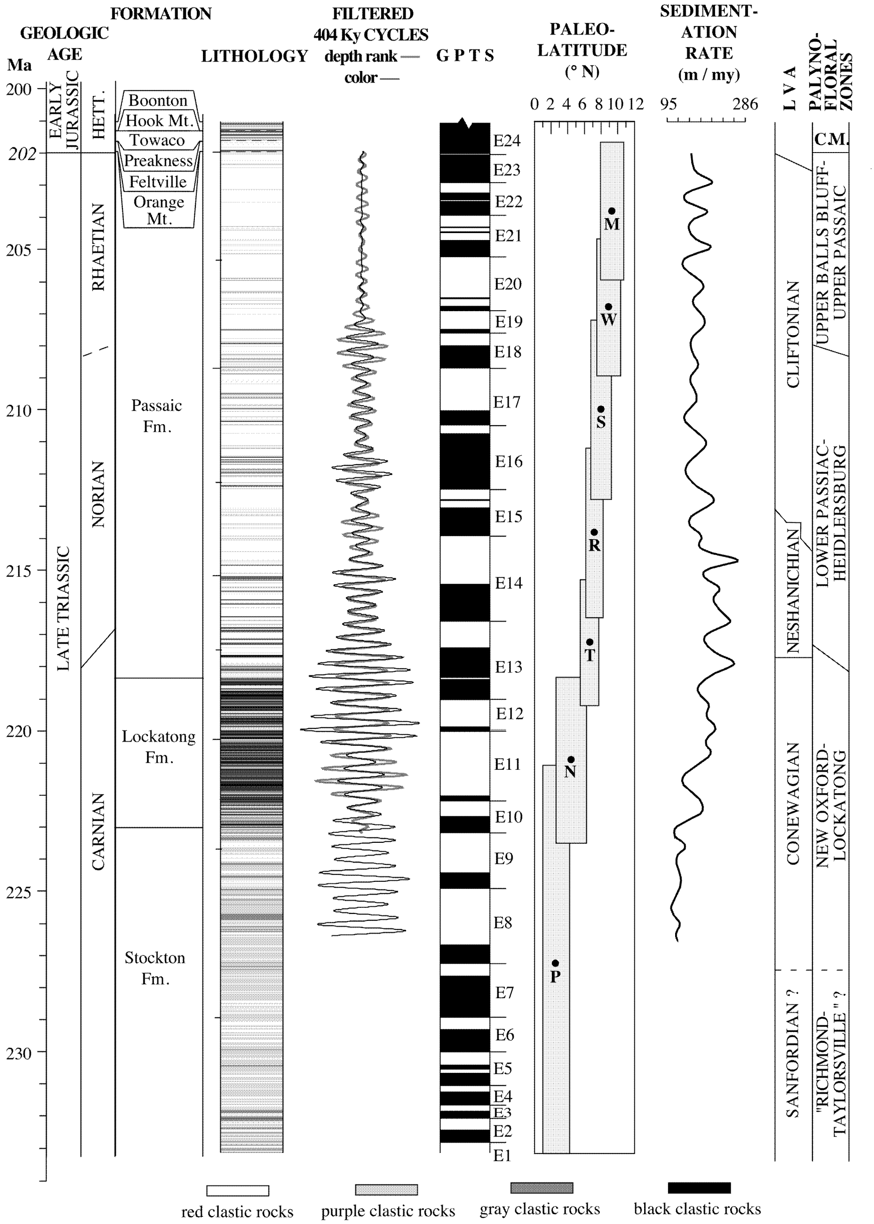

Fig. 2. Newark basin time scale, modified from Olsen and Kent (1999). Asterisks in lithology column indicate basalt flow horizons (dashed lines in lithology column) shown here represent zero duration (e.g. Olsen et al. 1996b). Magnetic polarity and paleolatitudes from Kent et al. (1995). Italicized date (*202*) under GEOLOGIC AGE is the absolute age tie point based on radiometric dates of lave flows.