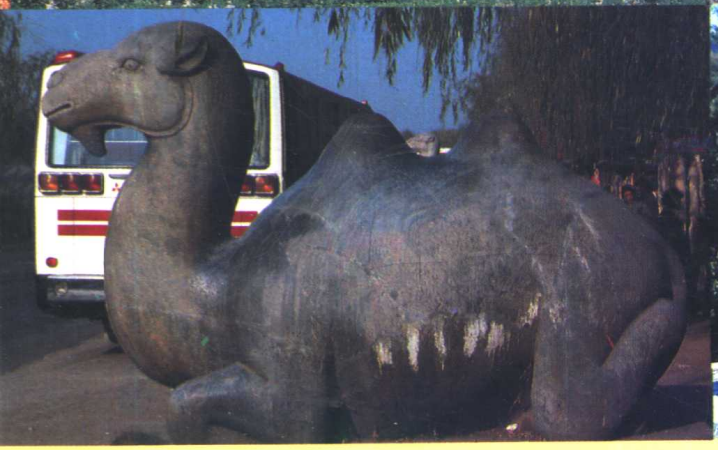
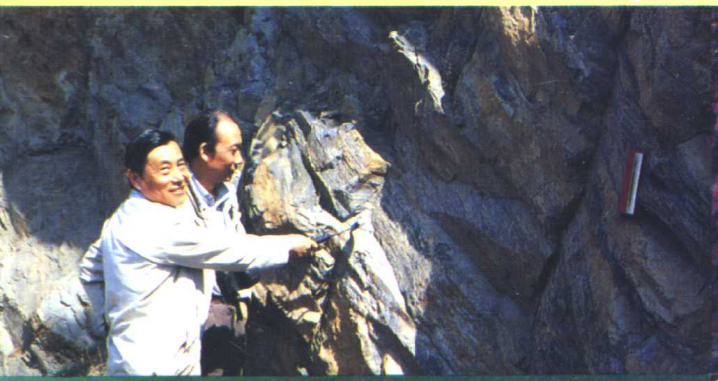
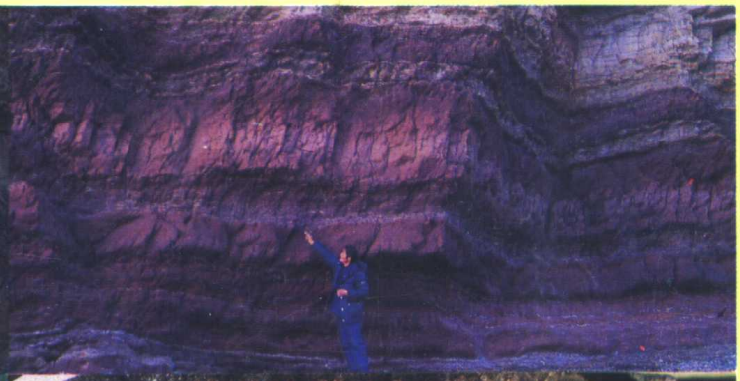





华北元古宙沉积岩

PROTEROZOIC SEDIMENTARY ROCKS IN NORTH CHINA

宋天锐　赵 震　王长尧　杨慧宁　刘仲秋　须湘官　著
Song Tianrui　Zhao Zhen　Wang Changyao　Yang Huining　Liu Zhongqiu　Xu Xiangguan


北京科学技术出版社

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内 容 简 介

本书是以研究华北元古宙沉积岩为对象，进行了沉积岩石学、地球化学、同位素地球化学和含矿岩系相标志的研究，在基础地质研究的基础之上，为华北板块北缘开拓找矿远景区服务．书中论述了元古宙沉积岩的相序、碳酸盐岩、泥质岩和砾岩、砂岩的特征，以及沉积成矿系列和含矿性．本书包括若干首次在国内外报导的沉积构造和相标志，有一些反映在封页的彩色照片中和图版中，可为区域地质研究、含矿岩系追索、地质生产、科研、教学和地质旅游等方面提供实际素材．书中还提出若干有待进一步探索的学术问题和理论问题．

