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## ROUTE 1: MAOTIANSHAN AND MA'ANSHAN, YUNNAN PROVINCE

# THE EARLY CAMBRIAN CHENGJIANG BIOTA: QUARRIES OF NONMINERALIZED FOSSILS AT MAOTIANSHAN AND MA'ANSHAN, CHENGJIANG COUNTY, YUNNAN PROVINCE, CHINA

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## INTRODUCTION

The Chengjiang Biota was first discovered in the Maotianshan Shale Member of the Yu'an-shan Formation (alternatively, the Yu'an-shan Member of the Heilinpu Formation or the Chiungchussu (Qiongzhusi) Formation at Maotianshan (alternatively, Mt. Maotian) in Chengjiang County (Zhang and Hou, 1985). However, research on fossils from the Maotianshan Shale Member of the Chengjiang area can be traced to the early years of last century (Deprat, 1912; for a brief review see Babcock and Zhang, 2001). Fossils from Chengjiang were reported, for example, by Mansuy (1912), Ho (1941), and Zhang *et al.* (1979, 1980). Since 1984, continuous excavations of the Chengjiang nonmineralized fossils in the Maotianshan Shale in the Chengjiang area by working groups from the Nanjing Institute of Geology and Palaeontology and Northwest University led to the development of several important quarries (see Chen *et al.*, 1996; Hou *et al.*, 1999). The quarries are distributed along a NE-SW belt of the Yu'an-shan Formation in Chengjiang County (Fig.1), and include localities at Maotianshan, Ma'an-shan (alternatively, Mt. Ma'an), and near Dapotou, Xiaolantian, and Fengkoushao villages. Up to now, thousands of nonmineralized fossil specimens have been collected, and more than 20 phylum-level animal groups, assigned to more than 100 species, have been described (see Chen *et al.*, 1996; Hou *et al.*, 1999, and reference therein). The Chengjiang Biota is the one of the most important and earliest known biotas of exceptional preservation in the world. Strata containing the Chengjiang Biota have provided not only important information about the early Paleozoic evolution of metazoans, but also have contributed important information about the taphonomic and depositional circumstances of exceptional preservation in the Cambrian generally (Babcock *et al.*, 2001; Zhu *et al.*, 2001).

The county town of Chengjiang, Fenglu Town, is 56 km from Kunming City. The town is

located in the center of a basin at an elevation of 1755 m. Chengjiang County is famous for Fuxian Lake, which is one of the deepest lakes in China. The lake is located 5 km south of Fenglu Town, and is 212 km<sup>2</sup> in size, with an average depth of 87 m, and a maximum depth of

