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ROUTE 2: MEISHUCUN AREA, YUNNAN PROVINCE

PRECAMBRIAN-CAMBRIAN BOUNDARY STRATIGRAPHY AT MEISHUCUN, YUNNAN PROVINCE, CHINA: BASE OF THE CAMBRIAN AND THE FIRST APPEARANCE OF TRILOBITE

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INTRODUCTION

The Meishucun area, Yunnan Province, located west of Dianchi Lake, exposes an excellent succession of Sinian (Neoproterozoic) and Lower Cambrian strata (Fig. 1). The Sinian-Cambrian stratigraphy in the area near Meishucun Village, Jinning County, has long been considered one of the best Precambrian-Cambrian boundary intervals globally (Luo *et al.*, 1984, 1994). Present in this interval are some of the earliest trilobites and abundant subtrilobitic small shelly fossils (SSFs). The village of Meishucun is about 71 km from Kunming, and reached by driving from Kunming along the highway on the east side of Dianchi Lake.

The subtrilobitic phosphatic rocks in the Meishucun area have been known since 1939, when Chen Y. Q. investigated the "white clay" at Zhongyicun Village in Kunming (Jinning). Because the phosphate beds contain *Hyolithes*, they were regarded as Cambrian in age (Wang Y. L., 1941). The *Hyolithes* specimens were first described by Wang H. C. in 1941. The phosphatic units were first considered as representing a new stage interval, which contained the *Salterella* Zone, by Sun (1961). Later, Qian (1977) established the Meishucunian Stage to define an interval covering the subtrilobitic strata. In China, this interval contains abundant SSFs. Since then, the term Meishucunian Stage has been widely used for the first stage of the Cambrian in China. Recently, it is subdivided by Peng (2000) into the Jinningian and Meishucunian stages.

The Precambrian-Cambrian boundary sections in the Meishucun area are well exposed, and they have been protected by the local government since the 1980s. The interval consists of the upper part of the Baiyanshao Member of the Tongying Formation, the Zhongyicun and Dahai members of the Zhujiaqing Formation, the Shiyantou Formation, and the Yu'anshan Formation (Fig. 2). The Shiyantou and Yu'anshan commonly have been regarded as members of the Chiungchussu (Heilinpu) Formation (e.g., Luo *et al.*, 1982; Luo *et al.*, 1996). However, they were

