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CAMBRIAN STRATIGRAPHY AT HUANGLIAN, GUIZHOU PROVINCE, CHINA: REFERENCE SECTION FOR BASES OF THE NANGAOAN AND DUYUNIAN STAGES

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INTRODUCTION

The purpose of this field trip stop is to examine a Lower Cambrian section at Huanglian, Songtao County, Guizhou. This section exposes strata representing the Nangaoan and Duyunian stages. Peng (2000a, b) established the Nangaoan Stage and the Duyunian Stage on the basis of the strata of eastern Guizhou, and designed the Xiaosai section in Yuqing County, and the Nangao section in Danzhai County as their stratotype respectively. These two sections, however, are not very good because of their unsatisfying exposure. Since 2000, we have worked to identify good rock-stratigraphic units and biostratigraphic units for boundary sections, but we still haven't found an ideal section. Because of the restrictions of time, we are considering the Lower Cambrian section at Huanglian, Songtao, as the basic section for illustrating Nangaoan Stage and the Duyunian Stage at the moment.

The Huanglian section is well exposed and curved along the highway from Panmen to Huanglian. Some formations are rich fossils.

The base of the Nangaoan Stage is the FAD of trilobites in South China. *Hupeidiscus*, and *Sinodiscus* occur in the Huanglian section, but further work is needed to precisely determine its FAD. *Arthricocephalus*, which marks the base of the Duyunian Stage, is also present in the Huanglian section.

This section, which located in the east of the dissected Songtao anticline (NE-trending direction) (Figs. 1, 2), consists of the Lower Cambrian Niutitang Formation and Balang Formation from west to east, from Panmen to Huanglian camp (Figs. 1-3). Total thickness is 900.02 meters. We used two parallel offsets along parallel section to account for the winding highway when we surveyed the section.