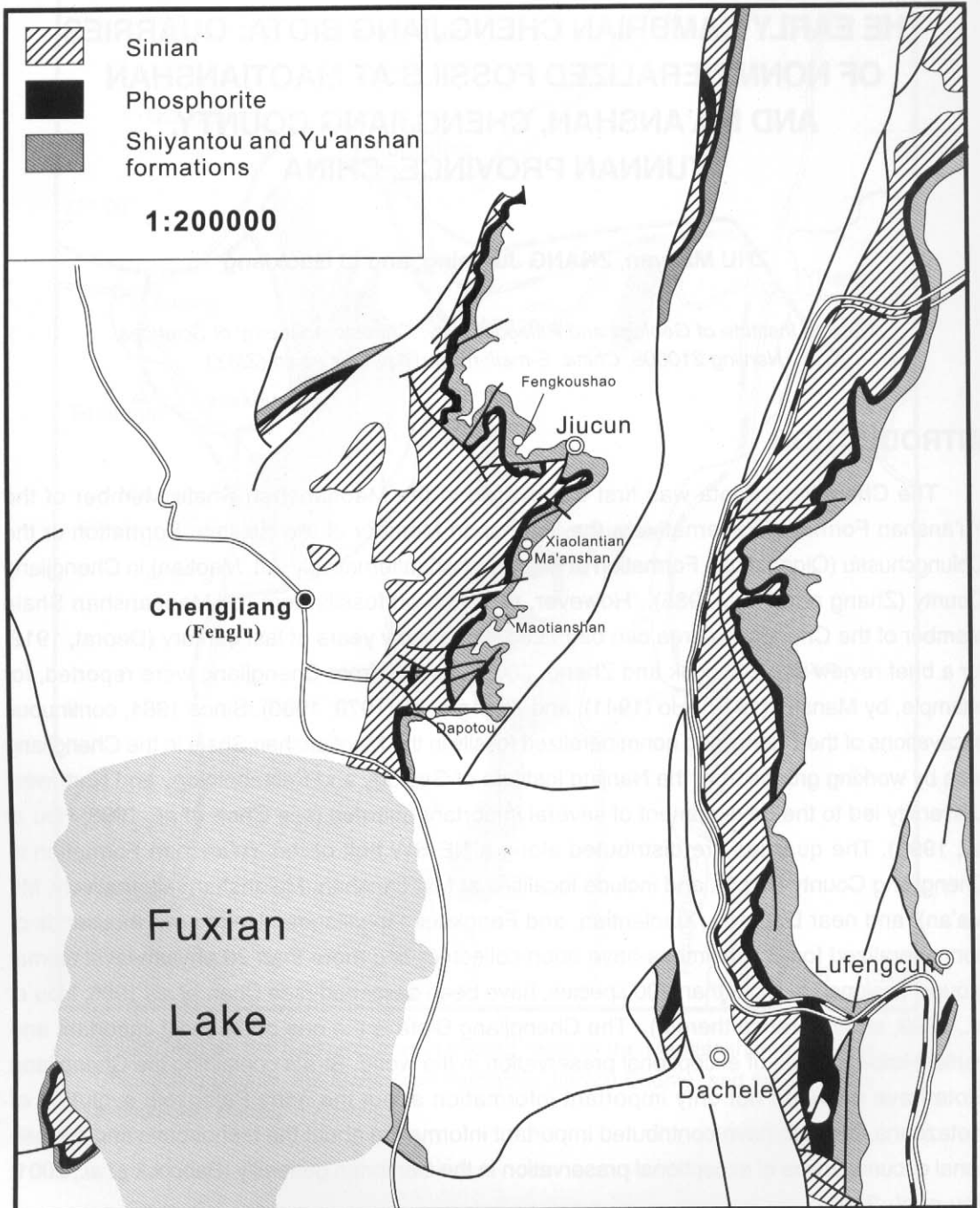


Fig. 1. Geological map in the Chengjiang area, showing the Sinian-Lower Cambrian outcrops and the quarries of the Chengjiang Biota in Chengjiang County.