本书可供从事区域地质、岩石、矿床、地球化学方面的野外地质、教学和科研人员使用，也可用于大专院校研究生、高年级学生参考书．

华北元古宙沉积积岩

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责任编辑 刘福源
特约编辑 余澄宇
封面设计 宋天锐

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北京科学技术出版社出版
（北京西直门南顺城街12号）

北京市海淀区三环快速印刷厂印刷

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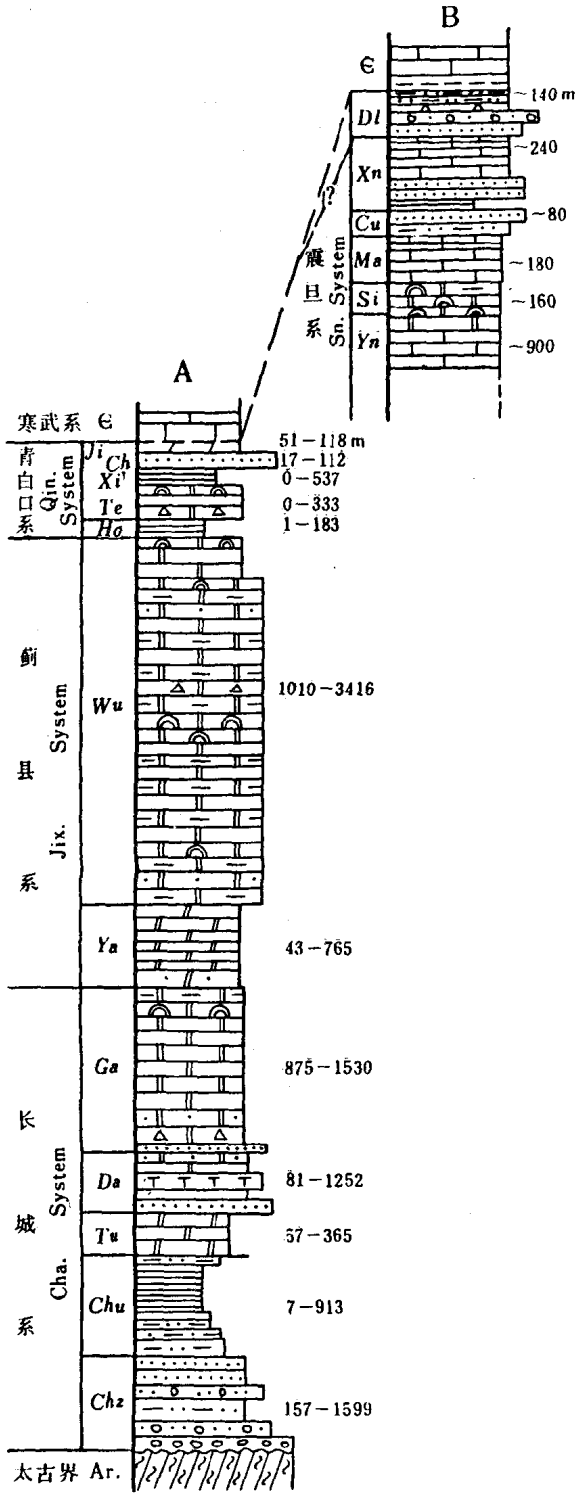
787×1092毫米 16开本 13.75印张 341 千字
1991年4月第一版 1991年4月第一次印刷
印数 1—1000册

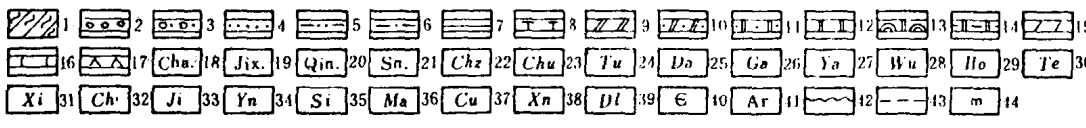
ISBN7-5304-0943-3／T·190 定价17元

封页附图



彩色照片号 (No. of colour photographs)