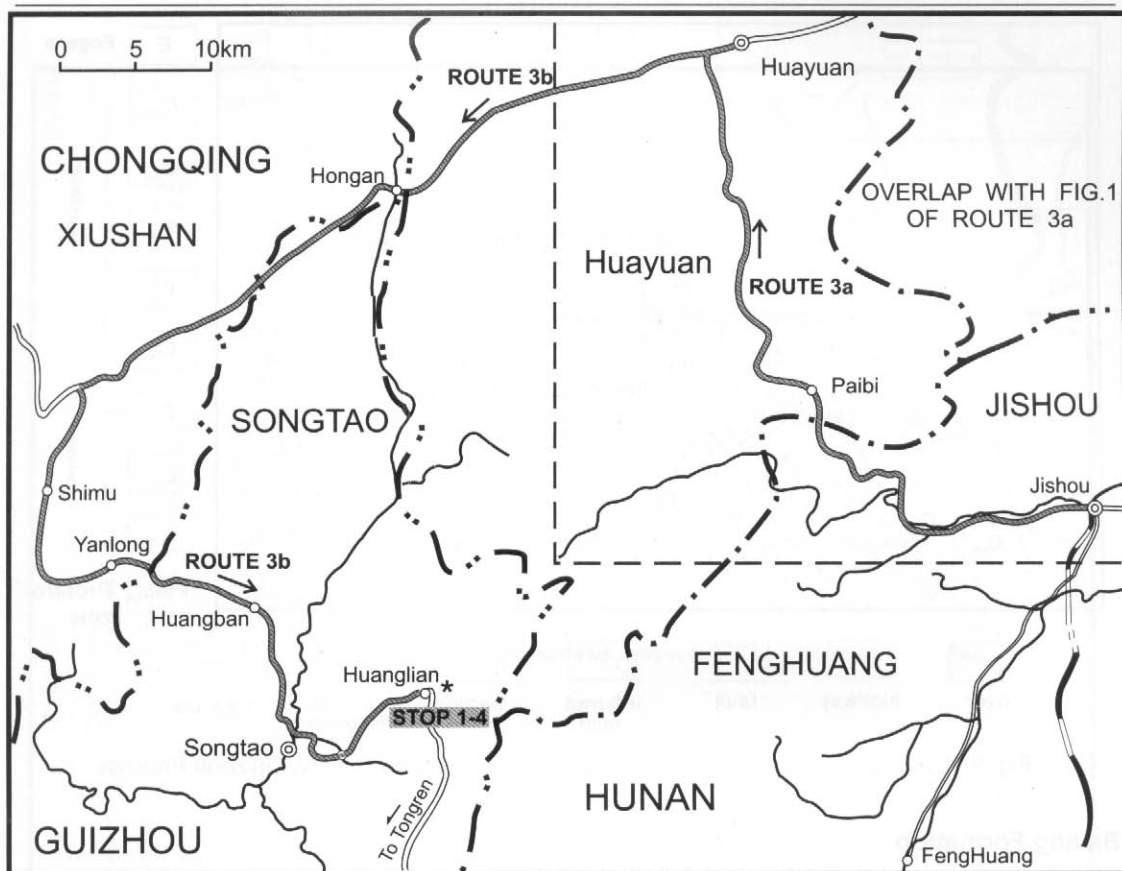


Fig. 1. Map showing the route (shaded) to Huanglian, Songtao, Guizhou from Hunan.

LITHOSTRATIGRAPHY

The uppermost part of the Liuchapo Formation consists of black silicolites and phosphatic-siliceous shale, with a little limestone aggregation and a few lenses.

Lower Cambrian Niutitang Formation

The formation includes two informal members. The lower member consists of black and grayish-black carbonaceous shale and silty shale and mudrock, and its base consists of nodular phosphate rocks in conformable contact with the Liuchapo Formation (Sinian - earliest Cambrian in age). Its middle-upper strata consist of dark gray argillaceous limestone, where we can collect *Hupeidiscus(?)* sp., *Sinodiscus changyangensis*, and *Metaredlichia* sp. The top consists of gray and dark gray silty limestone. Its thickness is 78.9 m. The upper member of the formation consists of dark gray and black carbonaceous shale and silty shale and mudrock, interbedded with grayish black argillaceous siltstone. Siltstone is more abundant in the upper part. Here we can collect sponge spicules, *Metaredlichia* sp., and *Chengkouia* sp. Its thickness is 403.5 m.

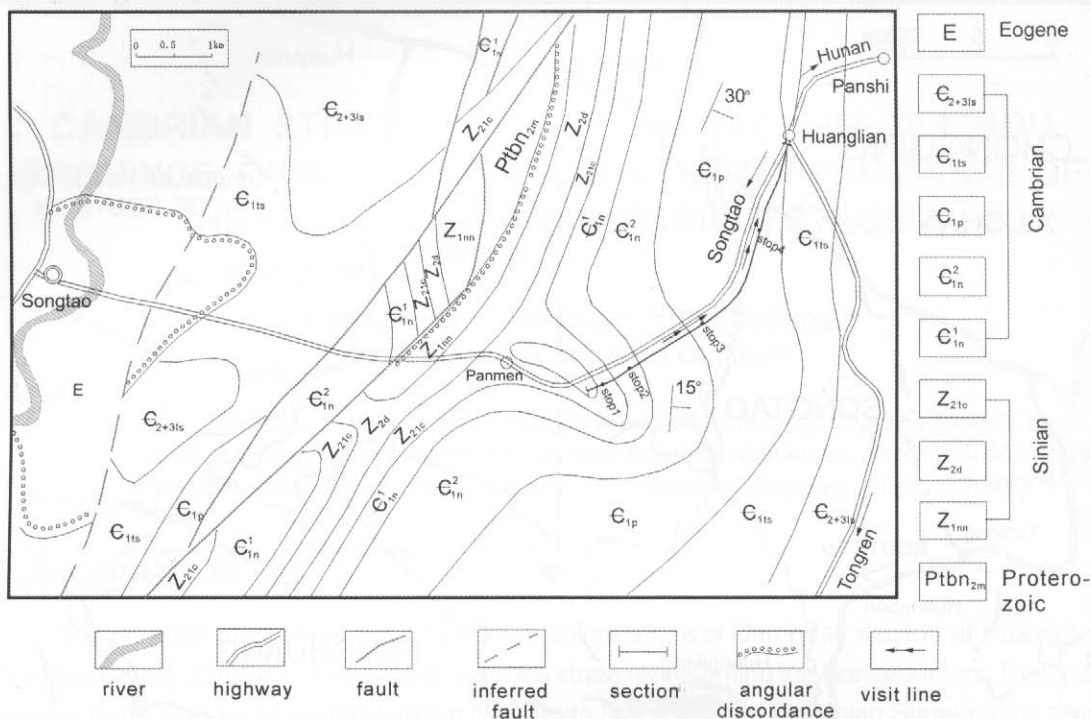


Fig. 2. Geological map of Huanglian-Songtao area, Songtao County, Guizhou Province.