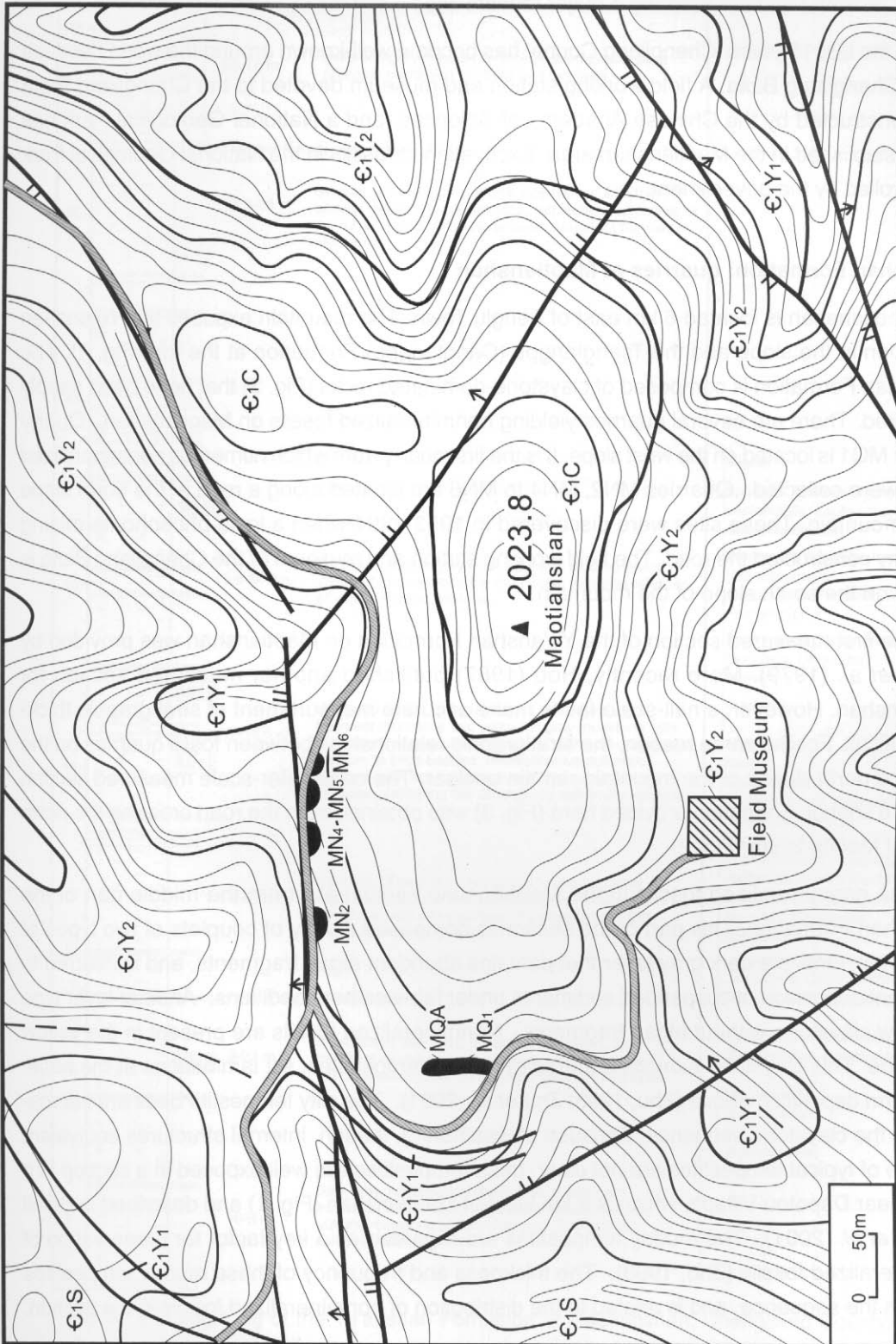


Fig. 2. Geological map around Maotianshan area, showing soft-bodied fossil quarries.  
 ε1S=Shiyantou Fm.  
 ε1Y1=Upper part of the Yu'anshan Fm.      ε1Y2=Lower part of the Yu'anshan Fm.  
 ε1C=Tsanglangpu Fm.

155 m. Fuxian Lake is becoming a major tourism site.

In the last 15 years, Chengjiang County has become well-known around the world because of the Chengjiang Biota. A field working station and museum devoted to the Chengjiang Biota was constructed by the Chinese Academy of Sciences, and a National Geological Park has been established in the Maotianshan area. Excavation of fossils in the National Geological Park is controlled by the government.

### Stop 1

#### Yu'anshan Formation: quarries at Maotianshan

Maotianshan is located 6 km east of Fenglu Town. The mountain exposes the Yu'anshan Formation in the slope and the Tsanglangpu (Canglangpu) Formation at the top (Fig. 2). The Yu'anshan Formation is composed of claystone-dominated rocks (Fig. 3) that have been deeply weathered. There are several quarries yielding nonmineralized fossils on Maotianshan. Quarry MQA or MQ1 is located on the west slope. It is the first quarry from which numerous nonmineralized fossils were collected. Quarries MN2, MN4 to MN6 are located along a road at the north slope of the mountain. These sites were discovered in 1993-1994 when a local phosphorite mining company constructed the road. The field working station and museum of the Chengjiang Biota is located on the south slope of the mountain.

The first measured section of the Yu'anshan Formation on Maotianshan was provided by Zhang *et al.* (1979). More recently, Hou (1987) published another measured section for Maotianshan. However, small-scale faults make accurate measurement of stratigraphic thickness difficult. For the same reason, the stratigraphic relationships between fossil quarries on the west and north slopes of the mountain remain unclear. The centimeter-scale measured section of the Yu'anshan Formation provided here (Fig. 3) was obtained from the road crossing the north slope of Maotianshan (Fig. 2).

The nonmineralized fossils in the Maotianshan section are from the middle part of the Yu'anshan Formation. This part of the section is composed mainly of couplets of two types of claystones. One is a dark gray layer that contains abundant algae fragments, and is inferred to represent deposition of suspended sediments under fair-weather conditions. Another layer type is yellow claystone without algae fragments. Nonmineralized fossils are present in the yellow claystone. This claystone exhibits features of muddy tempestites: silt laminations at the base, and storm deposition above (Zhu, 1993; Zhu *et al.*, 2001). The silty tempestite beds are intercalated in the claystone sequence. Because of weathering, though, internal structures equivalent to those of typical tempestites are not clear, fresh tempestites are well exposed in a section in a valley near Dapotou Village, which is 3 km west of Maotianshan (Fig. 1) and described in detail by Zhu *et al.* (2001). The muddy tempestites are regarded as a key factor for preservation of nonmineralized fossils (Zhu, 1993). The thickness and frequency of these muddy tempestites varies in the sequence, and is related to the distribution of nonmineralized fossils in the section.