Dl	6 32
Xn	16
Cu-Ma	15
Si	
Yn	
Ji	23
Ch	8
Te	
Ho	
Wu	22 27 3 9 10 11 12 13 14
Ya	1
Ga	24 20 2 4 26 28 29
Da	17 18 7
Tu	21
Chu	31
Chz	5 19 25 30



封页附图及封面、封二、封三、封底彩色照片说明

Ⅰ. 封页附图说明

A. 燕山一带中、上元古界地层柱状图

B. 辽宁金县震旦系上部地层柱状图

图例:

1. 片麻岩	2. 砾岩	3. 砂砾岩
4. 砂岩	5. 粉砂岩	6. 粉砂页岩
7. 页岩	8. 火山岩	9. 泥质白云岩
10. 含砂泥质白云岩	11. 砂质白云岩	12. 白云岩
13. 叠层石白云岩	14. 石灰岩	15. 泥灰岩;
16. 石灰岩	17. 角砾岩	18. 长城系
19. 蓟县系	20. 青白口系	21. 震旦系
22. 常州沟组	23. 串岭沟组	24. 团山子组
25. 大红峪组	26. 高于庄组	27. 杨庄组
28. 雾迷山组	29. 洪水庄组	30. 铁岭组
31. 下马岭组	32. 长龙山组	33. 景儿峪组
34. 营城子组	35. 十三里台组	36. 马家屯组
37. 崔家屯组	38. 兴民村组	39. 大林子组
40. 寒武纪	41. 太古代	42. 不整合
43. 假整合	44. 厚度 (m)	

Ⅱ. 彩色照片说明

A. 封面彩色照片说明

1. 北京十三陵中元古界蓟县系底部的杨庄组地层;

2. 平谷县海子水库周边出露的中元古界地层，包括高于庄组、杨庄组和雾迷山组;

3. 北京十三陵竭陵甬道旁的骆驼石雕像具有丘状叠层石构造;

4. 位于蓟县的由天津市人民政府建的"中、上元古界国家自然保护区"纪念碑;

5. 北京十三陵中元古界底部常州沟组中部的潮汐沉积层，由潮汐砂坪和泥坪沉积的薄层互层组成;

6. 辽宁金县大林子组的潮上带萨布哈沉积和咸湖沉积的碳酸盐岩屑砂岩层;