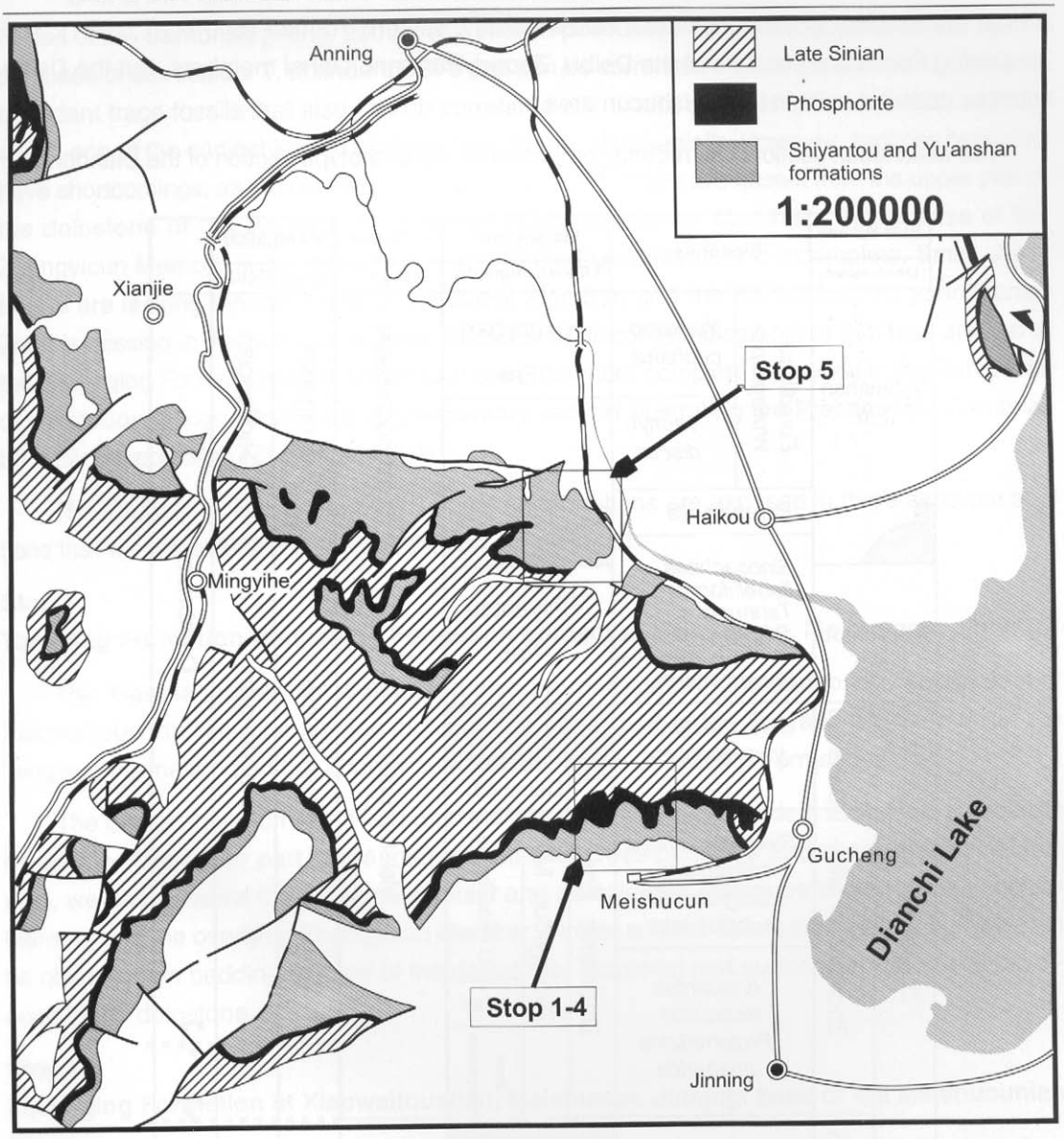

Fig. 1. Geological map in the western Dianchi Lake area, showing localities of Stop 1-5.

elevated to formation status by Chen *et al.* (1996), and that usage is followed here. The Shiyantou Formation is an interval between the Zhujiaqing Formation and the Yu'anshan Formation, and is composed of black siltstone with phosphatic clasts. The Yu'anshan Formation is mostly composed of claystones or shales. The two formations can be easily separated in the field: a phosphatic conglomerate marks the base of the Yu'anshan Formation in the Meishucun area. The Zhujiaqing Formation is a recently erected lithostratigraphic name proposed (Zhu *et al.*, 2001) to replace the Meishucun Formation because the Meishucun Formation is synonymous with name of the Meishucunian Stage. Replacement of the formation name was suggested by the majority of the Cambrian workers in China (Lu *et al.*, 1994). The type section of the Zhujiaqing Formation

is near the Zhujiaqing Villlage, Dahai, Huize County, eastern Yunnan (Zhu *et al.*, 2001). The Zhujiaqing Formation consists of the Daibu, Zhongyicun, and Dahai members, but the Daibu Member does not exist in the Meishucun area.