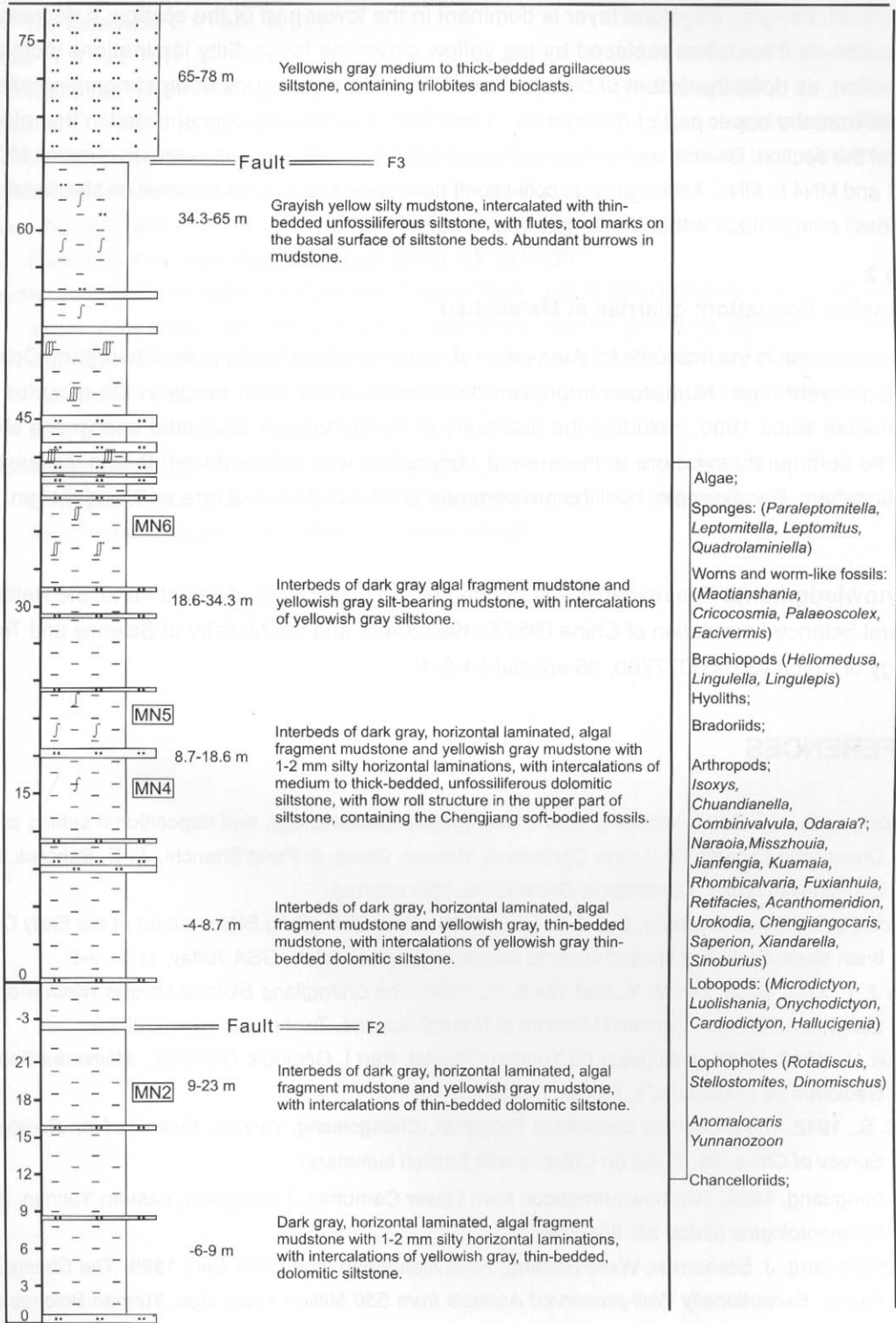


Fig. 3. Lithologic log of the Yu'an-shan Formation at Maotianshan, Chengjiang County, showing soft-bodied fossil quarries.

In general, the gray claystone layer is dominant in the lower part of the section; it decreases upsection as it becomes replaced by the yellow claystone layer. Silty laminations increase upsection, as does the extent of bioturbation. This limits occurrence of most nonmineralized fossils from the upper part of the section. Therefore, quarries are concentrated in the middle part of the section. Diverse well-preserved fossils have been discovered mainly in quarries MQA, MQ1 and MN4 to MN6. Although large collections have been made in the quarries on Maotianshan, the fossil composition within these quarries remains unclear.

## Stop 2

### Yu'anshan Formation: quarries at Ma'anshan

Ma'anshan is the main site for excavation of nonmineralized fossils in the Chengjiang County at the present time. Numerous important discoveries have been made in the quarries on Ma'anshan since 1990, including the discovery of *Yunnanozoon*. Collected specimens show that the community structure in the area of Ma'anshan was different from that in the area of Maotianshan. For example, hyoliths are common on Ma'anshan, but rare on Maotianshan.

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