Palaeogeography, Palaeoclimatology, Palaeoecology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

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

A Permian-Triassic boundary microbialite deposit from the eastern Yangtze Platform (Jiangxi Province, South China): Geobiologic features, ecosystem composition and redox conditions

Siqi Wu [a], Zhong-Qiang Chen [a,*], Yuheng Fang [a], Yu Pei [a], Hao Yang [a], James Ogg [a,b]

[a] State Key Laboratory of Biogeology and Environmental Geology and School of Earth Science, China University of Geosciences, Wuhan 430074, China
[b] Department of Earth, Atmospheric and Planetary Sciences, Purdue University, West Lafayette, IN 47907, USA

ARTICLE INFO

Article history:
Received 7 October 2016
Received in revised form 3 May 2017
Accepted 9 May 2017
Available online xxxx

Keywords:
Mass extinction
Thrombolite
Dendrolite
Calcimicrobes
Gakhumella
Microbialite ecosystem
Daye Formation
Earliest Triassic

ABSTRACT

A Permian-Triassic (P-Tr) boundary microbialite (PTB-microbialite) deposit occurs near Xiushui on the southern margin of the eastern Yangtze Platform, South China. This 2-m-thick microbialite overlies uppermost Permian bioclastic limestone with a 5-cm-thick oolite-like grainstone layer at the contact. This PTB-microbialite consists of lower thrombolite (1.5-m thick) and an upper dendrolite (0.5-m thick). The thrombolite interval is characterized by a clotted texture of reddish sparitic patches embedded in a gray micritic matrix, whereas the dendrolite texture consists of brownish sparitic patches embedded within a yellow micritic matrix. Abundant calcified microbes occur in both the thrombolite and the dendrolite, including 1) columnar and clustered fabrics, which are especially rich in the thrombolite, assigned as products of *Gakhumella* or related microorganisms and 2) microspheroids, 40–60 μm in diameter, with different interior structures. These calcimicrobes are considered to have played an important role in constructing the Xiushui PTB-microbialite. The demise of the microbialite was likely due to a sea-level fall during the early Griesbachian (lowermost Triassic), which resulted in a lowering of the wave base thereby destroying the microbialite frameworks and facilitating the deposition of winnowed skeletal grainstone. Metazoan community structures within the microbialite changed sharply across the end-Permian extinction horizon, which is placed at a sharp negative shift in $\delta^{13}C_{carb}$. Quantitative analyses show that the Xiushui microbialite community is similar to that of Chongyang and Cili microbialites. This is probably because all of these microbialites grew along the margins of the Lower Yangtze region during the P-Tr transition. However, unlike other PTB-microbialites, the Xiushui ecosystem contains fairly abundant metazoans, which are dominated by ostracods with minor occurrences of foraminifers, microgastropods and microconchids. Both the ostracod assemblage and the pyrite framboid analyses indicate an upper dysoxic zone to a well-oxygenated condition for the Xiushui microbialite. This implies that some PTB-microbialite ecosystems developed in conditions that were not always harsh; instead, some were hospitable for some metazoans to survive immediately after the end-Permian crisis. Considering that the redox conditions indicated by PTB-microbialites are quite variable, we infer that oxygen levels probably were not the crucial factor affecting the growth of the PTB-microbialites.

1. Introduction

Microbialite deposits near the Permian-Triassic boundary (PTB) are widely reported from carbonate facies successions across the entire low-latitude Paleo-Tethys region (e.g., Kershaw et al., 2012). The PTB-microbialites are usually composed of stromatolites with laminated mesostructures, thrombolites with clotted mesostructures, and dendrolites characterized by dendritic mesostructures (Riding, 1991). These are usually interpreted as buildups from microbial blooms that flourished in shallow carbonate habitats during and after the devastation linked with the end-Permian biocrisis (e.g., Bottjer et al., 2008; Algeo et al., 2011; Chen and Benton, 2012).