Balang Formation

The formation consists of shale and silty shale and mudrock. The color of rock varies from dark gray and grayish black in the lower part to grayish green in the upper part. Toward the upper part, the calcareous content increases and partial bog lime appears. Here there are a lot of trilobites: *Arthrocephalus chauveau*, *A. horridus*, *Arthrocephalus granulus*, *Changaspis placenta*, *Balangia* sp., *Redlichia* (*Redlichia*) sp., and *Redlichia* sp. Its thickness is 417.1 m.

Tsinghsutung Formation

Argillaceous zebra limestone, which varies from gray to grayish-black and from thin-to medium-bedded in the lower part, containing *Redlichia* (*Pteroredlichia*) *chinensis*. The limestone, which is from dark gray to light gray and from thick-bedded to lumpy, in the upper part, consisting of *Redlichia* (*Redlichia*) *nobilis*, *Redlichia* (*Redlichia*) *takooensis*. Its thickness is more than 300 m.

BIOSTRATIGRAPHY

The Huanglian section is a new section and still under active study. We have collected some fossils in the Niutitang, and Balang formations, but not a sufficient amount of collecting has been done to precisely determine zonal boundaries. At present, on the basis of these fossils, we can define several provisional zones:

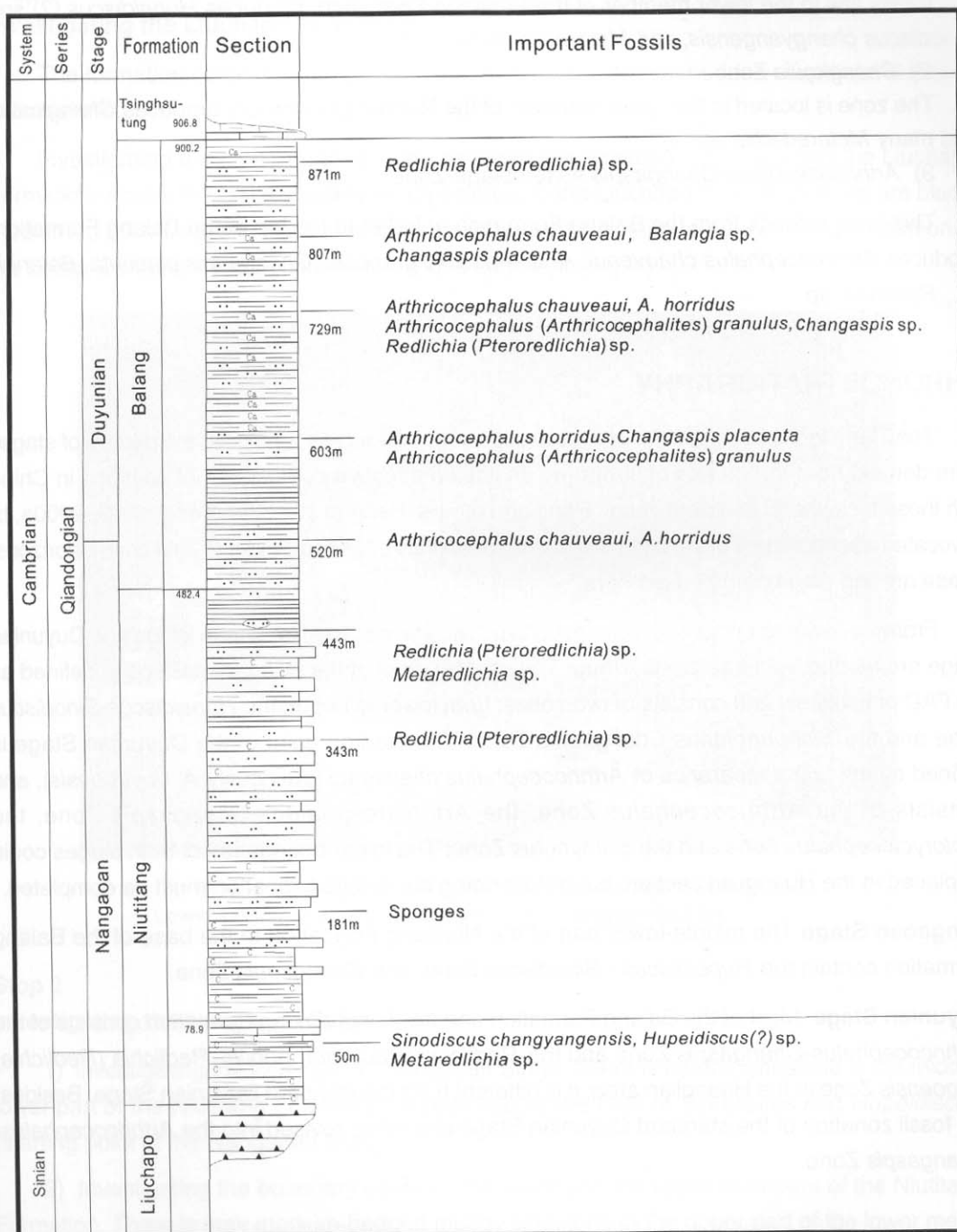


Fig. 3. The Columnar section of Lower Cambrian Niutitang Formation and Balang Formation at Huanglian, Songtao County, Guizhou Province.

1) *Huheidiscus-Sinodiscus* Zone

It only lies in the lower member of the Niutitang Formation, produces *Huheidiscus* (?) sp., *Sinodiscus changyangensis*, and *Metaredlichia* sp.

2) *Chengkouia* Zone

The zone is located in the upper member of the Niutitang Formation; produces *Chengkouia*, and many *Metaredlichia* sp.

3) *Arthricocephalus-Changaspis* Assemblage-Zone

This zone extends from the Balang Formation at 520m to the top of the Balang Formation; produces *Arthricocephalus chauveaui*, *A. horridus*, *A. granulus*, *Changaspis placenta*, *Balangia* sp., *Redlichia* sp.

CHRONOSTRATIGRAPHY

