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ROUTE 2: WANGCUN, HUNAN PROVINCE

CAMBRIAN STRATIGRAPHY AT WANGCUN, HUNAN PROVINCE, CHINA: STRATOTYPES FOR BASES OF THE WANGCUNIAN AND YOUSHUIAN STAGES

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INTRODUCTION

Wangcun is an ancient town in southernmost Yongshun County, Hunan Province. The town is an important tourist destination, in part because of its long history and in part because of the attractive riparian scenery nearby along the Mongdonghe River, a branch of the Youshui River. A lengthy Cambrian section is exposed in a roadcut along the highway connecting Wangcun and Luoyixi, on the north bank of the Youshui River (Fengtan Reservoir), about 4 km southeast of Wangcun (Figs. 1, 2). The highway was constructed for the benefit of travelers arriving at the Louyixi railway station, and needing to drive from the railway station to Wangcun. The section is situated on the southeast limb of an undulating syncline, the Liexi-Zhuitun Syncline (Fig. 3). It is one of the major synclines extending through the Jiangnan Slope Belt in northwestern Hunan. Strata exposed in the middle of the syncline include those of the Upper Cambrian through Lower Ordovician. The trend of the structure is north-northeast.

Cambrian formations exposed in the Wangcun section include the uppermost part of the Aoxi Formation and the lower and middle parts of the Huaqiao Formation. The Wangcun section serves as the stratotype for both the Wangcunian and the Youshuian stages of the Cambrian, and has recently been the subject of papers by Peng *et al.* (1995) and Peng and Robison (2000).

The Wangcun section is easily accessible by driving west for 48 km on the Zhangjiajie-Yongshun provincial highway from Zhangjiajie to Shiti. Turn left (south) at the T-junction with the Shiti-Wangcun highway, and drive 46 km toward Wangcun until reaching a T-junction with the Wangcun-Luoyixi highway at the east end of the town of Wangcun. At the junction, turn left again (southeast) and follow the highway 5 km to a large bridge over the Fengtan Reservoir (Youshui

