



Skeletal fossils and microfacies analysis of the lowermost Cambrian in the southwestern margin of the North China Platform



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ABSTRACT

The Xinji and Zhushadong formations are the oldest record of Cambrian deposits in the southwestern margin of the North China Platform. The two lithostratigraphic units are carbonate-dominated in lithology and are Cambrian Series 2 in age. The basal unit, the Xinji Formation yields diverse skeletal fossils, including sponge spicules, chancelloriid sclerites, hyoliths, micromolluscs, trilobites, echinoderm ossicles, cambroclaves, tianzhushanellids, protoconodonts and other small shelly fossils. The fossil assemblage, as the earliest fauna of the Cambrian in North China, provides an important window to investigate the Cambrian explosion in the region and contains fossil elements with biostratigraphical significance. Seven microfacies types of the Xinji and Zhushadong formations are recognized: (1) phosphorized and selectively dolomitized bioclastic grainstone, (2) dolomitized ooid grainstone, (3) dolomitized peloid wackstone, (4) lime mudstone preserved as dolomitic microsparite, (5) siliciclastic wackstone, (6) calcareous siltstone, and (7) breccia. The different microfacies are traced to three successive depositional environments, beginning with a bioclastic shoal, then a mixed-depositional back-shoal and finally an oolitic shoal. The system of the shoal and back-shoal is interpreted as representing the mixed siliciclastic-carbonate deposition during the initial transgression of the North China Platform as well as the early development of an epeiric environment.

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1. Introduction

During the early Cambrian (Terreneuvian and Cambrian Epoch 2), the North China Platform was situated near the northern margin of the Gondwana supercontinent; and it was submerged during the great transgression event in Cambrian Epoch 2, which resulted in deposition of Cambrian strata (Meng et al., 2007; Chough et al., 2010; Lee and Chough, 2011). According to Mei et al. (1997), Feng et al. (2002) and Mei (2011), the Cambrian of North China generally comprises two sets of rock-successions: the lower set, includes Series 2 and the lower part of Series 3, characterized by an alternation of clastic sediments and carbonates, representing tidal deposits; while the upper set is dominated by ramp carbonates. Specifically, the stratigraphic sequence of the lower set corresponds to mixed carbonate-siliciclastic sedimentation, deposited on an archipelago during the initial transgression of the North China plate (Lee and Chough, 2011) with the upper set indicating a gradual evolution to a carbonate platform.

The Xinji Formation is well exposed along the south margin of North China crossing the present-day Shaanxi, Henan and Anhui provinces (Zhang et al., 1979). This rock unit is composed of phosphorous carbonate rocks and siliciclastic rocks. It disconformably overlies the Ediacaran Dongpo Shale and is conformably overlain by the dolomitic limestones of the lower Cambrian Zhushadong Formation (Mei et al., 1997; Feng et al., 2002).

The Xinji Formation has attracted the attention of paleontologists as it yields abundant small shelly fossils (SSFs), which have been reported from the southern margin of the North China Platform in eastern Shaanxi (Yu et al., 1984; Li et al., 2014), southern Henan (e.g., He et al., 1984; Pei, 1988; Feng et al., 1994; Pei and Feng, 2005), and northern Anhui (Zhou and Xiao, 1984; Xiao and Zhou, 1984). By contrast, the Zhushadong Formation is relatively unfossiliferous. Only the trilobite *Redlichia* sp. and acritarchs are reported from this formation (Bureau of Geology and Mineral Resources of Henan Province, 1989; Pei et al., 2009).

Recently we have surveyed the lower Cambrian in the southwestern margin of North China Platform and found a new richly-fossiliferous locality of the Xinji Formation in the Longxian area, Shaanxi province, where only the trilobite *Hsuaspis* (= *Estangia*) was previously reported (Zhang and Zhu, 1979;

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Zhang et al., 1979). This fossil assemblage is hosted in typical bioclastic limestone, contrasting with the phosphorous siltstone that crops out in Anhui, Henan and eastern Shaanxi. As the earliest skeletal fauna of the Cambrian in North China, the Xinji fossil assemblage is also potentially important in investigating diversification of animal lineages during the Cambrian explosion. In this paper we present a preliminary report of the faunal composition and biostratigraphical significance of the fossil assemblage. In addition, the microfacies and depositional environment of the fossil-bearing rock and relevant units are analyzed to reconstruct a specific fossil-related depositional succession during the early transgression of the epeiric platform, which has not been investigated previously (e.g., Mei et al., 1997; Feng et al., 2002; Mei, 2011).

2. Geologic setting, material and methods

The four studied sections, the Chaijiawa, Zhoujiaqu, Shuiyancun and Niuxinshan sections, are located in the southwestern margin of North China Platform, all within the territory of Longxian County, Shaanxi Province (Fig. 1). The main section is located on the west bank of the Chaijiawa Water Reservoir at Chaijiawa village, named the Chaijiawa section (Fig. 2A and B). The other three sections are mainly served as auxiliary sections for lithological correlation. The Zhoujiaqu section (Fig. 2C and D) is 100 m south to Zhoujiaqu village and approximately 2 km north of the Chaijiawa section. The Shuiyancun section (Fig. 2E) is adjacent to Shuiyancun village and is at the foot of the Niuxinshan Mountain, about 10 km north of the Chaijiawa section. And the Niuxinshan section (Fig. 2F) is in the Niuxinshan Mountain, about 3.5 km southeast of the Shuiyancun section. The abandoned phosphorus mining caves close to all sections described herein demonstrate

the typical characteristics of phosphorous deposits in the early Cambrian. In addition, the Xinji Formation is partly exposed in the Jingfushan Mountain however its relation with other formations is difficult to distinguish and fossils are scarce.