The stage is the basic unit for chronostratigraphy. Historically, in China, the names of stages were derived from the names of strata, which limited effective comparison of sections in China with those elsewhere. In recent years, Peng and others (Peng *et al.*, 1998; Peng, 1999, 2000a, b) advocated abandonment of the older stage in favor of ones bounded by identifiable chronohorizons. These are the stage names used here.

From the lower to upper, we have recognized two stages. The Nangaoan Stage and Duyunian Stage are named from eastern Guizhou. The starting point of the Nangaoan Stage is defined as the FAD of trilobites, and consists of two zones: from lower to upper, the *Huheidiscus-Sinodiscus* Zone and the *Sichuanolenus-Chengkouia* Zone. The starting point of the Duyunian Stage is defined by the first appearance of *Arthricocephalus chauveaui* (previously *A. duyunensis*), and consists of the *Arthricocephalus* Zone, the *Arthricocephalites-Changaspis* Zone, the *Protoryctocephalus* Zone and the *Bathynotus* Zone. The lower boundaries of both stages could be placed in the Huanglian section, but before doing so, detailed zonation must be completed.

Nangaoan Stage The middle-lower part of the Niutitang Formation to the base of the Balang Formation contain the *Huheidiscus - Sinodiscus* Zone, and *Chengkouia* Zone.

Duyunian Stage Most of the Balang Formation and the Tsinghsutung Formation consists of the *Arthricocephalus-Changaspis* Zone and the *Redlichis (Redlichia) nobilis-Redlichia (Redlichia) takooensis* Zone in the Huanglian area; it is different from the standard Duyunian Stage. Besides, the fossil zonation of the standard Duyunian Stage should be revised into the *Arthricocephalus-Changaspis* Zone.

FIELD EXCURSION

From Panmen to Huanglian; investigating the Huanglian section; investigating formation boundary and stages of the Lower Cambrian along the road (Figs. 2, 6); collecting fossils at the fossil localities.

Stop 1

Investigating the Liuchapo Formation

The formation consists of black thin-bedded, thin-to medium-bedded silicolite and lenses of limestone.

