G Model
PGEOLA 587 No. of Pages 20
ARTICLE IN PRESS
Proceedings of the Geologists' Association xxx (2017) xxx–xxx
Contents lists available at ScienceDirect
Proceedings of the Geologists' Association
journal homepage: www.elsevier.com/locate/pgeola

Rifts, rivers and climate recovery: A new model for the Triassic of England

Andrew J. Newell

British Geological Survey, Maclean Building, Wallingford, OX10 8BB Oxfordshire, United Kingdom

ARTICLE INFO

Article history:
Received 28 January 2017
Received in revised form 14 March 2017
Accepted 4 April 2017
Available online xxx

Keywords:
Permian
Triassic
England
Sherwood Sandstone
Mercia Mudstone

ABSTRACT

Triassic basins of England developed under a regime of largely W–E extension and progressed from non-marine fluvial and aeolian sedimentation (Sherwood Sandstone Group), through marine-influenced playa lacustrine deposits (Mercia Mudstone Group) to marine environments (Penarth Group). A new tectono-stratigraphic model for the Sherwood Sandstone Group is proposed in which two major long-distance river systems developed under conditions of relative fault inactivity in the Early Triassic (Budleigh Salterton Pebble Beds and equivalent) and Middle Triassic (Otter Sandstone and equivalent). These are separated by a late Early Triassic syn-rift succession of fluvio–aeolian sandstones (Wildmoor Sandstone and Wilmslow Sandstone formations) and playa lacustrine muds (Nettlecombe Formation) which show major thickness variation and localisation with hanging wall basins. The partitioning of syn-rift deposits into mudstones within upstream basins (close to the source of water and sediment) and clean aeolian or fluvio–aeolian sandstones in downstream basins is similar to the pattern observed in the underlying late Permian. Under conditions of rapid tectonic subsidence chains of extensional basins may become disconnected with upstream basins (Wessex Basin) acting as traps for fines and water permitting more aeolian activity in temporarily unlinked downstream basins (Worcester and Cheshire basins). In addition to tectonic controls, fluctuating climate, relief related to limestone resilience in arid settings, the smoothing effect of fill and spill sedimentation and Tethyan sea-level change all contributed toward the observed Triassic stratigraphy in England.
© 2017 The Geologists' Association. Published by Elsevier Ltd. All rights reserved.

1. Introduction

The Triassic represents a pivotal time in the geological record, both globally and within the stratigraphy of England. Throughout much of the preceding Palaeozoic the continents of the world had been progressively amalgamating into the supercontinent Pangaea ('all Earth'), a single landmass that extended virtually from pole to pole (Stampfli et al., 2013) (Fig. 1). The Triassic represents an important turnaround point. Pangaea showed signs of instability almost as soon as it had coalesced in the Permian and began to break apart in a process which would eventually lead to the formation of the North Atlantic Ocean. In England and adjoining areas the initial rifting of Pangaea was marked by the development of fault-bounded basins which acted as conduits for rivers that mostly flowed away from eroding Carboniferous (Variscan) mountain belts around the periphery of the Tethys Ocean (Bourquin et al., 2007; Hounslow and Ruffell, 2006; McKie and Williams, 2009). As North Atlantic rifting progressed, these terrestrial basins would eventually become marine at the end of the Triassic and into the Early Jurassic (Hesselbo et al., 2004). However, the initial continental clastic Triassic basin fills would later assume huge economic importance as subsurface stores for water and hydrocarbons. Triassic sandstones host western Europe's largest onshore oilfield at Wytch Farm (Bowman et al., 1993) and together with underlying Permian deposits represents England's second most important aquifer (Tellam, 1994).

The Triassic also marks the start of the Mesozoic which began in the wake of the end Permian mass extinction and ended with the Cretaceous–Tertiary mass extinction (Benton, 2016). The end Permian mass extinction at around 252.3 Ma was the largest of all time and had a devastating effect on marine life and terrestrial plants and animals, wiping out approximately ninety percent of all living organisms (Benton and Newell, 2014; Chen and Benton, 2012). The Triassic lasting from 251.9 to 201.3 million years (Ogg et al., 2016) was a time of gradual recovery during which time modern ecosystems and all of the key modern vertebrate groups originated (Benton, 2016).