The Meishucun section was recently proposed as the stratotype section of the Diandongian

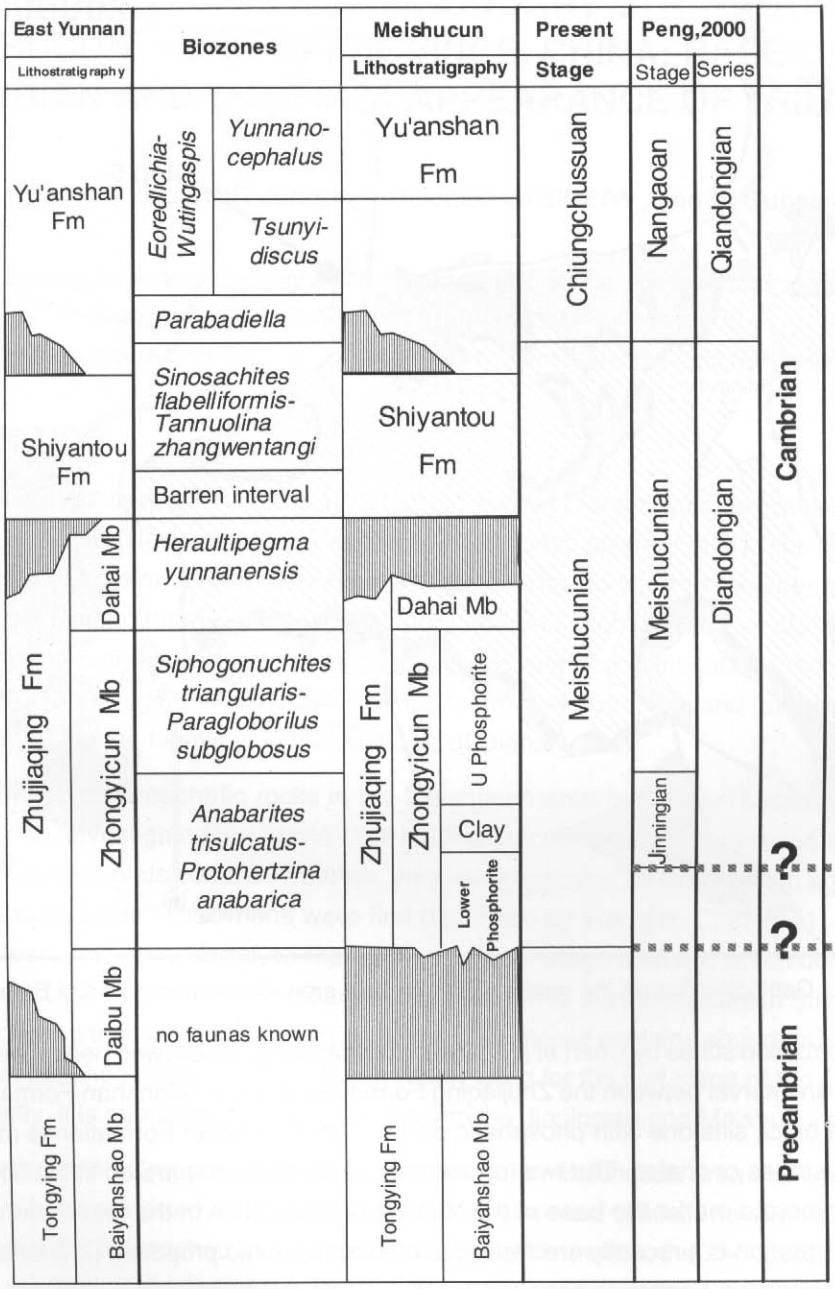

Fig. 2. Stratigraphic chart of the Precambrian and Cambrian boundary interval in the Meishucun section, Jinning County.

Series of the Cambrian (Peng, 2000). The section possesses the following advantages for the purposes of correlation: 1, abundant SSFs that can be correlated with strata outside of China; 2, abundant trace fossils that also can be correlated with strata on other continents (Zhu, 1997); and 3, one of the earliest-known trilobites from China, *Parabadiella*. However, sections here also have shortcomings, as indicated by Qian *et al.* (1996): 1) SSFs are absent from the upper part of the dolostone of the Baiyanshao Member (Xiaowaitoushan Member); 2) the base of the Zhongyicun Member is disconformable; and 3) the Dahai Member is incomplete. Small shelly fossils are lacking through most of the Dahai Member, and the *Heraultipegma yunnanensis* Zone is missing in the Meishucun area. Because of disconformities both at the base and top of the Zhujiaqing Formation in the Meishucun area, the more complete sequence in the Dahai area of Huize County can serve as a supplementary section illustrating the Precambrian-Cambrian boundary succession (Zhu *et al.*, 2001).

