Gondwana Research 17 (2010) 194–222

Contents lists available at ScienceDirect

Gondwana Research

journal homepage: www.elsevier.com/locate/gr

GR Focus

Evolution of the Rheic Ocean

R. Damian Nance [a,*], Gabriel Gutiérrez-Alonso [b], J. Duncan Keppie [c], Ulf Linnemann [d], J. Brendan Murphy [e], Cecilio Quesada [f], Rob A. Strachan [g], Nigel H. Woodcock [h]

[a] Department of Geological Sciences, 316 Clippinger Laboratories, Ohio University, Athens, Ohio 45701, USA
[b] Departamento de Geología, Universidad de Salamanca, 33708 Salamanca, Spain
[c] Departamento de Geología Regional, Instituto de Geología, Universidad Nacional Autónoma de México, 04510, México D.F., Mexico
[d] Senckenberg Naturhistorische Sammlungen Dresden, Museum für Mineralogie und Geologie, Königsbrücker Landstraße 159, D-01109 Dresden, Germany
[e] Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia, Canada B2G 2W5
[f] Instituto Geológico y Minero de España, Ríos Rosas 23, 28003 Madrid, Spain
[g] School of Earth & Planetary Sciences, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL, UK
[h] Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ, UK

ARTICLE INFO

Article history:
Received 12 May 2009
Received in revised form 10 August 2009
Accepted 22 August 2009
Available online 29 August 2009

Keywords:
Rheic Ocean
Variscan–Alleghanian-Ouachita orogen
Pangaea
Europe
North America

ABSTRACT

The Rheic Ocean, which separated Laurussia from Gondwana following the closure of Iapetus, is arguably the most important ocean of the Palaeozoic. Its suture extends from Mexico to Turkey and its closure produced the climactic Variscan–Alleghanian–Ouachita orogeny that assembled the supercontinent, Pangaea.

Following protracted Cambrian rifting that represented a continuum from Neoproterozoic orogenic processes, the Rheic Ocean opened in the Early Ordovician with the separation of several Neoproterozoic arc terranes from the continental margin of northern Gondwana. Separation occurred along the line of a former Neoproterozoic suture following the onset of subduction in the outboard Iapetus Ocean. The timing of rift–drift transition and drive for subsequent spreading was likely governed by slab pull, accounting for the rapid rate (8–10 cm/yr) at which the Rheic Ocean widened.

During the Ordovician, the ocean broadened at the expense of Iapetus and attained its greatest width (~4000 km) in the Silurian, by which time Baltica had sutured to Laurentia and the Neoproterozoic arc terranes had accreted to Laurussia, closing Iapetus in the process. Closure of the Rheic Ocean began in the Devonian and was facilitated by northward subduction beneath southern Baltica and southward subduction beneath northwest Gondwana. Closure was largely complete by the Mississippian as Gondwana and Laurussia sutured to build Pangaea, North Africa colliding with southern Europe to create the Variscan orogen in the Devonian–Carboniferous, and West Africa and South America suturing to North America to form the Alleghanian and Ouachita orogens, respectively, during the Carboniferous–Permian.

The Rheic Ocean consequently plays a dominant role in the basement geology of southern Europe, in the Appalachian–Ouachita orogeny of North America, and in the Palaeozoic sedimentary, structural and tectonothermal record from Middle America to the Middle East. With its closure, the ocean brought about the assembly of Pangaea and brought the Palaeozoic Era to an end.

Contents

* Corresponding author.
E-mail address: nance@ohio.edu (R.D. Nance).