The Triassic stratigraphy of England thus needs to be considered against a very dynamic background of tectonic and climatic

E-mail address: ajn@bgs.ac.uk (A.J. Newell).

http://dx.doi.org/10.1016/j.pgeola.2017.04.001
0016-7878/© 2017 The Geologists' Association. Published by Elsevier Ltd. All rights reserved.

Please cite this article in press as: A.J. Newell, Rifts, rivers and climate recovery: A new model for the Triassic of England, Proc. Geol. Assoc. (2017), http://dx.doi.org/10.1016/j.pgeola.2017.04.001

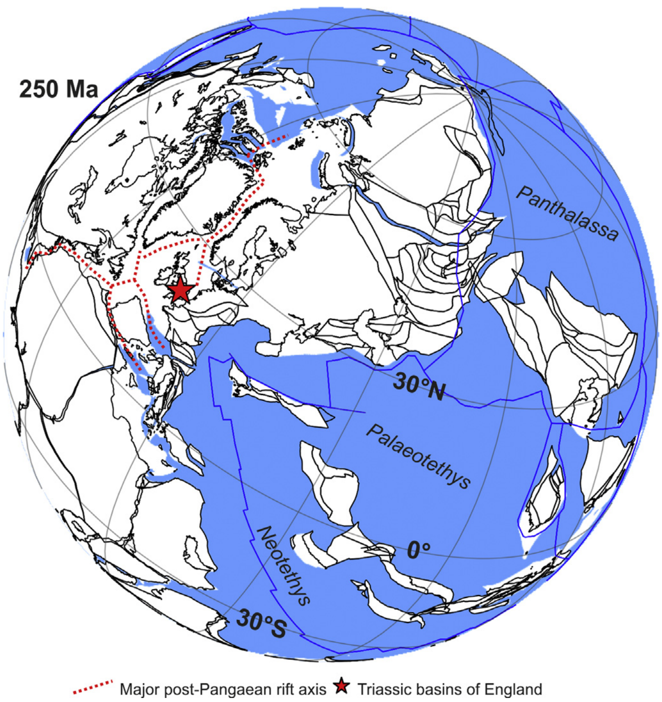

Fig. 1. Reconstruction of Pangaea at around the Permo–Triassic boundary (250 Ma). The position of England is shown and the lines of crustal separation in the future Atlantic are indicated. The plate tectonic reconstruction was produced using GPlates software using the datasets of Matthews et al. (2016).

instability. Events in the Triassic are fundamental to understanding the evolution of England throughout the Mesozoic and how it arrived at its current position on the eastern seaboard of the North Atlantic Ocean.

2. Aim and methods

A great deal has been published on the structure, stratigraphy, dating and depositional systems of the Triassic of England (Benton et al., 2002; Bourquin et al., 2007; Chadwick and Evans, 1995; Hounslow and Ruffell, 2006; McKie and Williams, 2009; Warrington et al., 1980; Wills, 1970). The aim of this paper is not only tosummarize some of this work but to introduce as much new data as possible in a very graphical form. The paper makes particular use of deep boreholes and geophysical logs which have been obtained over many decades of oil, coal and hydrogeological exploration and production in onshore England. Boreholes have an advantage over outcrops in that they provide a continuous stratigraphic record through the often extremely thick (up to 3 km) Permo–Triassic successions of England's onshore basins. Geophysical logging is a form of remote sensing where the properties of rocks are determined indirectly by measuring attributes such as resistivity, radioactivity and sonic velocity (Asquith and Gibson, 1982). Geophysical logs have long been used as tools for high resolution stratigraphic subdivision and correlation (Whittaker et al., 1985). This study is based largely on a database of 56 geophysically-logged boreholes distributed across the onshore Triassic basins of England and adjacent offshore areas.