Investigating the conformable boundary between the Niutitang Formation and the Liuchapo Formation: Above the black silicolite which belongs to the Liuchapo Formation, there are black, medium-to thick-bedded phosphatic mudrock beds which belong to the Niutitang Formation of the Lower Cambrian; the boundary is obvious and clear (Fig. 4).

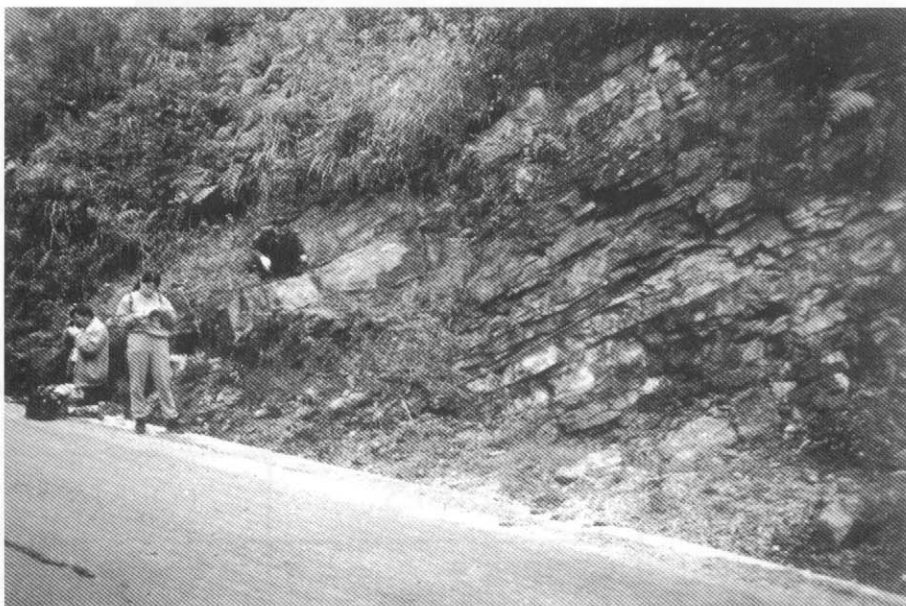


Fig. 4. The boundary between Upper Sinian Liuchapo Formation and Lower Cambrian Niutitang Formation at Huanglian section.

Stop 2

Investigating the Nangaoan Stage

1) Investigating the lower part of Nangaoan Stage. There is muddy limestone in the middle-lower part of the Niutitang Formation; at 50m occurs the FAD of *Sinodiscus* and *Hupeidiscus*, (starting point of the Nangaoan Stage).

2) Investigating the boundary between the lower and the upper members of the Niutitang Formation. There is gray medium-bedded muddy limestone in the upper part of the lower member of Niutitang Formation beginning at 69m. Above this interval is grayish black silty shale and mudrock of the upper member (Fig. 5).

3) Investigating the upper member of the Niutitang Formation. At 85m (Fig.4), investigating gray, and dark gray silty mudrock and argillaceous siltstone of the member; collecting sponges,



Fig. 5. The outcrop of Lower Cambrian Niutitang Formation at Huanglian section.

Metaredlichia, redlichids etc.

4) Investigating the boundary between the Niutitang Formation and the Balang Formation. Under the boundary, the upper member mainly consists of grayish black silty mudrock and shale

STAGES	FORMATIONS
Duyunian	Balang
Nangaoan	Niutitang
Meishucunian	Liuchapo
Jinningian	
Neoproterozoic	

Fig. 6. Stratigraphic nomenclature used for Stops 1 to 4. Heavy lines show lithostratigraphic and chronostratigraphic boundaries to be examined.

intercalated with much silt; above it, the Balang Formation consists of dark gray to greenish gray silty mudrock, the lithologically gradually changes near the boundary.

Stop 3

Investigating the Duyunian Stage

1) Investigating the lower part of the Duyunian Stage. In the lower part of the Balang Formation is dark gray silty mudrock; at 520 m there occurs firstly *Arthricocephalus*, *Arthricocephalus* (*Arthricocephalites*) etc. (beginning of the Duyunian Stage).

2) Collecting trilobites such as *Arthricocephalus* at 630 m.

3) Collecting trilobites such as *Arthricocephalus* at 654 m; will moving in parallel fashion along the section about 1 kilometer from the 677 m point; arriving at the parallel displacement by bus.

