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Microfossils across the Llandovery–Wenlock boundary in Ziyang–Langao region, Shaanxi, NW China

Peng Tang [a,*], Jian Wang [b], Cheng-Yuan Wang [a], Rong-Chang Wu [a], Kui Yan [a], Yan Liang [a], Xin Wang [b]

[a] *State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China*

[b] *Xi'an Center of Geological Survey, China Geological Survey, Xi'an 710054, China*

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Abstract

A total of 80 samples were collected primarily for chitinozoans from the Wuxiahe Formation (late Llandovery–early Sheinwoodian) in the Ziyang–Langao region, Shaanxi Province, Northwest China. Besides chitinozoans, several other microfossil groups have been recovered unexpectedly, including conodonts, melanosclerites, acritarchs, and scolecodonts. Colonized acritarchs and club-shaped melanosclerites appear sporadically. Among the rare recorded chitinozoans, *Angochitina longicollis* is a Telychian–early Sheinwoodian species occurring throughout the studied interval of the Wuxiahe Formation at the Bajiaokou A section of Ziyang County. Conodonts of the late Telychian *Pterospathodus eopennatus*, *Pterospathodus celloni*, *Pterospathodus a. amorphognathoides* biozones and the early Sheinwoodian *Pterospathodus p. procerus* Biozone are identified at the Qiaoxi section of Langao County, where they co-occur with graptolites. The occurrences of melanosclerites and turbidite deposits support an open marine environment during late Llandovery to early Wenlock in the study region. Based on the recovered microfossils, the Llandovery–Wenlock boundary seems to be confined within a 0.73 m-thick interval at the Qiaoxi section.

It is the first time that microfossils, especially conodonts, have been recorded in the Llandovery–Wenlock transitional interval in the Ziyang–Langao region, Northwest China. The discovery of these microfossil groups supplements biostratigraphic information in the Ziyang region, where a possible GSSP candidate for the base of the Wenlock Series is located. The potential input of these microfossil groups in defining the Llandovery–Wenlock boundary is discussed.

Keywords: Conodonts; Chitinozoans; Melanosclerites; Llandovery–Wenlock boundary; Shaanxi Province; NW China

1. Introduction

In July 2000, during the "Palaeontology Down Under 2000" meeting in Orange, Australia, the International Subcommission on Silurian Stratigraphy (ISSS) decided to restudy the base of the Wenlock Series (see Loydell, 2001). However, as there lacks a strong candidate for a new GSSP for the base of Wenlock, the ISSS has decided to stick temporarily to the old GSSP until new studies can propose an alternative (see Silurian Times 14, 15).

Chinese palaeontologists have endeavoured to carefully restudy the base of the Wenlock Series in the Ziyang area, Shaanxi Province, Northwest China, where several Llandovery–Wenlock boundary sections with well-preserved graptolites are developed. In particular, five graptolite biozones of *Cyrtograptus* were reported across the boundary (Fu, 1986). Since 2008, Dr. Jian Wang and his colleagues have been restudying graptolites and sedimentology at the Ziyang section (also called as the Xianzhonggou section, or the Bajiaokou section by different authors), which was considered as a possible GSSP

* Corresponding author. Tel.: +86 25 83282250.
E-mail address: pengtang@nigpas.ac.cn (P. Tang).