The Xinji Formation is well exposed in all four sections and can be subdivided into three lithologic units in ascending order (Figs. 3 and 4). Unit A, ca 0.6 m thick in Chaijiawa section, consists of maroon phosphorous quartz sandstones overlain by a thin layer of purple breccias-containing siltstones; it is over 2 m in thickness and consists of thick-bedded breccias observed in the Zhoujiaqu, Shuiyancun and Niuxinshan sections. Unit B, ca 5 m thick in all sections, is composed dominantly of dark purple-red bioclastic limestones, which is recognized as five beds, varying up section from medium- to thick-beds. Unit C, ca 30 m thick in Chaijiawa and Zhoujiaqu sections, ca 20 m thick in Shuiyancun section and is not well-exposed in Niuxinshan section, consists of maroon medium- and thick-bedded phosphorous and calcareous quartz siltstones with scattered bioclasts. The overlying Zhushadong Formation, is only well-exposed in Chaijiawa and Shuiyancun sections (Fig. 3) and is composed of carbonate rocks that are 50–60 m thick. It is also subdivided into three lithologic members, which are, in ascending order, the brown medium- to thick-bedded siliciclastic limestones (Unit D, ca 8 m thick in both sections), the dark grey thick-bedded dolomitic limestones (Unit E, ca 30 m thick in Chaijiawa section and ca 28 m thick in Shuiyancun section), and the thick-bedded ooid limestones (Unit F, ca 10 m thick in Chaijiawa section and ca 22 m thick in Shuiyancun section).

The large majority of material investigated herein was systematically sampled along outcrop sections in Chaijiawa and Zhoujiaqu. A few rock samples from the Shuiyancun and Niuxinshan sections are used as supporting material for the lithologic subdivision and interpretation of the depositional setting. Seven samples were collected, samples B1 to B5 from beds 1–5

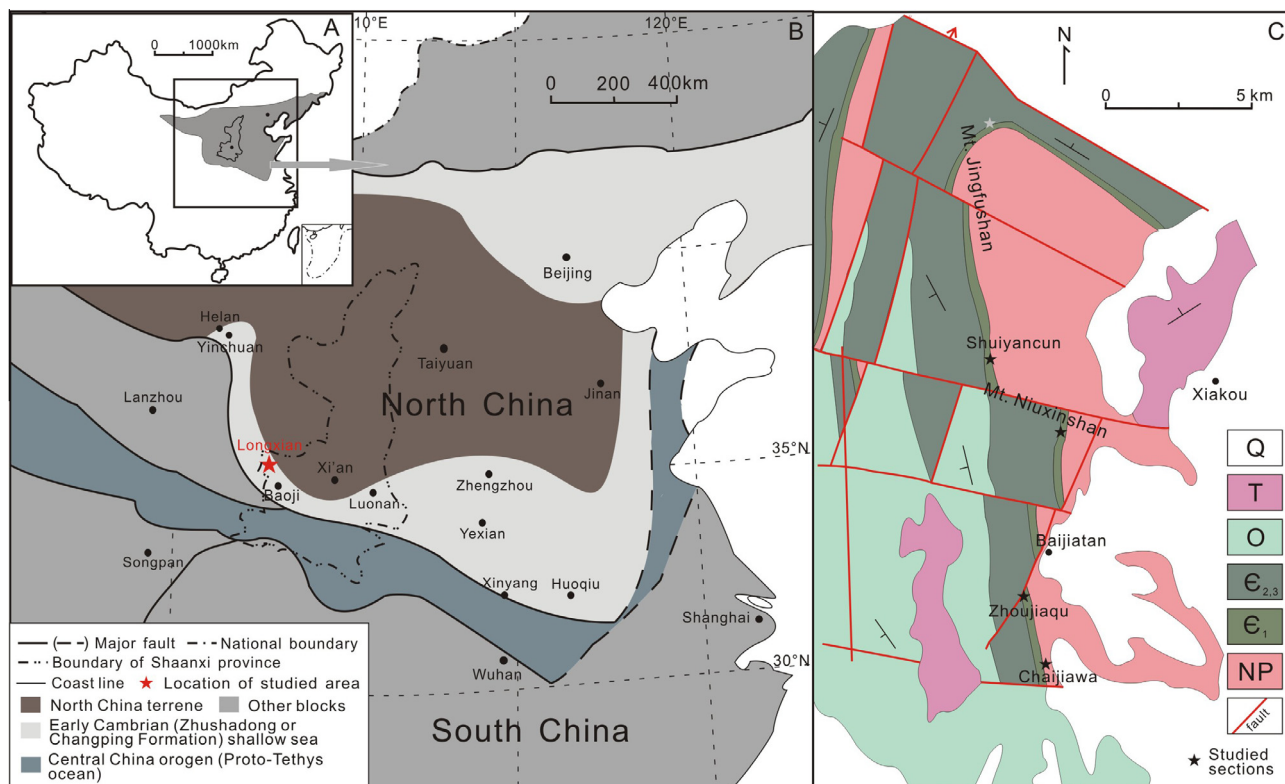


Fig. 1. Geologic setting and location of the studied area. (A) Outlines of China. (B) North China plate and the location of Longxian county. (C) Geologic map of the relative stratigraphic distributions in Longxian (modified from the 1:200000 geologic map published in 1967) and locations of the studied sections. NP, Neoproterozoic; C, Cambrian; O, Ordovician; T, Triassic; Q, Quaternary. The grey star mark in C is the location of the partly-exposed Xinji Formation in Jingfushan Mountain.

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