The Zhujiaqing, Shiyantou, and Yu'anshan formations are exposed in three separate sections that we will examine in the Meishucun area (Fig. 3).

Stop 1

Tongying Formation-Zhujiaqing Formation contact at Xiaotuanpo, Meishucun, Jinning

The Xiaotuanpo section is exposed along a road cut on Xiaotuanpo Hill, 100 m east of Xiaowaitoushan Hill. The section includes the upper part of the Baiyanshao Member of the Tongying Formation and the Zhongyicun Member of the Zhujiaqing Formation.

The Baiyanshao Formation is composed of medium- to thick-bedded, laminated, intraclastic dolostone. The upper part of the member exhibits cross-beddings and chert nodules. At this stop, we can observe the erosional contact and paleokarstic fillings between the Baiyanshao Member and the overlying Zhongyicun Member. Simple surface traces and shallow burrows can be observed on bedding surface of the dolostone. Bacterial mat surfaces are also well developed in the dolostone.

Stop 2

Zhujiaqing Formation at Xiaowaitoushan, Meishucun, Jinning: base of the Meishucunian Stage

The Xiaowaitoushan section (Fig. 4) is on the south slope of the Xiaowaitoushan Hill, which begins on the top of the hill, and exposes phosphorite of the Zhongyicun Member and dolostone of the Dahai Member of the Zhujiaqing Formation. In the section, the following features are noteworthy:

1) the basal conglomerate, and hardground layer of the Zhongyicun Member;
2) the oncolites and oolitic structures in the lower phosphorite;
3) abundant SSFs and trace fossils in the upper part of the lower phosphorite;
4) the bentonite and light dolostone interval in the middle part of the Zhongyicun Member;
5) abundant SSFs near the China B horizon in the middle part of the upper phosphorite;