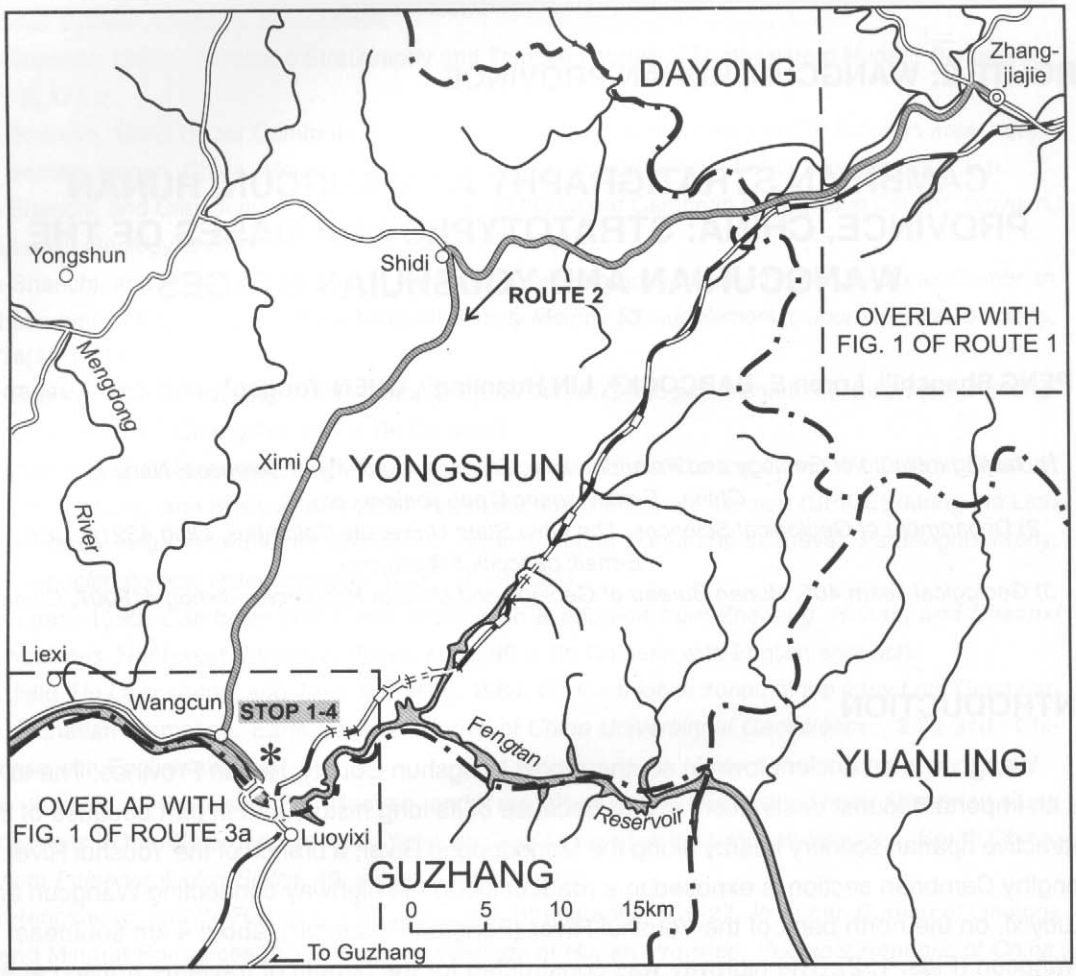


Fig. 1. Map showing the route (shadowed) to the Wangcun section from Zhangjiajie, Hunan Province, China.

STAGES	FORMATIONS
Waergangian	Huaqiao
Youshuian	
Wangcunian	
Taijiangian	Aoxi

Fig. 2. Stratigraphic nomenclature for Stops 1 to 4. Heavy lines show lithostratigraphic and chronostratigraphic boundaries to be examined.

River). There is another T-junction at the location of the section. The section extends to the northwest along the highway (Fig. 4). The section can be also reached by train travel from either from Zhangjiajie in the north, or from Jishou in the south to Luoyixi; from Luoyixi, it is a 4 km drive to the section. Alternatively, the section can be reached by driving 70 km north from Jishou (Route 3a, Fig. 1).

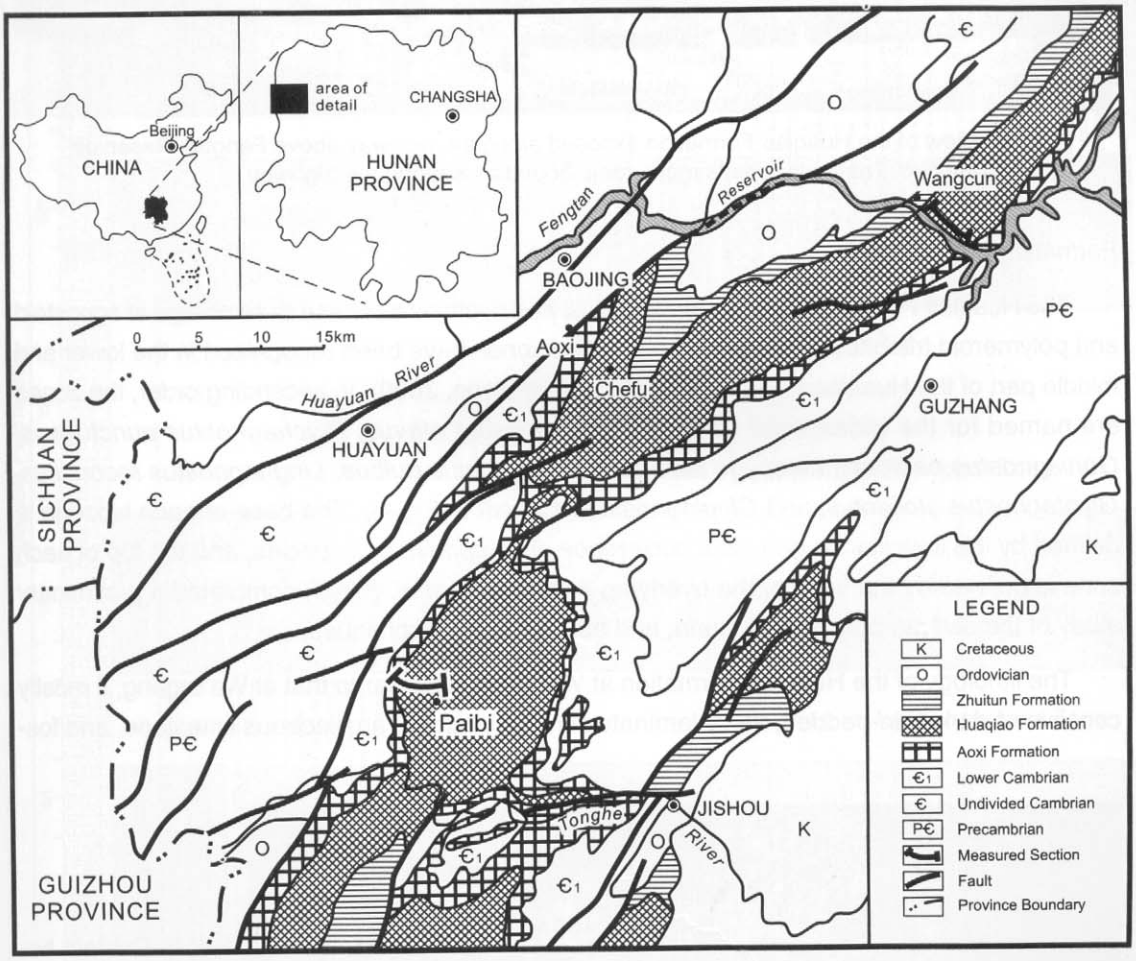


Fig. 3. Geological map showing locations of measured stratigraphic sections near Wangcun and Paibi in northwestern Hunan, China (from Peng and Robison, 2000).