Stop 4

Investigating upper part of Balang Formation (Duyunian Stage) from 677 to 900.2 m

1) Collecting trilobites such as *Arthricocephalus* at 726 m.

2) Investigating the conformable contact between the Balang Formation and the Tsinghsutung Formation at Huanglian: under the boundary, there is grayish green, medium to thick-bedded lime mudstone and silty mudstone; above it, the Tsinghsutung Formation consists of gray medium-to thick-bedded limestone and muddy limestone.

REFERENCES

- GEYER, G., and J. SHERGOLD, 2000. The quest for internationally recognized divisions of Cambrian time. *Episodes*, **23**(3): 188-195.
- JEGOROVA, L. I., XIANG, L. W., LEE, S. J., NAN, R. S., and KUO, C. M., 1963. The Cambrian trilobite faunas of Kueichow and western Hunan. Spec. Pap. Inst. Geol. Miner. Resour., (B) *Stratigraphy and Palaeontology*, **3**(1) :117 (In Chinese).
- PENG Shanchi, 1987. Early Late Cambrian stratigraphy and trilobite fauna of Taoyuan and Cili, Hunan. In Nanjing Institute of Geology and Palaeontology, Academia Sinica (ed), *Collection of Postgraduate theses, Nanjing Institute of Geology and Palaeontology, Academia Sinica*, **1** : 53-134 (In Chinese with English abstract).
- PENG Shanchi, 2000a. Chapter 2, Cambrian of the slope facies. p 23-38. In Nanjing Institute of Geology and Palaeontology (ed.), *Stratigraphical Studies in China (1979-1999)*, 379 p. (In Chinese with English abstract).
- PENG Shanchi, 2000b. A new chronostratigraphical subdivision of Cambrian for China. p. 119-120. In G. F. Aceñoaza, and S. Peralta (eds.), *Cambrian from the Southern Edge. Institute Superior de Correlación Geológica (INSUGEO), Miscelánea*, **6**.
- PENG Shanchi, YUAN Jinliang, and ZHAO Yuanlong, 2000. Taijiang Stage: a new chronostratigraphical unit for the traditional lower Middle Cambrian in South China. *Journal of Stratigraphy*, **24**(1): 53-54 (In

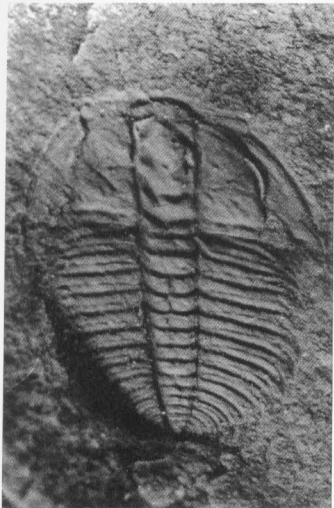
Chinese with English abstract).

- PENG Shanchi, ZHOU Zhiyi, LIN Tianrui, and YUAN Jinliang, 2000. Cambrian chronostratigraphy research: Present and Tendency. *Journal of Stratigraphy*, **24**(1): 8-17 (In Chinese with English abstract).
- Regional Geological Survey Team of Geology, Bureau of Guizhou Province, 1980. *Geological map series, Xifeng at 1:200,000 (H-48-XI)*. Geology Bureau of Guizhou Province (In Chinese).
- YIN Gongzheng, 1987. Cambrian System. p. 49-96. In *Regional Geology of Guizhou Province*. People's Republic of China Ministry of Geology and Mineral Resources, *Geological Memoirs*, Series 1, no. 7, Geological Publishing House, Beijing (In Chinese with English abstract).
- ZHANG Wentang, LU Yanhao, ZHU Zhaoling, QIAN Yiyuan, LIN Huanling, ZHOU Zhiyi, ZHANG Sengui, and YUAN Jinliang, 1980. Cambrian trilobite faunas of Southwestern China. *Palaeontologica Sinica*, B. **159**. Science Press, Beijing. 497p.