1342-937X/$ – see front matter © 2009 International Association for Gondwana Research. Published by Elsevier B.V. All rights reserved.
doi:10.1016/j.gr.2009.08.001

1. Introduction

The Rheic Ocean, which separated the major palaeocontinents of Gondwana and Laurussia (Laurentia–Baltica–Avalonia) following the closure of Iapetus (Fig. 1), was one of the principal oceans of the Palaeozoic (e.g., Nance and Linnemann, 2008). Its suture extends over 10,000 km from Mexico to Turkey, and its closure assembled the greater part of Pangaea with the formation of the vast Variscan–Alleghanian–Ouachita orogen. The evolution of the Rheic Ocean is consequently central not only to the history of the Palaeozoic, but also to the broader issue of supercontinent assembly (e.g., Murphy et al., 2009; Santosh et al., 2009).

Named for the Titan, Rhea, sister to Iapetus in Greek mythology, the importance of the Rheic Ocean has long been recognized in Europe, where its suture is well constrained and well separated from that of the Iapetus Ocean to the north. Hence, in Europe, the Caledonide orogen, created by the closure of Iapetus, is a geographically distinct orogenic belt from the Variscan orogen, created by the closure of the Rheic Ocean (Fig. 2). In North America, however, the Rheic Ocean has historically received less attention than Iapetus because its suture follows a similar path, but unlike that of Iapetus, lies buried beneath the sediments of the Coastal Plain or was removed with the opening of the Atlantic Ocean and Gulf of Mexico. As a result, the history of the Appalachian–Ouachita orogen is traditionally

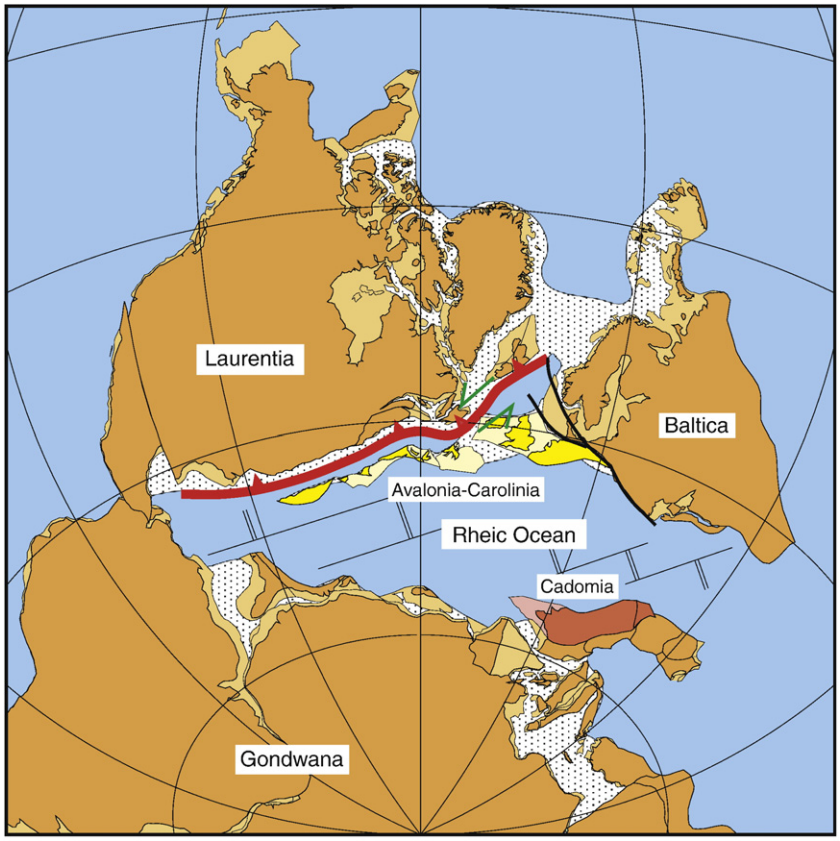

Fig. 1. Early Silurian reconstruction of the Rheic Ocean immediately prior to the closure of Iapetus by way of subduction beneath Laurentia (toothed red line). Stippled areas denote inferred regions of thinned and/or anomalous thickness of continental and arc crust (simplified after Pickering and Smith, 1995, with Cadomia placed adjacent to Gondwana). Rheic ridge-transform system purely schematic. Heavy black lines trace Tornquist suture zone.