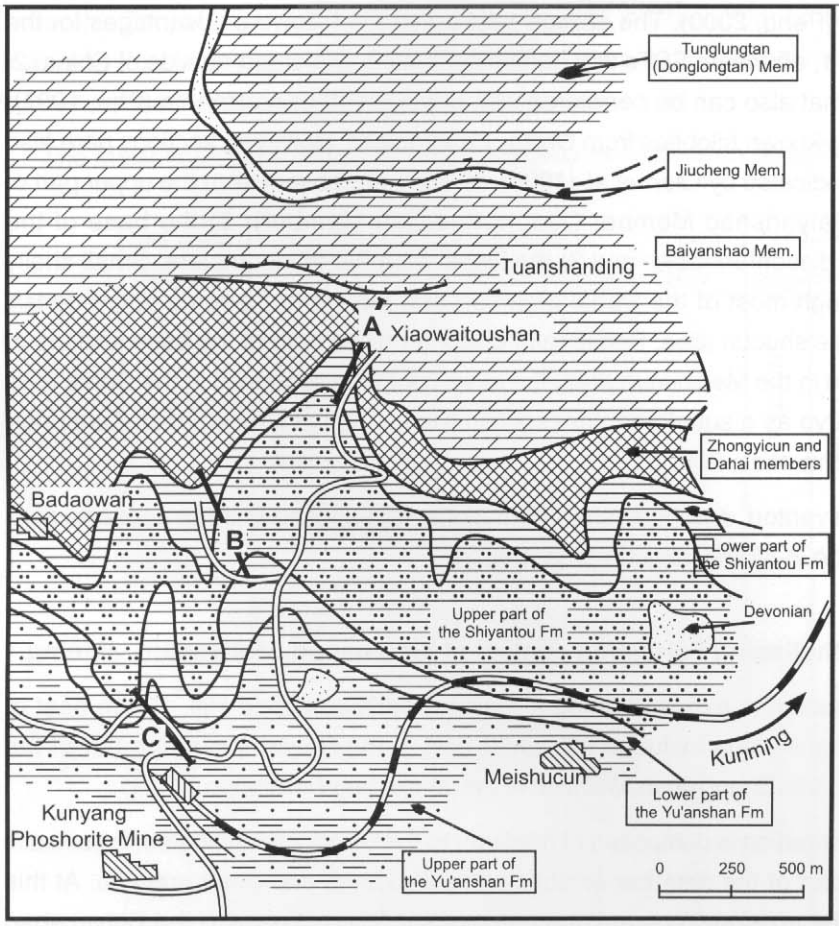

Fig. 3. Geological map near Meishucun Village, Jinning County.
A. Section of the Zhongyicun and Dahai members at Xiaowaitoushan; B. Section of the Shiyantou Formation at Heishahe; C. Section of the Yu'anshan Formation at Badaowan.

6) traces (*Rusophycus*) and bacterial mat structures in the large bedding surface of the upper phosphorite;

7) thick-bedded dolostone of the Dahai Member.

It should also be noted that *Trichophycus pedum* occurs in the upper part of the lower phosphorite and the lower part of the upper phosphorite elsewhere (Zhu, 1997; Zhu *et al.*, 2001). Definition of the Precambrian-Cambrian boundary in the section is under debate. Based on the FAD of *Trichophycus pedum*, the base of the Cambrian should be within the upper part of the lower phosphorite in the section.

Stop 3

Shiyantou Formation at Heishahe, Meishucun, Jinning: abundant trace fossils

The Heishahe section is (Fig. 5) located near the Heishahe Valley. The Shiyantou Formation can be subdivided into two parts. The lower part is black, laminated siltstone with dolomitic concretions and rare traces. The upper part is dark gray, laminated siltstone with intercalations of gray silty beds (tempestites); trace fossils and bioturbated beds are abundant (Zhu, 1997).