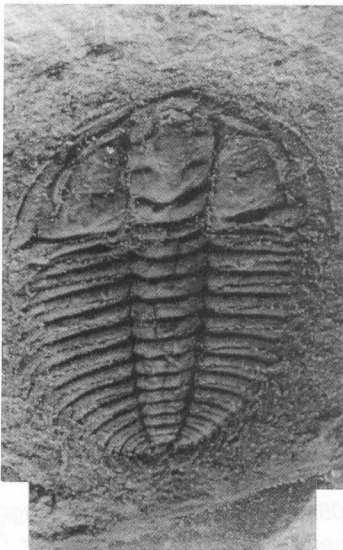
EXPLANATION OF PLATE

Plate 1

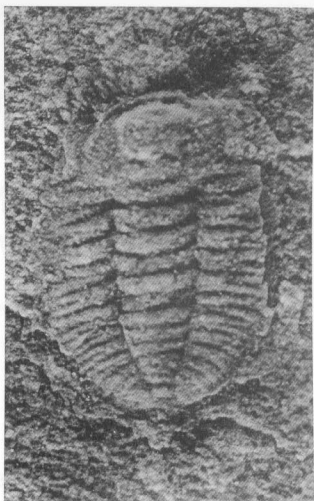
1. *Changaspis placenta* Qian et Lin, 1980. Exoskeleton, x10; SF603-4.
2. *Changaspis placenta* Qian et Lin, 1980. Exoskeleton, x8; SF627-2.
3. *Duyunaspis* sp. Exoskeleton, x12; SF729-8.
4. *Arthricocephalus granulus* Qian et Lin, in Zhou *et al.*, 1977. Exoskeleton, x10; SF654-2a-②.
- 5-6. *Arthricocephalus granulus* Qian et Lin in Zhou *et al.*, 1977.
 5. Exoskeleton, x7; SF603-7-②.
 6. Exoskeleton, x7; SF602-8.
7. *Arthricocephalus* sp. Exoskeleton, x7; SF603-7-①.
8. *Sinodiscus changyangensis* Zhang in Zhou *et al.*, 1977. cranidium, x10; SF59-4.
9. *Metaredlichia* sp. cranidium, x2; SF59-2.



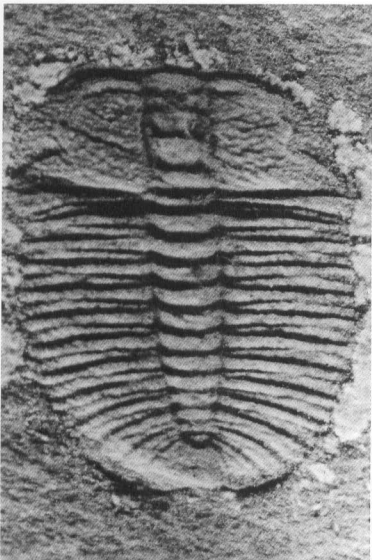
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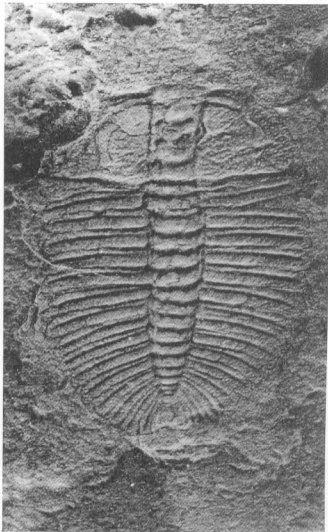
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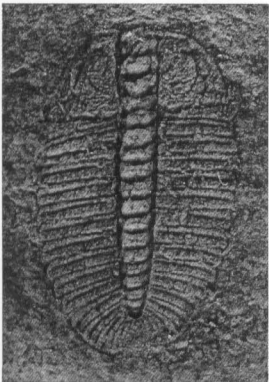
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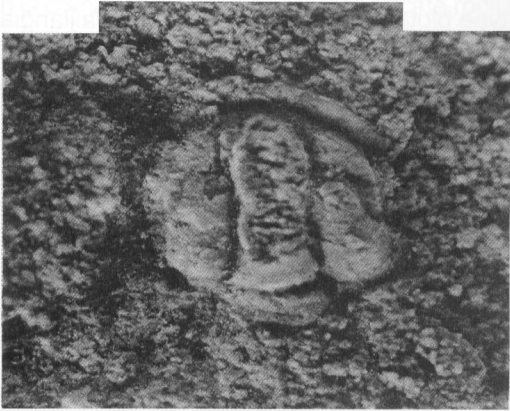
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