Stop 1

Aoxi Formation and lower part of the Huaqiao Formation

The Aoxi Formation at this site includes gray, thinly laminated dolomite, 25 m thick, in the lower part, and black shale interbedded with dolostone and dolomitic limestone, 25 m thick, in the upper part. Trilobites have not been recovered from this interval. The contact of the Aoxi Formation with the overlying Huaqiao Formation is gradational, and arbitrarily placed at the point of change from shale of the Aoxi Formation to thin-bedded argillaceous limestone of the Huaqiao

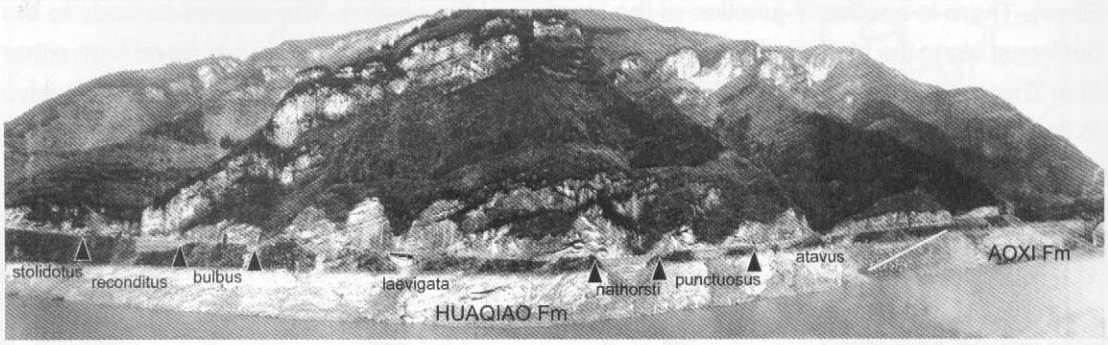


Fig. 4. View of the Huaqiao Formation exposed along the highway above Fengtan Reservoir near Wangcun. Triangular points mark zonal boundaries along the highway.

Formation (Fig. 5).

The Huaqiao Formation is richly fossiliferous, and contains a diverse assemblage of agnostoid and polymeroid trilobites. Eight agnostoid-based zones have been recognized in the lower and middle part of the Huaqiao Formation (Peng and Robison, 2000). In ascending order, the zones are named for the widespread species *Ptychagnostus atavus, Ptychagnostus punctuosus, Goniagnostus nathorsti, Lejopyge laevigata, Proagnostus bulbus, Linguagnostus reconditus, Glyptagnostus stolidotus,* and *Glyptagnostus reticulatus* (Fig. 6). The base of each biozone is defined by the lowest stratigraphical occurrence of its eponymous species, and the top of each zone is defined by the base of the overlying zone. Peng *et al.* (1995) completed a preliminary study of the diverse polymerioid fauna, and additional work continues.

The lithology of the Huaqiao Formation at Wangcun is similar to that at Wa'ergang; it mostly consists of dark, thin-bedded, thinly laminated lime mudstone, argillaceous limestone, and fos-

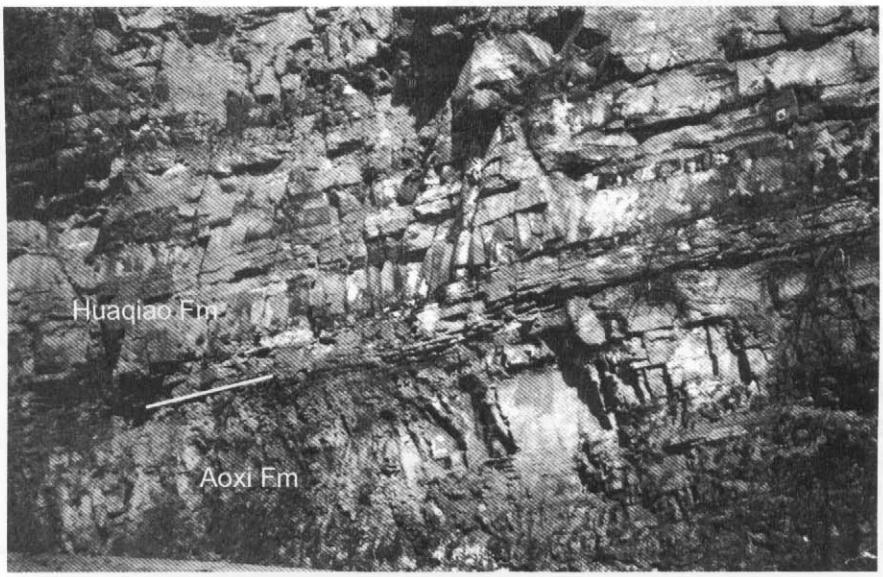


Fig. 5. Contact between the Aoxi Formation and the overlying Huaqiao Formation in the Wangcun section. The upper Aoxi Formation consists of black, thin-bedded shale. Those beds are overlain by black, thin-bedded argillaceous and carbonaceous limestone beds of the Huaqiao Formation.