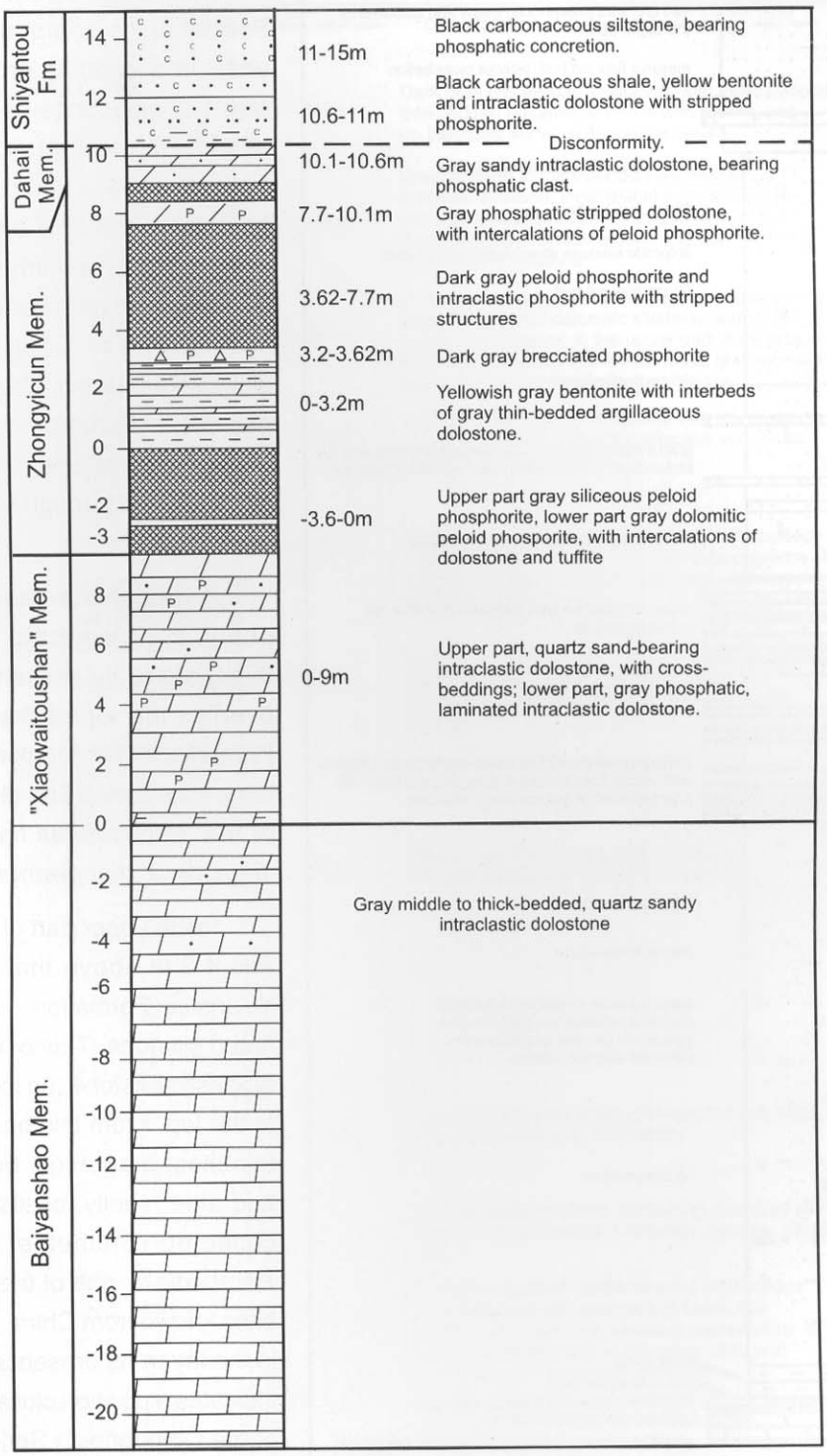

Fig. 4. Lithologic log of the Zhongyicun Member and Dahai Member in the Xiaowaitoushan section, Meishucun Village, Jinning County.

