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Vegetation changeover across the Permian–Triassic Boundary in Southwest China
Extinction, survival, recovery and palaeoclimate: A critical review

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ABSTRACT

This paper reviews critically the Permian–Triassic (P–Tr) fossil plants and microflora recorded in three well-studied terrestrial Permian–Triassic boundary (PTB) sections, namely Chahe, Zhejue, and Jiucaichong, and two marine–terrestrial transitional PTB sections, namely Mide and Tucheng, in western Guizhou Province and eastern Yunnan Province (WGEY), Southwest China. Distinct floral composition, abundance and diversity across the PTB allow the establishment of two terrestrial macrofloral assemblages. The *Lobatannularia multifolia–Gigantoclea guiyangensis* (L–G) assemblage was recognized from the upper Xuanwei Formation, while the *Annalepis–Peltaspermum* (A–P) assemblage from the lower Kayitou Formation. The former flora comprises 105 species in 39 genera and is late Changhsingian in age. The latter assemblage includes 18 species in 14 genera and is Induan in age. The Changhsingian assemblage is characterized by the loss of many Wuchiapingian elements of the *Gigantopteris* flora and an increase of the gymnosperms. Most of the Permian-type plant taxa were wiped out in the PTB crisis on land with only few relicts persisting into the Early Triassic, which saw the flourishing of *Annalepis* and common presence of *Peltaspermum* and Permian relicts of the gigantopterids. During the Permian–Triassic transition some rare gigantopterids elements as well as some *Peltaspermum* representatives survived the biocrisis. *Annalepis* a pioneering lycopsid genus in the recovery of the Triassic land plants, and its proliferation marks the recovery of land plants after the PTB crisis on land in WGEY. Accordingly, vegetation changeover across the PTB is marked by a dramatic turnover of plants on land from the Permian *Gigantopteris* flora to the Triassic *Annalepis*-dominated assemblage. Palynofloras are characterized by a dramatic drop of palynomorphs in both abundance and diversity and show a stepwise extinction pattern. Moreover, macro- and microfloras of the WGEY region indicate that humid and warm climate regime prevailed through the P–Tr transition in Southwest China. The coal forming-swamps gradually migrated westward due to marine transgressions throughout the Late Permian. The "*Gigantopteris* flora" also migrated from east to west and a few species can survive into the earliest Triassic in the WGEY region, but disappeared soon after.

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1. Introduction

The Latest Permian Mass Extinction (LPME) event, the most severe biocrisis of the Phanerozoic, marked the collapse of marine and terrestrial ecosystems on a world-wide scale (Erwin, 1994; Retallack, 1995; Looy et al., 2001; Chen and Benton, 2012). Locally, about 95% of peat-forming plants became extinct and the number of families of higher land plants has drastically declined in this biocrisis (Retallack, 1995; Michaelsen, 2002).

Recently developed botanical and palynological records from the Upper Permian to Lower Triassic have provided a better understanding of the mechanism and dynamic of floral turnover across the Permian–Triassic Boundary (PTB). Land vegetation, as one highly sensitive index to environmental change, is one of the most useful proxies for analyzing the patterns of biotic extinction, survival and recovery during this critical period of Earth life (Looy et al., 2001). Terrestrial floras over the Permian–Triassic (P–Tr) transition have been investigated in many terrestrial PTB sections from around the world. Nevertheless, the PTB in those terrestrial sections has not been precisely defined, and they do not correlate well with one another (Chen and Benton, 2012).

South China records are not only the best exposed and most continuous marine PTB successions in the world (Chen and Benton, 2012), but also many well-exposed, continuous PTB successions of terrestrial–marine transition and terrestrial facies (Wang and Yin, 2001; Peng et al., 2005; Yu, 2008; Yu et al., 2007, 2010) (Fig. 1). The latter usually yield abundant fauna and flora, and are exposed mainly in the western Guizhou and eastern Yunnan (WGEY) region, Southwest China, which

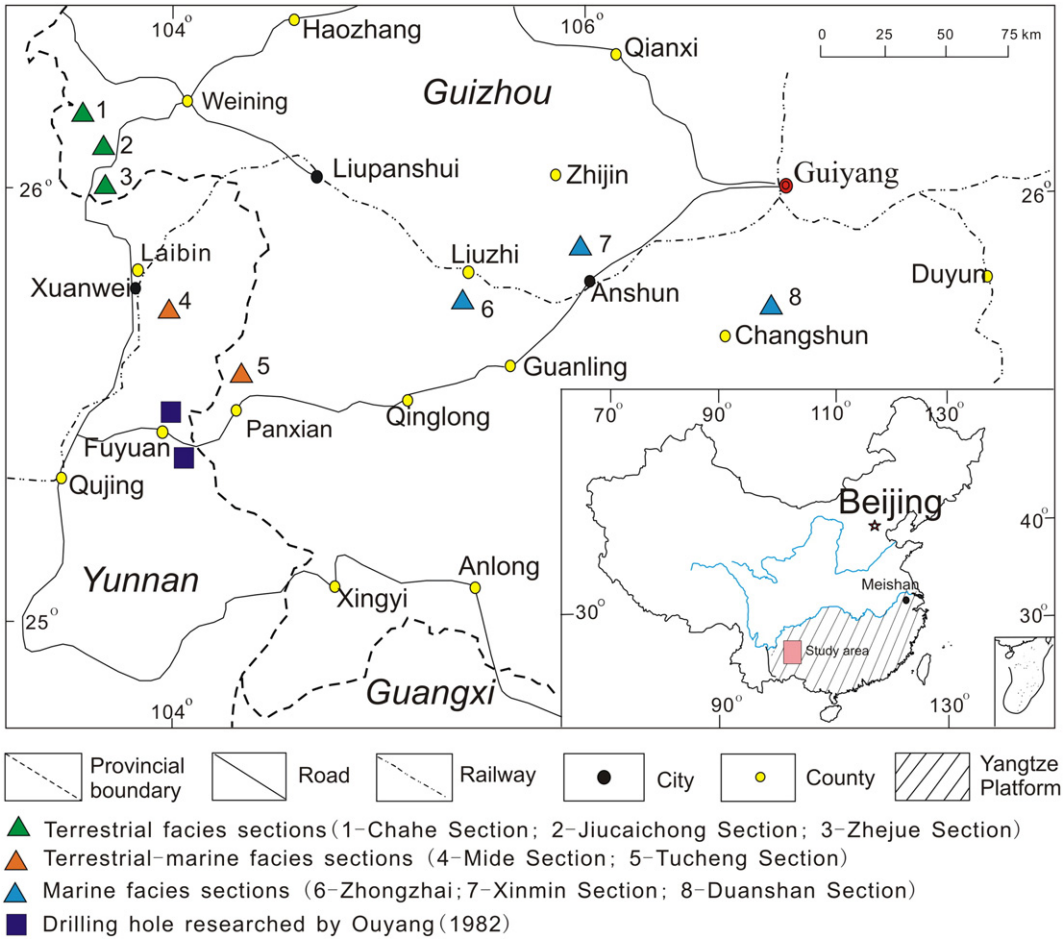

Fig. 1. Location of the studied marine and non-marine PTB sections in western Guizhou and eastern Yunnan, southwestern China.