Gondwana Research 24 (2013) 55–76

Contents lists available at SciVerse ScienceDirect

Gondwana Research

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

GR focus review

A review of Permian stratigraphy, palaeobiogeography and palaeogeography of the Qinghai–Tibet Plateau

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ARTICLE INFO

Article history:
Received 9 February 2012
Received in revised form 21 May 2012
Accepted 6 June 2012
Available online 6 July 2012

Keywords:
Qinghai–Tibet Plateau
Permian
Palaeobiogeography
Palaeogeography

ABSTRACT

The Permian marine lithostratigraphy, biostratigraphy and faunal compositions among all the major tectonic blocks in the Qinghai–Tibet Plateau are synthesised based on published literature, authors' unpublished data and field observations.

Palaeobiogeographically, the Permian marine faunas in the Qinghai–Tibet Plateau can be assigned to four biotic provinces: Cathaysian, Indoralian, Cimmerian and Himalayan provinces, as well as a broad South Transitional Zone for parts of the Permian. The Qamdo Block clearly belongs to the Cathaysian province as it is characterised by a lack of glacial deposits and a dominance of warm-water faunas during the whole Permian. The Qiangtang Block, Lhasa Block and the Himalaya Tethys Zone in southern Tibet can be grouped into the South Transitional Zone during the Cisuralian, which is characterised by the combination of the bivalve *Eurydesma*, the brachiopods *Cimmeriella*, *Bandoproductus* and the fusuline *Monodiexodina*. The South Transitional Zone gave birth to the Cimmerian province, as shown in the Qiangtang and Lhasa blocks, from Roadian to Capitanian, during which its faunas were characterised by an admixture of cold- and warm-water elements supplemented by a limited number of endemic taxa such as the fusuline *Eopolydiexodina*, the non-fusuline foraminifer *Shanita-Hemigordiopsis* assemblage and the coral *Thomasiphyllum*. The formation and development of the South Transitional Zone and the Cimmerian province is interpreted to be closely linked to and driven by the northward drift of the Cimmerian Continent superimposed with a gradual global warming in the wake of Gondwanan deglaciation. The consequently combined effects of these events forced the climate of the drifting peri-Gondwana blocks to ameliorate and its marine faunas to transform from an essentially cold-water Gondwanan type in the Early Cisuralian through a transitional stage to a predominantly warm-water Cathaysian type by the Lopingian. The Himayala Tethys Zone in southern Tibet is assigned to the Himalayan province from Late Guadalupian to Lopingian and identified by persistent occurrences and dominance of cold-water brachiopods and corals.

Both the Permian sedimentary sequences and faunal successions are strongly different between the Qamdo Block and the Qiangtang Block. This is taken to suggest that the Longmu Co-Shuanghu-Lancangjiang suture between the two blocks most likely represents the main branch of the Palaeotethys suture in Tibet. A comparison and correlation of Permian sequences and faunas between Tibetan blocks and adjacent blocks in western Yunnan indicates that the Qiangtang Block should be aligned with the Baoshan Block whereas the Lhasa Block more closely related to the Tengchong Block. Further comparison and correlations of Permian stratigraphy and faunas of all major peri-Gondwana blocks suggest that they probably constituted three different continental slices, rather than one as perceived in some previous literature. The first slice is composed of Central Pamir, the Qiangtang Block and the Baoshan Block; the second slice consists of South Pamir, Karakorum, South Afghanistan, Central Iran and Turkey. These two continental slices are both characterised by a continuously active rifting event from Artinskian to Guadalupian. By contrast, the third slice is interpreted to consist of the Lhasa Block, the Tengchong Block and the Sibumasu Block, none of which has late Cisuralian rift-related basalts. The Baoshan Block and the Lhasa Block are thought to have initially (early Cisuralian) intersected probably at a triple junction point close to western Australia, and were then rifted off from Gondwana at different times during the Permian.

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1342-937X/$ – see front matter
doi:10.1016/j.gr.2012.06.010

Contents

1. Introduction

The Qinghai–Tibet Plateau referred to in this review includes the vast area between the Jinshajiang Suture to the north and the Himalayas to the south (Fig. 1). Current understanding of the Late Palaeozoic history of this region remains confusing due to both limited work undertaken in the high-altitude plateau and the complex Mesozoic–Cenozoic tectonic evolution that has destroyed and/or overprinted its Late Palaeozoic record. For example, to date few reliable Permian palaeomagnetic (and hence palaeolatitude) data have been obtained from northern Tibet due to severe younger tectonic overprinting, rendering the Permian palaeogeographic positions of these blocks one of the most interesting and contentious issues in Tibetan geology.

The Permian Period is a critical time in northern Gondwana (including southern parts of the Qinghai–Tibet Plateau) because it has been considered to evidence the rifting of the Cimmerian Continent and the gradual reduction of the Palaeotethys Ocean (Sengör, 1979; Sengör and Hsü, 1984; Metcalfe, 2002, 2009). In addition, the Permian Period is also of note because of its recording a drastic palaeoclimatic change from a global icehouse in the Carboniferous–Early Cisuralian (Early Permian) towards a greenhouse state in the Lopingian (Late Permian) (Isbell et al., 2003; Veevers, 2004; Fielding et al., 2008; Shi and Waterhouse, 2010). These changes have been well recorded in the Qinghai–Tibet Plateau, where the glacio-marine deposits disappeared after Sakmarian. The northward drift of the Cimmerian Continent, the climatic amelioration, or the combination of these two processes, have led to the development of a distinctive transitional palaeobiogeographic province in southern and central Tibet (Shi et al., 1995). However, despite these and other related studies in the past several decades, the detailed timing of the inferred tectonic and climatic events, and the mechanisms and consequences of their impacts on the contemporaneous marine biotas, remain poorly constrained.

The purpose of this paper is thus attempted to address these questions by providing an overview and a comparison of the Permian stratigraphy, palaeogeography and palaeobiogeography of the main tectonic blocks that constitute the Qinghai–Tibet Plateau. This paper is built upon and substantially updated from two earlier reviews by Jin (1985) and Yin (1997), supplemented by results from our recent field work in the region. Specifically, the review is aimed at three key aspects: (1) an overview and update of Permian marine stratigraphy and biostratigraphy of all blocks; (2) the palaeobiogeographic features of every province; and (3) the palaeogeographic evolution of all the concerned Tibetan tectonic blocks through the Permian.

2. Regional geological and tectonic setting

Tectonic subdivision of the Qinghai–Tibet Plateau has been reviewed by Yin and Harrison (2000), but a brief summary of the tectonic background is necessary for further discussion in this paper.

Tectonically, the Qinghai–Tibet Plateau is composed of a complex assembly of allochthonous blocks or terranes divided by major fault zones or sutures. These sutures may represent palaeo-oceans or arc basins bearing ocean affinity with different age constraints. These blocks/terranes and sutures identified here include, from south to north respectively: the Himalaya Tethys Zone, Yarlung–Zangbo suture zone, Lhasa Block, Bangong–Nujiang suture zone, Qiangtang Block, Longmu Co-Shuanghu-Lancangjiang suture zone, Qamdo Block and Jinshajiang suture zone (Fig. 1). It is noteworthy that the Qiangtang Block in this paper corresponds to the West Qiangtang Block of Sengör et al. (1988) or the South Qiangtang Block (e.g., Jin, 2002; Li et al., 2007a; Zhang et al., 2009a), while the Qamdo Block corresponds to the East Qiangtang Block of Sengör et al. (1988) or the North Qiangtang Block of Li et al. (2007a).