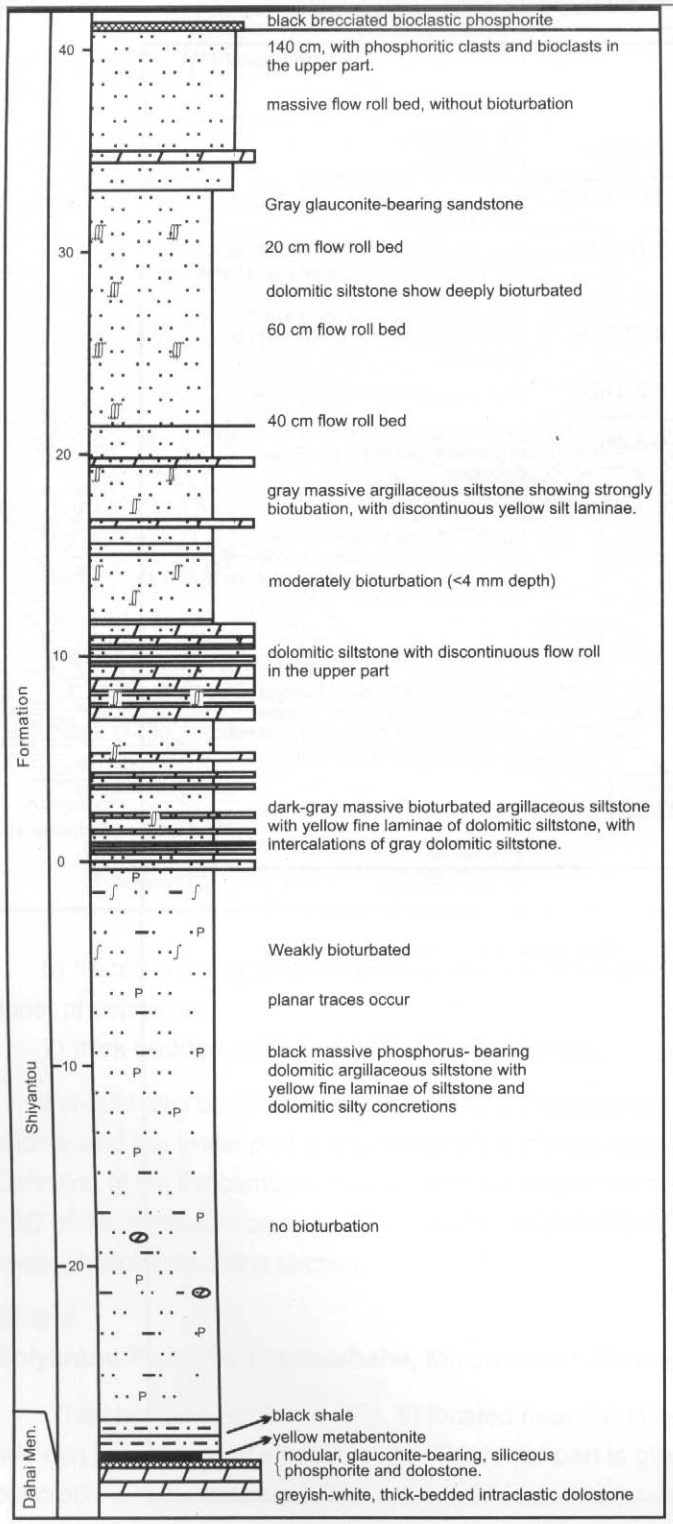

Fig. 5. Lithologic log of the Shiyantou Formation at Heishahe, Meishucun Village, Jinning County.

The basal part of the Shiyantou Formation is composed of three units. In ascending order the units are: 1, a glauconite-bearing, phosphatic conglomerate (20 to 40 cm thick); 2, a yellow bentonite layer (30 cm thick); and 3, a black carbonaceous shale with intercalations of black siltstone containing phosphatic nodules (1.0 to 1.4 m thick). The glauconite-bearing, phosphatic conglomerate disconformably overlies the Dahai dolostone. The bentonite can be traced through much of eastern Yunnan.

A glauconite-bearing, phosphatic conglomerate (20-40 cm thick) of the Yu'anshan Formation overlies the top of the Shiyantou Formation. The conglomerate contains abundant SSFs characteristic of the *Sinosachites flabelliformis-Tannuolina zhangwentangi* Zone.

In the upper part of the section, about 8 m above the base of the Yu'anshan Formation, occurs a laminated siltstone. This bed includes a bioclastic siltstone (up to 1.4 m thick) at the top. From this bed, abundant trilobites, bradoriids, brachiopods, and other shelly fossils have been collected (Steiner *et al.*, 2001). *Parabadiella*, one of the oldest trilobites known from China, also occurs in the layer. Its presence in this bed indicates a position close to the base of the Qiandongian Series.