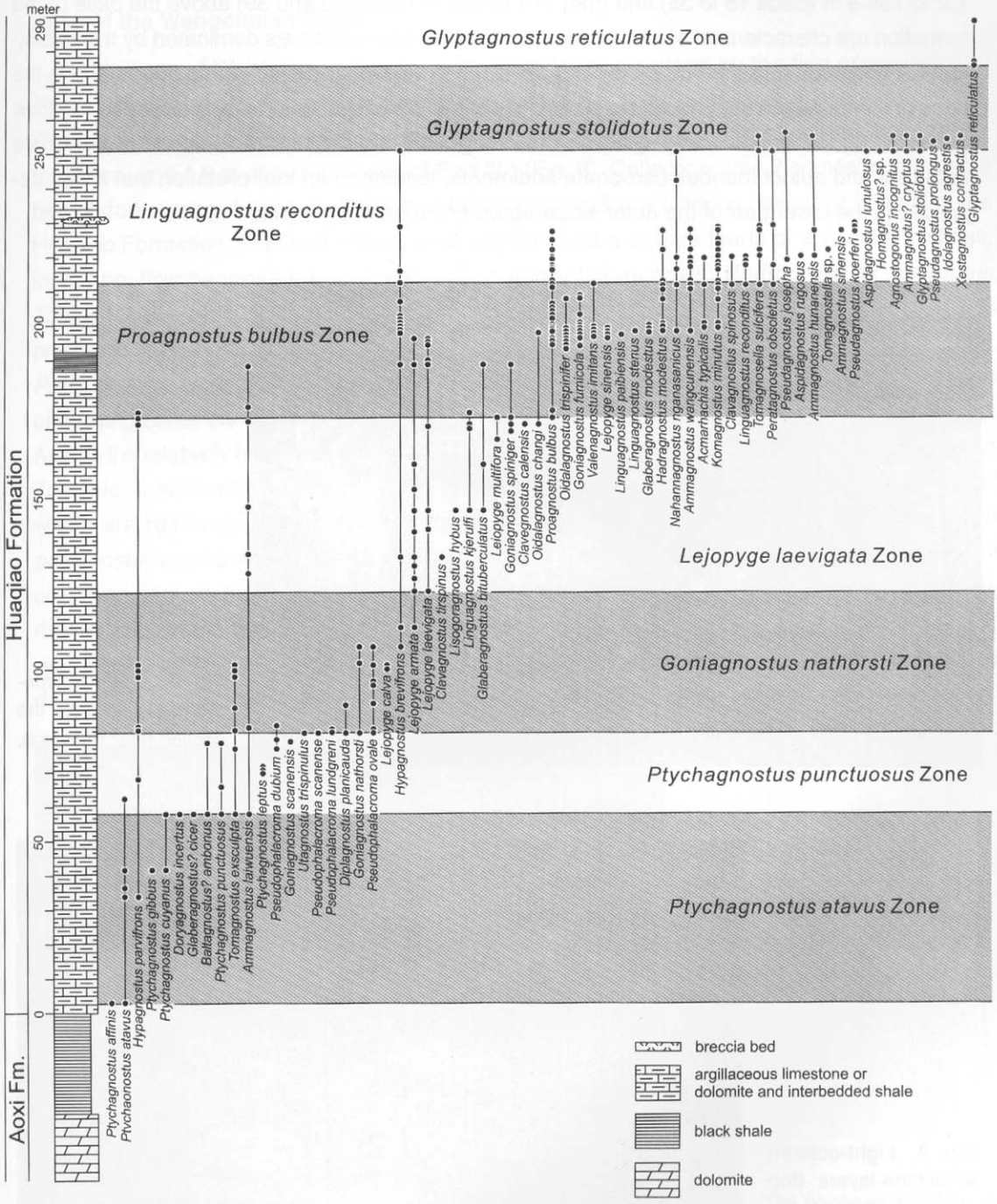


Fig. 6. Zonation and observed stratigraphic distribution of agnostoid species in the Huaqiao Formation near Wangcun (from Peng and Robison, 2000 with additional occurrences of *Glyptagnostus reticulatus*).

sil-rich limestone lenses; light-colored ribbon limestones are present in places. Intervals from 1.2 to 138.8 m (Beds 15 to 35) and from 174 to 209 m (Beds 38 and 39) above the base of the formation are characterized by numerous limestone lenses in intervals dominated by thinly laminated limestones (Fig. 7). The intervals from 138.8 to 174 m, and from 209 to 307 m above the base of the formation are characterized by the alternation of light-colored argillaceous limestone beds and ribbon limestones (Fig. 8). In the Wangcun area, the formation includes carbonate turbidites and autochthonous carbonate sediments, leading to an interpretation that it was deposited in the lower part of the outer slope-apron environment (Fu *et al.*, 1999).