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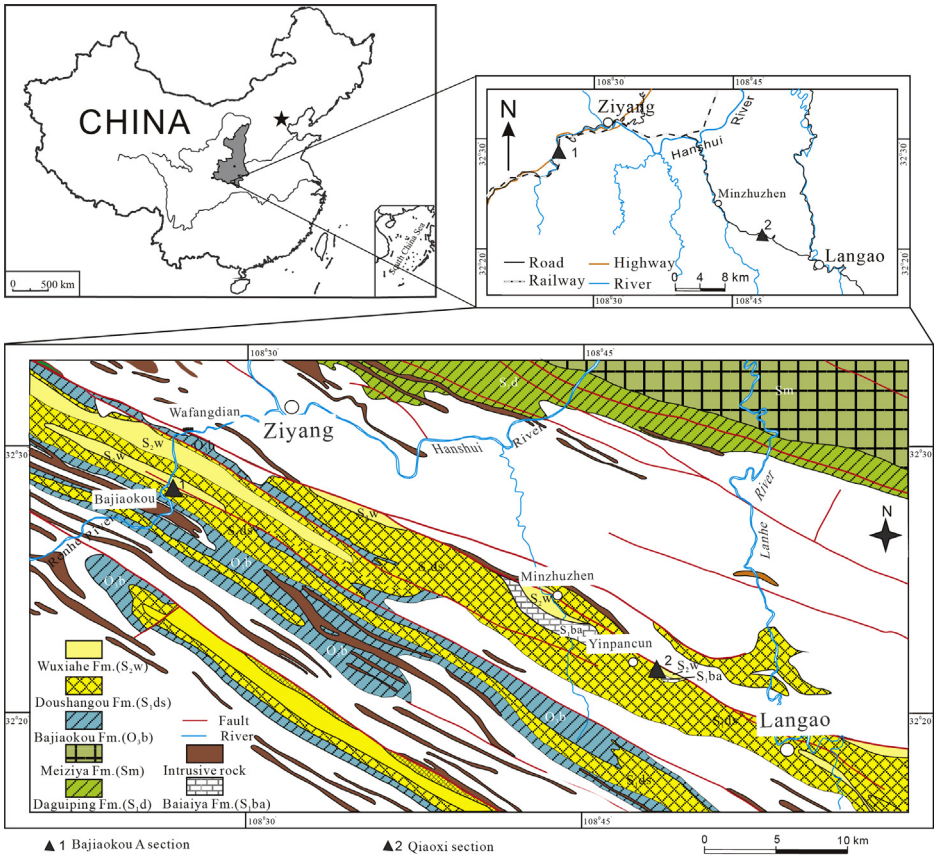

Fig. 1. Geological map and locality of the studied sections.

candidate for the base of the Wenlock Series (see Silurian Times 15, 18). Some preliminary results of graptolite biostratigraphy at the Bajiaokou A section of Ziyang County (ZBA section in brief) and the Qiaoxi section of Langao County (LQX section in brief) have been presented (Wang et al., 2011, 2013, 2014). However, in the Ziyang–Langao region, the biostratigraphic study of the boundary interval has been focused mainly on graptolites. Microfossils, such as conodonts, chitinozoans and others of the Llandovery–Wenlock boundary interval, have not yet been recorded.

In 2009, a series of 29 samples from the ZBA section was collected by Dr. Jian Wang to make some chitinozoan investigations. The possibility of finding chitinozoans in those samples was considered relatively low because Prof. Liang-Yu Geng and Dr. Xiao-Hong Chen had done such investigations but no chitinozoans were obtained. Fortunately, in the present work, some poorly preserved chitinozoan specimens, together with melanosclerites and scolecodonts, were obtained in the first analysis. These findings led to the collection of another patch of 51 samples from the LQX section of Langao County in 2012. At the LQX section, no chitinozoans were found, but some conodonts and melanosclerites were surprisingly obtained in the palynomorph residues. The finding of conodont is significantly important. For decades, Chinese conodont experts have been searching carbonate rocks in the study area for conodonts in vain. The findings of these microfossils, especially conodonts, can supplement the graptolite biostratigraphy of the Llandovery–Wenlock boundary interval in the Ziyang–Langao region, China.

The present paper shows all the recovered microfossils across the Llandovery–Wenlock boundary in the two sections mentioned above. Their potential roles in defining the boundary are discussed.

2. Geological setting

As a consequence of the Guangxi Orogeny (Chen et al., 2010), most of South China Plate was uplifted by the end of the Llandovery. The Wenlock deposits in South China are preserved mainly in three limited regions, including the west Qinling, south Qinling, and north Jiangsu Province (Rong et al., 2003). The Ziyang–Langao region of south Qinling is a key area in China to the study of the Wenlock Series (Rong et al., 2003, 2005; Fu et al., 2004). Llandovery to Wenlock strata are well exposed and distributed continuously along the NW-SE belts to the south of the Ziyang County Town. Several sections with well-preserved upper Llandovery and lower Wenlock graptolites have been studied since the early 1930s (Chao and Huang, 1931; Ge and Li, 1984; Fu, 1986; Fu and Song, 1986; Ge, 1994; Fu et al., 2006), and the late Telychian *Cyrtograptus lapworthi*, *Cyrtograptus sakmaricus*, and *Cyrtograptus insectus* biozones, as well as the early Sheinwoodian *Cyrtograptus centrifugus*,