The paper covers all of the Triassic, but the primary focus is on the Early and Middle Triassic Sherwood Sandstone Group: a fining upward succession of fluvial conglomerates and fluvio–aeolian sandstones which ranges up to around 1.2 km thick (Fig. 2). The Sherwood Sandstone Group represents a relatively short time span (around 10 million years) relative to the overall duration of the Triassic (around 51 million years) but has long attracted the most attention because of its economic importance, well-exposed sedimentary structures and tetrapod faunas (Benton et al., 2002). However, it is of course impossible to understand the Sherwood Sandstone Group without considering underlying Permian deposits and the overlying Middle to Late Triassic Mercia Mudstone Group (Fig. 2). Mid to late Permian deposits are very much part of the Triassic story because they represent the initial fill of sedimentary basins formed during orogenic collapse and regional extension of the Variscan mountain belt and its foreland (McCann et al., 2006). In England and adjacent parts of western Europe, major unconformities related to thermal uplift and erosion of the Variscan foreland separate mid to late Permian syn-rift deposits from early Permian molasse formed during the closing stages of Variscan mountain building (Edwards et al., 1997; Glennie, 1997; Glover and Powell, 1996). The Mercia Mudstone Group must be included in the discussion because of the great thickness (up to around 1.3 km) of this succession of playa lacustrine mudstones and evaporites, the large amount of Triassic time it occupies, and its diachronous relationship with the Sherwood Sandstone Group (Warrington et al., 1980). An understanding of thickness changes within the Mercia Mudstone Group has an important role to play in understanding the extent to which tectonics controlled the deposition of the Sherwood Sandstone (Ruffell and Shelton, 1999).

3. Triassic palaeogeographic and palaeoclimatic context

During the Triassic, England was located on the eastern part of the Pangaean Supercontinent at a palaeolatitude of around 20°N (Fig. 1). While it was relatively close to the oceanic areas of Palaeotethys and Neotethys it was largely isolated from marine influence by a chain of upland areas which included the Iberian, Armorican, Vindelician and Bohemian massifs (Fig. 3). In the Triassic, marine influence in northwest Europe was limited to incursions through narrow gateways which mostly did not extend far beyond the Middle Triassic Muschelkalk Sea of the Central European Basin (Franz et al., 2015 Ziegler, 1991) and the western extension of Tethys between Iberia and Africa (Ziegler, 1991). The narrow fault-bounded Triassic basins of England, separated from the German Basin by the London–Brabant Massif, remained an area of largely terrestrial fluvial, aeolian and playa lacustrine sedimentation throughout most of the Triassic until marine transgression in the Rhaetian (Blue Anchor Formation), which marked the start of long-term sea-level rise into the Early Jurassic (Hesselbo et al., 2004). This is not to say that the Triassic of England was totally isolated from marine influence. Organic-walled microplankton provide evidence of marine influence in the Middle Triassic Tarporley Siltstone, coincident with the Muschelkalk transgression (Warrington, 1970; Williams and Whittaker, 1974). Marginal marine influence continued throughout the Late Triassic with stable isotopic signatures of sulphates and dolomites (Taylor, 1983) and magnesium-rich clays (Leslie et al., 1993) showing that marine and continental derived waters mixed during the deposition of the Mercia Mudstone Group.

The bulk of the Early to Middle Triassic Sherwood Sandstone Group is fluvial in origin and the general configuration of the drainage system in the onshore Triassic basins of England has long been established through the use of various sediment provenance indicators and palaeocurrent analysis (Audley-Charles, 1970; Wills, 1951). The Early Triassic Budleigh Salterton Pebble Beds contains quartzite clasts with Ordovician and Devonian body and trace fossils that were derived from sources in Brittany and Normandy (Cocks, 1993; Radley and Coram, 2015) and the presence of comparable quartzite clasts in the English Midlands led to the concept of the Budleighensis River: a major drainage system which

Please cite this article in press as: A.J. Newell, Rifts, rivers and climate recovery: A new model for the Triassic of England, Proc. Geol. Assoc. (2017), http://dx.doi.org/10.1016/j.pgeola.2017.04.001

Download English Version:

https://daneshyari.com/en/article/8914572

Download Persian Version:

https://daneshyari.com/article/8914572

Daneshyari.com