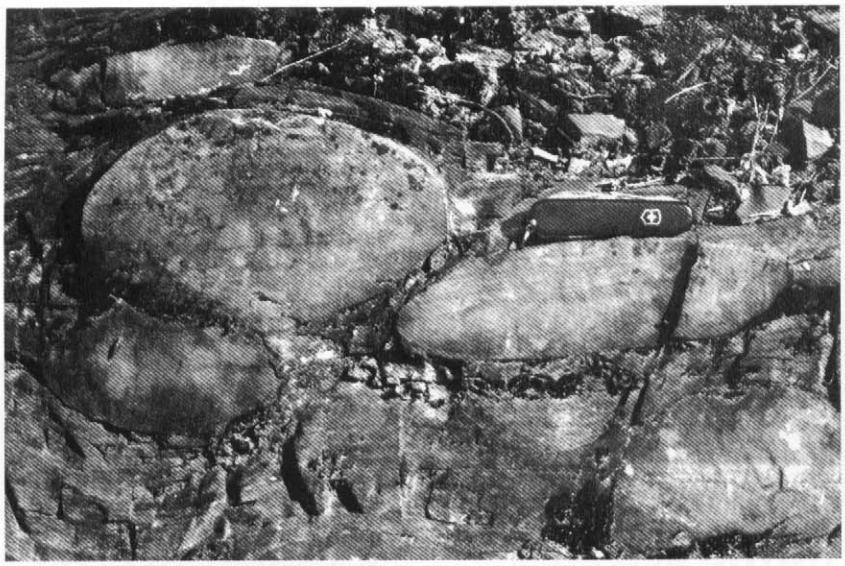


Fig. 7. Nodular limestone at 88.5 m in the section near Wangcun.