PTB-microbialites were particularly common in South China along the margins of the Yangtze Platform (Fig. 1). To date, 17 PTB microbialite sites have been documented in this region (Kershaw et al., 1999, 2002, 2007, 2012; Lehrmann, 1999; Ezaki et al., 2003, 2008; Wang et al., 2005; Wu and Jiang, 2007; Wu et al., 2007, 2016; Wu, Yu, et al., 2014; Wu, Yuan, et al., 2014; Yang et al., 2008, 2011; Liu et al., 2014; Lehrmann et al., 2015; Zheng et al., 2015; Tang et al., 2017; Fang et al., 2017; Fig. 1). Most of the known microbialites are distributed in the western part of the Yangtze Platform (or the "Upper Yangtze region" of Wang and Chen, 2005) or on isolated platforms within the Nanpanjiang basin. In the eastern part of the Yangtze Platform (the

* Corresponding author.
E-mail address: zhong.qiang.chen@cug.edu.cn (Z.-Q. Chen).

http://dx.doi.org/10.1016/j.palaeo.2017.05.015
0031-0182/© 2017 Elsevier B.V. All rights reserved.

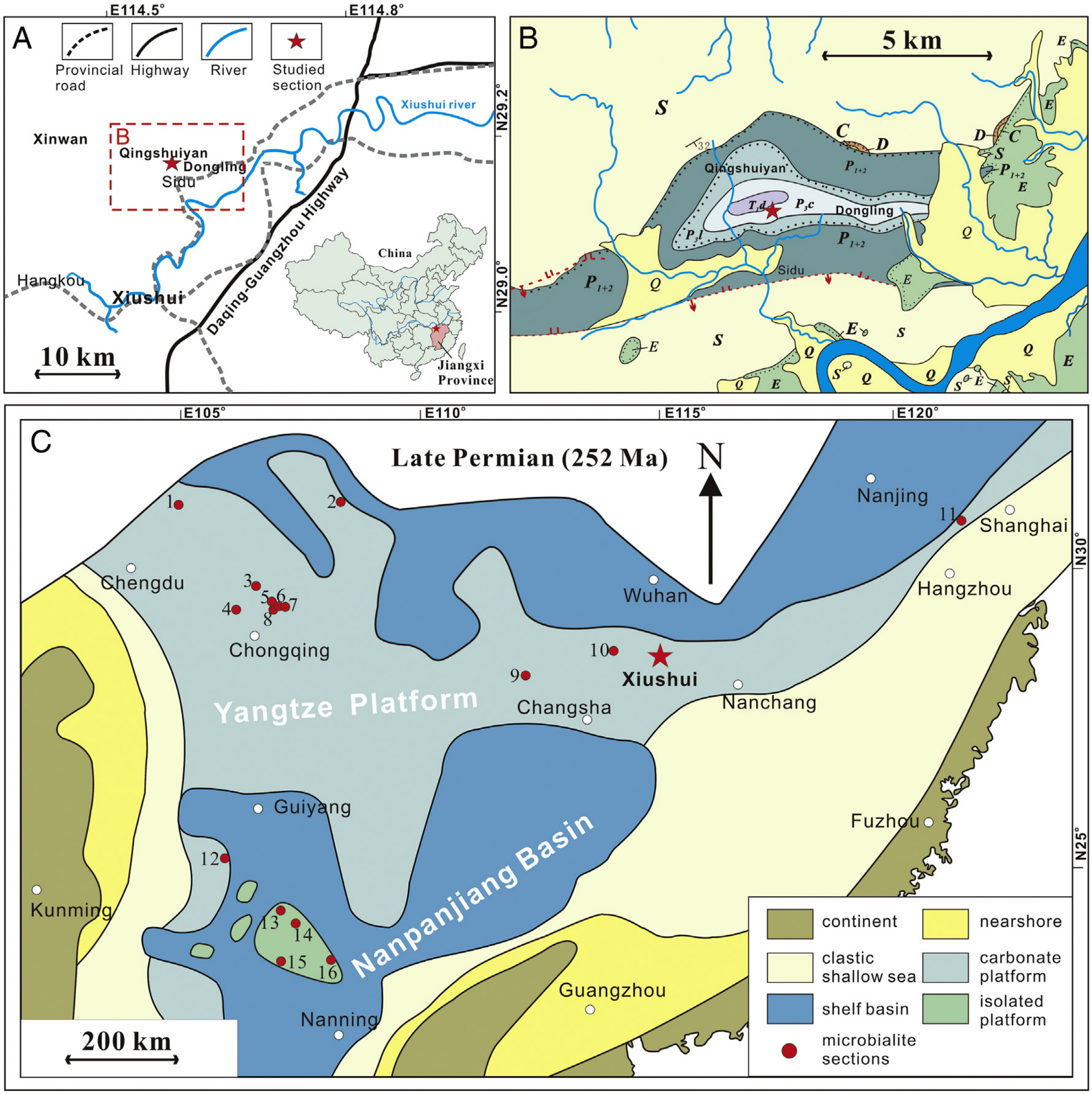

Fig. 1. A) Location of the Xiushui (Qingshuiyan) section, Xiushui County, Jiangxi Province, South China. B) Geological map of the studied area (modified from Zhu et al., 1994). C) Schematic paleogeographic map of South China during latest Changhsingian (constrained by the *Clarkina meishanensis* conodont zone; Yin et al., 2014) with localities of Xiushui and other selected PTB-microbialites in South China. Numbered localities are 1-Yudongzi, 2-Panlongdong, 3-Huayingshan, 4-Tudiya, 5-Baizhuyuan, 6-Jianshuigou, 7-Dongwan, 8-Laolongdong, 9-Cili, 10-Chongyang, 12-Ziyun, 13-Dajiang, 14-Heping, 15-Zuodeng, and 16-Taiping.

Middle and Lower Yangtze regions in the terminology of Wang and Chen, 2005), microbialites are located at Chongyang (Yang et al., 2008) and Suzhou (Zheng et al., 2015).

Conodont biostratigraphy in these PTB-microbialite sections generally places the first occurrence of conodont *Hindeodus parvus*, the widespread marker event for the base of the Triassic, at the middle or lower part of the microbialite (Lehrmann et al., 2003; Wang et al., 2005; Liu et al., 2007; Chen et al., 2009; Yang et al., 2011; Wang et al., 2015), indicating the PTB-microbialite spans latest Changhsingian to earliest Griesbachian in age. In one section at Dajiang in southern Guizhou Province, the first occurrence of *H. parvus* was reported from the base of the microbialite (Jiang et al., 2014), although others have suggested that these *H. parvus* specimens may have fell down from higher horizons of the microbialite during post-deposition partial solution (Chen et al., 2009; Jiang et al., 2014; Wang et al., 2015).

