

# Chitinozoan biostratigraphy across the base of Darriwilian Stage from the type area in Eastern China

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## Abstract

The base of the Darriwilian Stage is defined by the first appearance datum (FAD) of *Undulograptus austrodentatus*. The Darriwilian GSSP was formally designated in the Ningkuo Formation at the Huangnitang section, Zhejiang Province, eastern China. Four sections, i.e. Hengtang, Fengzu, Dianbatou and Chenjiawu sections, are systematically sampled for chitinozoan investigation. Abundant and diverse chitinozoans are recovered in the Ningkuo dark shales, and three distinctive assemblages (Assemblages A, B and C) are identified. Dramatic changes are documented between the third assemblage and the two preceding ones. The first appearances of *Belonechitina zhejiangensis* sp. nov., *Lagenochitina praepirum* sp. nov. and *Sagenachitina* sp. 1 are close to the base of the Darriwilian Stage. Thus, the association of *B. zhejiangensis* sp. nov., *L. praepirum* sp. nov. and *Sagenachitina* sp. 1 can be used as an auxiliary tool for locating the base of the Darriwilian Stage.

Chitinozoan elements of the Laurentia and northern Gondwana realms coexist on the South China palaeoplate. This conforms that South China is a particularly suitable region for documenting biostratigraphic ties between the main Ordovician palaeoplates.

*Belonechitina zhejiangensis* sp. nov., *Belonechitina chenjiawuensis* sp. nov., *Bursachitina laminaris* sp. nov., *Lagenochitina praepirum* sp. nov., *Euconochitina hengtangensis* sp. nov. regarded as new species are described and illustrated.

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## 1. Introduction

Ordovician strata are well developed and widely distributed in eastern China. Classic sections of this area, which are rich in fossils, and stratigraphic complete, have been studied by many authors since the 1920's (Liu and

Chao, 1927; Lu et al., 1955; Mu, 1957; Ge, 1964; Chen and Han, 1964; Mu, 1974; Chen et al., 1983; Chen and Yang, 1987; Xiao et al., 1985; Xiao and Chen, 1990; Zhang, 1993; Chen et al., 1995; Chen et al., 2003). In the early nineties, an international working group investigated the sections spanning the Yapeenian–Darriwilian interval in the Jiangshan–Changshan–Yushan (JCY) area in order to select a GSSP for the base of the Darriwilian Stage. On the basis of these joint investigations and of previous work, the GSSP for the Darriwilian Stage is defined by the

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FAD of *Undulograptus austrodentatus* in the Huangnitang section in the Changshan County, Zhejiang Province, eastern China (Mitchell et al., 1997) (Fig. 1).

In the JCY area, located on the borders of Jiangxi and Zhejiang provinces, eastern China (Fig. 1), the Ordovician succession is represented in ascending order by the Yinchufu, Ningkuo, Hulo, and Yenwashan formations. Lithology, sedimentology, and depositional hypotheses for these formations in the JCY area have been described and discussed in detail by Zhang and Winston (1995), and Winston and Zhang (1995). The widely distributed Ningkuo Formation yields abundant well preserved graptolites and other fossils, such as conodonts, chitinozoans, brachiopods, phyllocarids and trilobites. Han et al. (1984) described conodont fossils from the JCY area. Yao and Yang (1991), Wang and Bergström (1995) later recollected conodont samples and presented more detailed conodont successions through the Ningkuo and Hulo formations. Abundant Phyllocarids belonging to *Caryocaris zhejiangensis* Shen (1985), and *C. wrightii* Salter (1863) occur throughout the Ningkuo Formation in this area.

So far, three papers have briefly listed chitinozoans from this area (Paris and Chen, 1995; Chen et al., 1996; Geng et al., 2000). The fact that chitinozoans are associated with graptolites in the Ningkuo Formation allows precise correlation between these two groups. Early Darriwilian (i.e., late Arenig) chitinozoan faunas have been reported from North America (Achab, 1982), South America (Grahn, 1992), Europe (Martin, 1969; Bockelie, 1980; Grahn, 1980, 1984; Paris, 1981; Paris and Mergl, 1984; Molyneux, 1987; Nölvak and Grahn, 1993), North Africa (Benoit and Taugourdeau, 1961; Elaouad-Debbaj, 1984; Soufiane and Achab, 1993; Oulebsir and Paris, 1995), Australia (Combaz and Péniguel, 1972; Playford and Miller, 1988; Winchester-Seeto et al., 2000), and China (Gao, 1985; Zhen, 1985; Grahn and Geng, 1990; Chen, 1994; Chen et al., 1996). However, the present study provides the more precise correlations between chitinozoans and graptolites in this time interval.

This paper details chitinozoans from four sections, i.e. the Hengtang, Fengzu, Dianbatou sections (Zhejiang Province) and the Chenjiawu section (Jiangxi Province)

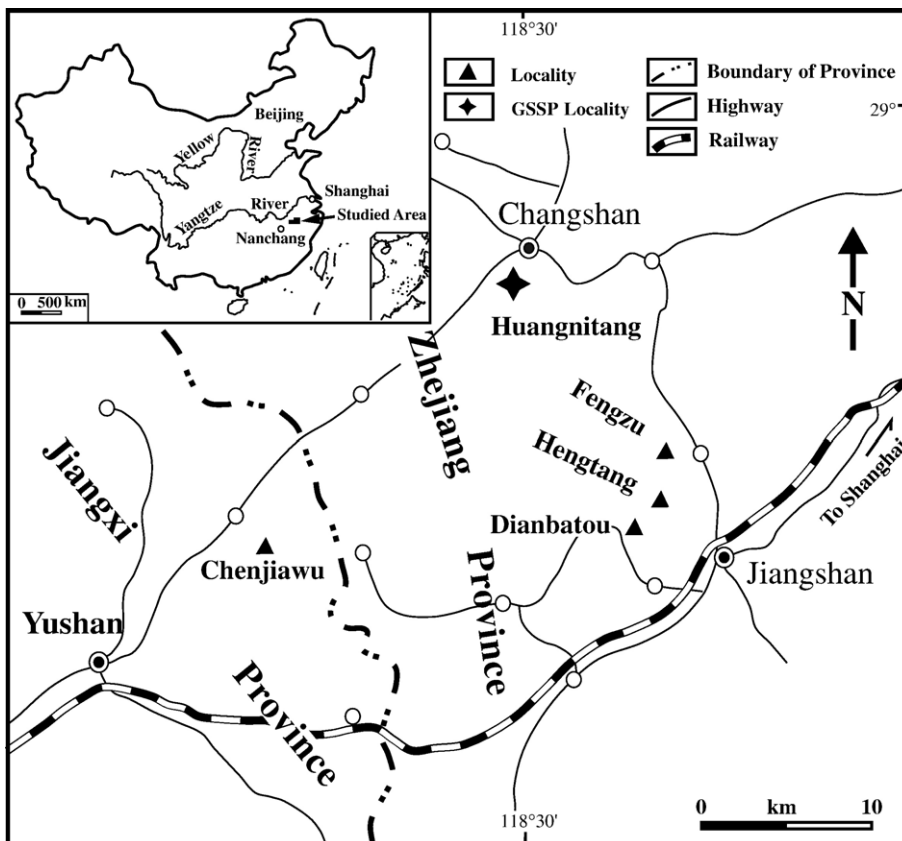


Fig. 1. Location of the studied area in Jiangshan–Changshan–Yushan (JCY) counties, borders of Jiangxi and Zhejiang provinces, eastern China.

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