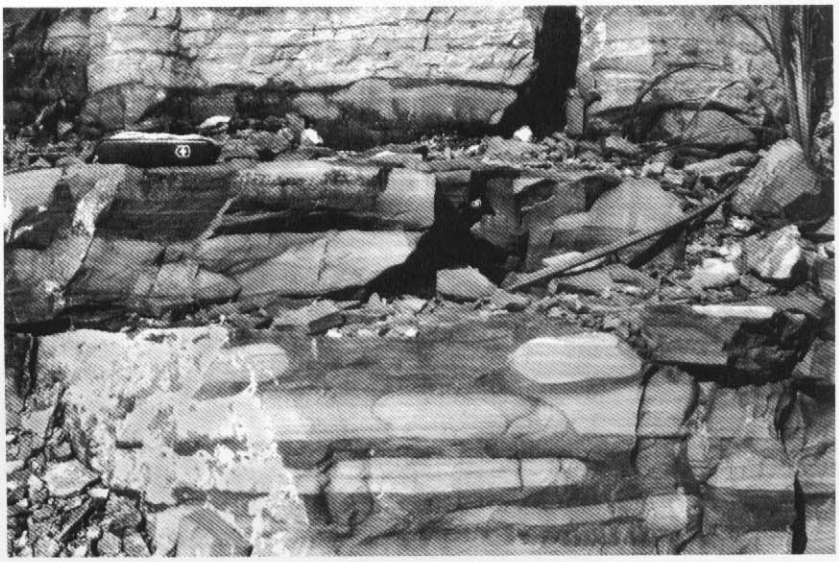


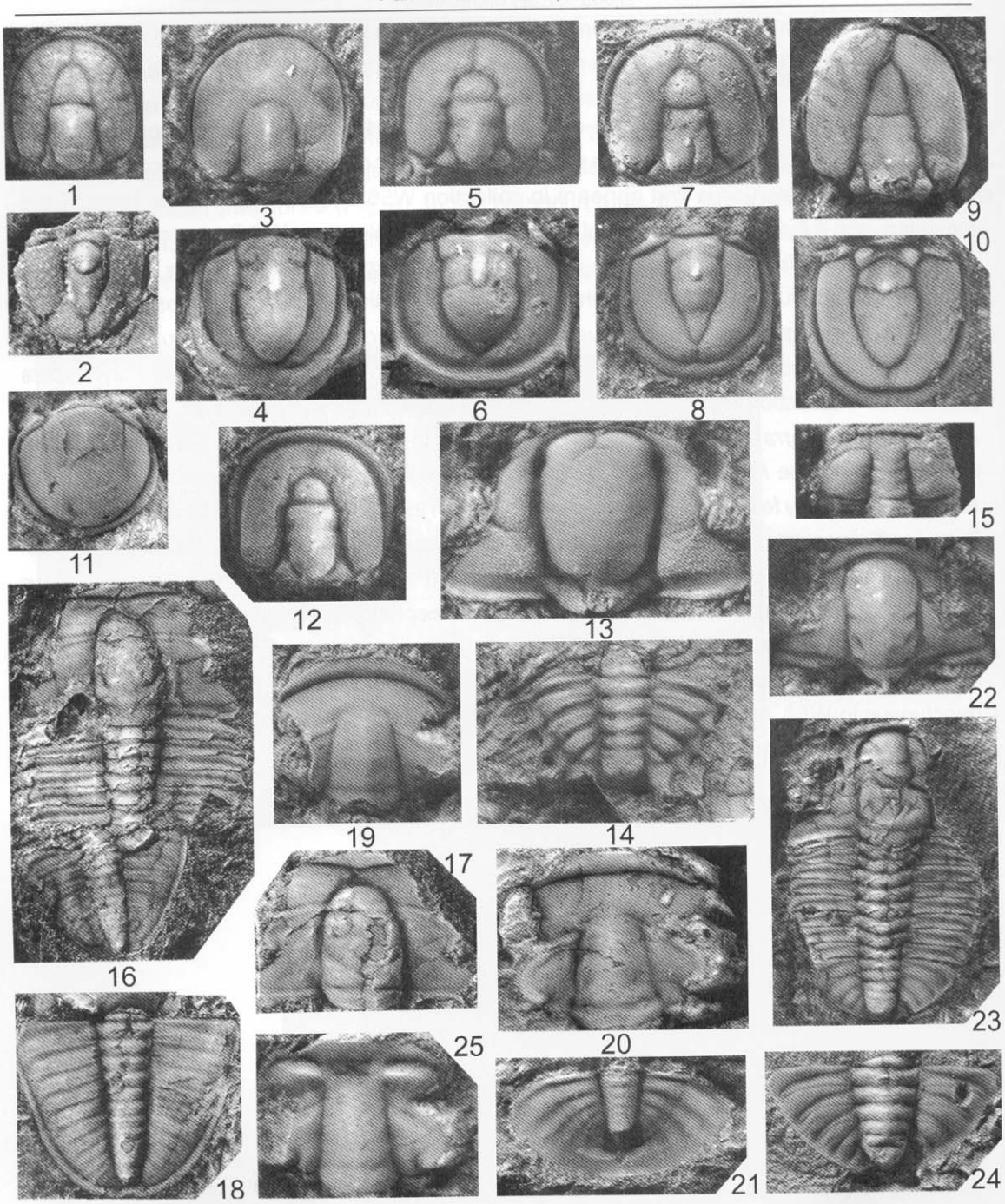
Fig. 8. Light-colored limestone layers (top of the photo) and ribbon limestones at 233 m in the section near Wangcun.

Stop 2

Base of the Wangcunian Stage

The base of Wangcunian Stage of the Cambrian is defined by the first appearance of *Ptychagnostus punctuosus*, which also defines the base of the *Ptychagnostus punctuosus* Zone. *Ptychagnostus punctuosus* first appears in collection W56.7 (56.7 m above the base of the formation, and 4.6 m above the base of Bed 25) (Fig. 9). Collection W56.7 comes from a single bed of dark, lime-rich limestone within a thinly laminated argillaceous limestone interval of the Huaqiao Formation. This bed is 9 cm thick and contains a diverse fauna of agnostoid trilobites, including *Ptychagnostus punctuosus*, *Doryagnostus incertus, Baltagnostus? ambonus, Tomagnostella exsculpta, Ptychagnostus cuyanus*, and *Ammagnostus laiwuensis*. Polymeroids present in the collection include *Wangcunia wangcunensis*, *Dorypyge richthofeni, Fuchouia chiai, Prodamesella bicerrata*, and *Paranomocarella?* sp. (Fig. 10). Compared to the fauna from the underlying zone, the *Ptychagnostus atavus* Zone, there is considerable change in composition. Among the relatively few species that range upward from the *P. atavus* Zone into the *P. punctuosus* Zone are *T. exsculpta, D. incertus, B.? ambonus, A. laiwuensis*, *D. richthofeni*, and *F. chiai,* all of which are relatively common in collection W56.7. It should be noted that *Ptychagnostus punctuosus* is quite rare in collection W56.7 (only one cephalon and two pygidia were found in a collection of more than 300 specimens). *Ptychagnostus punctuosus* is somewhat more common in collections (e.g., W64.7 and W77.8) from higher in section. The relative rarity of *P. punctuosus* in W56.7 suggests the possibility that this level represents the first appearance datum (FAD) of this species.