The accretion process and microbial composition of most PTB-microbialites are poorly understood (Kershaw et al., 2012). Even though these microbialites are considered to be biogenic in origin, very few studies have unraveled the details of geo-biological features. However, there is evidence that the widespread microbialites are excellent materials for unraveling the enigmatic oceanographic conditions during and immediately after the end-Permian biocrisis (Kershaw et al., 2012; Lehrmann et al., 2015). PTB-microbialites are usually considered to represent an abnormal marine environment after the biotic extinction enabled calcareous microbes to replace metazoans in the leading role in shallow carbonate ecosystems (Baud et al., 2007; Kershaw et al., 2007; Chen and Benton, 2012). However, there is growing evidence that metazoans within the microbialites are actually much more abundant and diverse than previously thought (Yang et al., 2011; Yang, Chen and Ou, 2015a; Yang, Chen, Wang, et al., 2015b; Forel et al., 2012; Forel, 2013, 2015; Tarhan et al., 2013). Therefore, a detailed analysis of microbialite ecosystem composition is essential to understand the biotic turnover across the extinction horizon in these microbialite sections. Quantification of compositions (e.g., Yang et al., 2011) is one method to compare similarities among various coeval PTB-microbialites.

Another debated aspect of these PTB-microbialites is their redox conditions. This is because there are conflicting results when comparing the redox proxies from pyrite framboids (Wu et al., 2007; Liao et al., 2010; Wang et al., 2015), from ostracod assemblages (Crasquin-Soleau and Kershaw, 2005; Forel et al., 2009), and from rare earth elements

Please cite this article as: Wu, S., et al., A Permian-Triassic boundary microbialite deposit from the eastern Yangtze Platform (Jiangxi Province, South China): Geobiologic features..., Palaeogeogr. Palaeoclimatol. Palaeoecol. (2017), http://dx.doi.org/10.1016/j.palaeo.2017.05.015