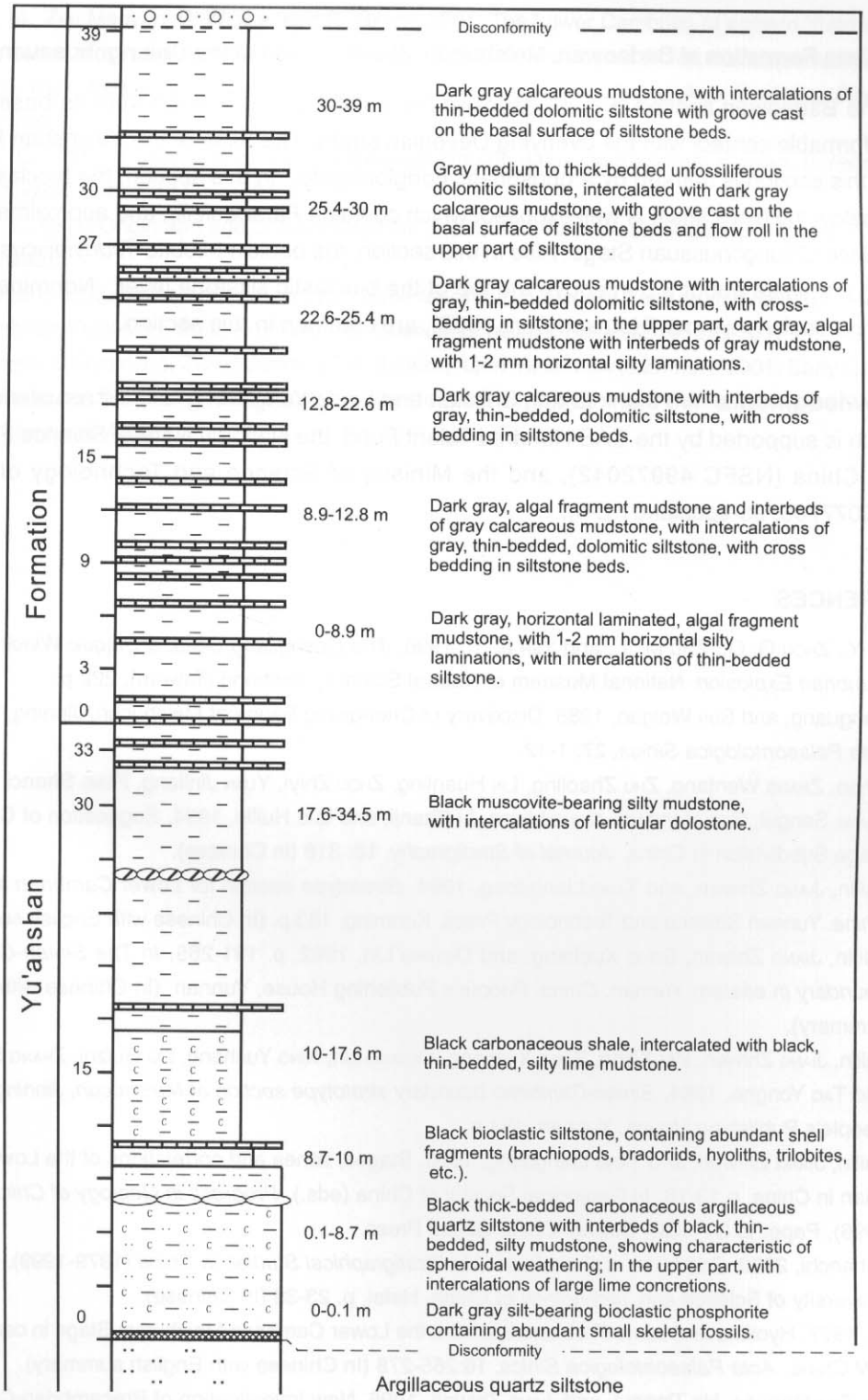

Fig. 6. Lithologic log of the Yu'anshan Formation at Badaowan, Meishucun Village, Jinning County.

Stop 4

Yu'anshan Formation at Badaowan, Meishucun, Jinning: base of the Chiungchussuan Stage

The Badaowan section (Fig. 6) exposes the Yu'anshan Formation from its base to the disconformable contact with the overlying Devonian strata. The base of the Yu'anshan Formation at this section is marked by a phosphatic conglomerate. In this section, the bioclastic siltstone below the black shale is well exposed, which contains *Parabadiella*, and approximates the base of the Chiungchussuan Stage. Also in this section, the eodicid trilobite *Tsunyidiscus* occurs in the black shale about 3.8 m above the top of the bioclastic siltstone layer. Nonmineralized fossils, particularly worms (Hou and Sun, 1988), are common in this section.

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