Fig. 9. The boundary point for the base of the Wangcunian Stage at 56.7 m in the section near Wangcun.



Stop 3

Base of the Youshuian Stage

The base the Youshuian Stage of the Cambrian is defined by base of the *Linguagnostus reconditus* Zone. This level also has been proposed as a candidate GSSP for the base of a

Cambrian series (Peng and Robison, 1997, 2000) if the boundary is chosen at a level close to the traditional Middle-Upper Cambrian boundary. The Middle-Upper Cambrian boundary traditionally has been defined at the base of the *Agnostus pisiformis* Zone in Scandinavia (Westergård, 1946) and other areas of Europe. *Linguagnostus reconditus* occurs in association with *Agnostus pisiformis* in the *Agnostus pisiformis* Zone of Sweden (Ahlberg and Ahlgren, 1996) and England (Rushton, 1978). As discussed by Peng and Robison (2000), the base of the *Agnostus pisiformis* Zone is defined by the local taxon abundance, rather than the first appearance, of *A. pisiformis*. Nevertheless, the base of the *L. reconditus* Zone (and, by implication, the base of the Youshuian Stage) should be close to the base of the *Agnostus pisiformis* Zone of Sweden.

The precise stratigraphic position of the base of Youshuian Stage is at 210.5 m in the Wangcun section, where *Linguagnostus reconditus* first occurs in a 5-cm-thick limestone bed (Fig. 11) of the Huaqiao Formation. This bed contains a rich and diverse trilobite fauna. Species in the collection (W210.5) include the agnostoid trilobites *Acmarhachis typicalis, Ammagnostus wangcunensis, Clavagnostus spinosus, Hadragnostus modestus, Linguagnostus reconditus, Kormagnostus minutus, Nahannagnostus nganasanicus,* and *Tomagnostella sulcifera;* and the polymeroid trilobites *Ajrikina hunanensis, Fenghuangella coniforma, Eoshengia latilimbata, Glaphyraspis nitida, Neoanomocarella asiatica, Monkaspis quadrata, Pseudomapania truncata, Proceratopyge fuyangensis,* and *Torifera taoyuanensis*.

The most fossiliferous interval in the Wangcun section, and one of the most fossiliferous intervals from any section in northwestern Hunan, occurs about 20 m below the lowest occurrence of *Linguagnostus reconditus* (i.e., about 20 m below the base of the Youshuian Stage). *Linguagnostus stenus*, a possibly ancestor of *Linguagnostus reconditus,* is present in this interval. An even older species in the *Linguagnostus* lineage, *Linguagnostus kjerulfi*, first occurs in the *Lejopyge laevigata* Zone in the Wangcun section. The most distinctive morphological change through the lineage is the progressive shortening of the terminal piece in the pygidial axis. The phylogenetic series of *Linguagnostus* as preserved in the Wangcun section suggests that the lowest occurrence of *L. reconditus* at 210.7 m in the section is the FAD for the species.

Fig. 10. Trilobites from collection W56.7 (collected from the bed beginning at 56.7 m in the measured section near Wangcun). 1, 2. *Ptychagnostus punctuosus* (Angelin), cephalon, pygidium, x10, x10; 3, 4. *Tomagnostella exsculpa* (Angelin), cephalon, pygidium, x6.7, x6.7; 5, 6. *Baltagnostus? ambonus* Peng and Robison, cephalon, pygidium, x10, x10; 7, 8. *Doryagnostus incertus* (Brøgger), cephalon, pygidium, x4, x 5; 9, 10. *Ptychagnostus cuyanus* (Rusconi), cephalon, pygidium, x6.7, x7; 11. *Glaberagnostus? cicer* (Tullberg), pygidium, x 6.7; 12. *Ammagnostus laiwuensis* (Lorenz), cephalon, x7; 13, 14. *Dorypyge richthofeni* Dames, cranidium, pygidium, x2.5, x1.6; 15. *Prodamesella bicerrata* Jell *in* Jell and Robison, cranidium; x10; 16-18. *Wangcunia wangcunensis* Peng, Lin and Chen, exoskeleton, cranidium, pygidium, x3.3, x4,x8; 19-21. *Paranomocarella*? sp., cranidium, cranidium, pygidium; x4, x2.6, x2.6; 22-24, *Fuchouia chiai* Lu, cranidium, exoskeleton, pygidium, x6.7, x1.3, x2.6; 25. Leiostegiid gen. et sp. nov.

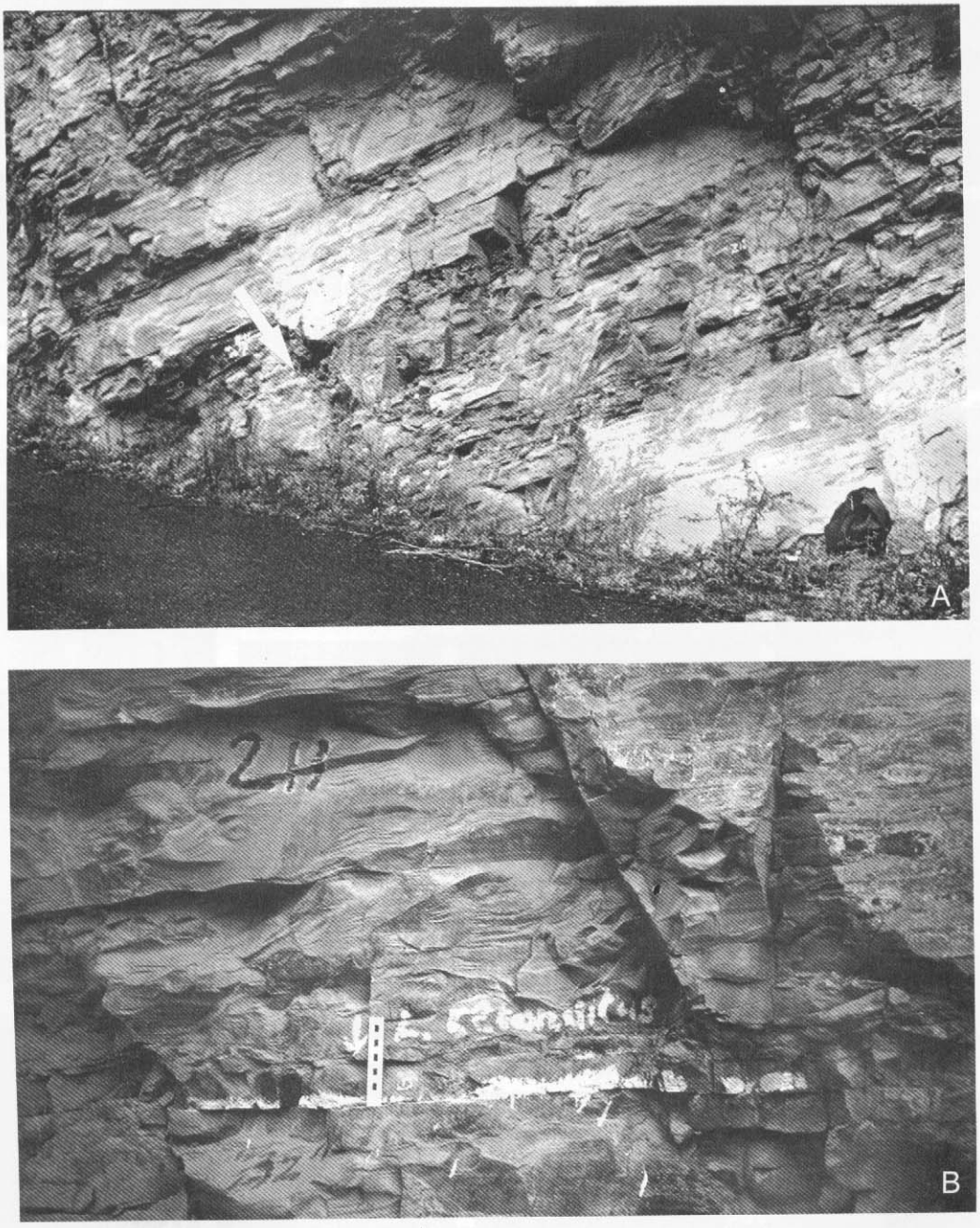


Fig. 11. The boundary point for the base of the Youshuian Stage at 210.7 m in section near Wangcun. A. General view of the exposure in the boundary interval. Arrow shows the point of first appearance of *Linguagnostus reconditus*; B. Close-up view of the boundary point for the base of Youshuian Stage.

Stop 4

First occurrences of *Glyptagnostus stolidotus* and *Glyptagnostus reticulatus*

Both *Glyptagnostus stolidotus* and *G. reticulatus* are present in the Huaqiao Formation in the Wangcun section. *Glyptagnostus stolidotus* was previously known from two collections, W251.2 and W254.4; while *G. reticulatus* was known from collection W288.9. Because of the limited number of collections containing these trilobites, the lower boundary of the *Glyptagnostus reticulatus* Zone remained undefined in this section (Peng and Robision, 2000). In more recent fieldwork, *G. reticulatus* has been identified in two additional collections (W275.3 and W277). Thus, the lowest-known occurrence of *G. reticulatus* in this section is now 275.3 m above the base of the formation, and 13.6 m below its previously known first occurrence.

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