7. 河北平泉县长城系大红峪组中砂岩层面上的双脊波痕，反映潮汐砂坪带沉积特

征；

8. 北京西山青白口系长龙山组海绿石砂岩层内的鱼骨状交错层理，反映潮坪带潮沟沉积特征。

B. 封二彩色照片说明

9. 北京十三陵雾迷山组白云岩层中的典型丘状、洼状风暴交错层理，由地震-海啸风暴产生；

10. 北京十三陵雾迷山组中的筑丘状构造，反映地震-海啸的风暴沉积特征；

11. 北京十三陵雾迷山组由地震引起的内层褶曲构造；

12. 北京十三陵雾迷山组白云岩中分散状分布的板刺状角砾；

13. 北京十三陵蓟县系雾迷山组中的硅化岩中的板刺状角砾构造，由地震-海啸风暴造成；

14. 北京十三陵雾迷山组地震-海啸序列中，由垂直相交的两组褶皱组成"龙皮构造"，铁锤代表主褶皱轴方向，铁锤柄代表次褶皱轴的方向；

15. 辽宁金县金石滩风景区出露的震旦系兴民村组地层；

16. 金县震旦系兴民村组石灰岩层内的地震塌陷角砾周围伴生泄水线。

C. 封三彩色照片说明

17. 北京十三陵大红峪组中硅化岩呈同沉积弯曲构造，四周见有硅化透长石凝灰晶屑；

18. 北京十三陵大红峪组中的硅化岩具有核形石组成的"眼状"构造，其中发现颤藻属的藻丝体（*Oscillatoriopsis sp.*）；

19. 北京十三陵长城系底部常州沟组中段潮汐沉积岩层中，具成组出现的透镜状-脉状层理代表典型的潮汐沉积；

20. 北京西山高于庄组中部白云岩层面上的饥饿波痕；

21. 北京十三陵团山子组中泥质白云岩层内的滑动揉皱构造；

22. 北京十三陵雾迷山组顶部的墙状叠层石和中间的泥质充填物；

23. 北京西山景儿峪组中的层内滑动角砾多层出现于泥灰岩层中；

24. 北京十三陵高于庄组顶部白云岩层内的硅质条带显示鱼骨状交错层理，反映碳酸盐潮坪的潮沟沉积。

D. 封底彩色照片说明

25. 北京十三陵长城系常州沟组中砂岩层面上的最古老的后生动物遗迹化石（*Planolites sp.*(?)）；

26. 北京西山高于庄组中的遗迹化石（据宋武的标本摄）；

27. 蓟县雾迷山组白云岩中的燧石层；

28. 蓟县高于庄组中宏观生物遗迹（据杜汝霖的标本摄）；

29. 蓟县高于庄组底部砂岩层面上的波痕；

30. 北京十三陵长城系常州沟组中的砂岩层面上的对称波痕，并伴有雨点迹；

31. 北京十三陵串岭沟组中部的粉砂质泥岩中的季节性沉积的韵律层构造；

32. 辽宁金县大林子组泥灰岩层面的帐篷构造。

彩色照片所在位置示意图如下:

A		B		C		D	
1	2	9	10	17	18	25	26
3	4	11	12	19	20	27	28
5	6	13	14	21	22	29	30
7	8	15	16	23	24	31	32

EXPLANATION OF THE COLUMNS AND COLOUR PHOTOGRAPHS ON THE COVERS OF THE MONOGRAPH " PROTEROZOIC SEDIMENTARY ROCKS IN NORTH CHINA"

I. Columns on the Book Cover

A. Upper–Middle Proterozoic stratigraphic column of the Yanshan Mountains

B. Upper Sinian stratigraphic column of Jingxian, Liaoning Province

Legend:

1. Gneiss
2. Conglomerate
3. Sandy conglomerate
4. Sandstone
5. Siltstone
6. Silty shale
7. Shale
8. Volcanic rock
9. Muddy dolostone
10. Sand–bearing muddy dolostone
11. Sandy dolomite
12. Dolomite
13. Stromatolite dolomite
14. Silicified dolomite
15. Marl
16. Limestone
17. Breccia
18. Changcheng System
19. Jixian System
20. Qingbaikou System
21. Sinian System
22. Changzhougou Formation
23. Chuanlinggou Formation
24. Tuanshanzi Formation
25. Dahongyu Formation
26. Gaoyuzhuang Formation
27. Yangzhuang Formation
28. Wumishan Formation
29. Hongshuizhuang Formation
30. Tieling Formation
31. Xiamaling Formation
32. Changlongshan Formation
33. Jingeryu Formation
34. Yinchengzi Formation
35. Shishanlitai Formation
36. Majiatun Formation
37. Cuijiatun Formation
38. Xingmincun Formation
39. Dalinzi Formation
40. Cambrian
41. Archean
42. Unconformity

II. Explanation for Colour Photographs

A. Illustration for colour photographs on the front cover:

1. Distribution of the Yangzhuang Formation at the base of the Mid–Proterozoic Jixian System in the Ming Tombs District, Beijing.

2. Outcrop of Middle Proterozoic strata around the Haizi Reservoir in Pinggu County.

3. A camel statue with dome–shaped stromatolite structure beside the route to the

Ming Tombs, Beijing.

4. Monument for the "National Nature Reserve of Upper–Middle Proterozoic Strata" established by the People's Gove nment of Tianjin Municipality in Jixiang.

5. Typical tidal sequence composed of interbedded sand flat and mud flat sediments in the middle part of the Changzhougou Formation at the bottom of the Middle Proterozoic of the Ming Tombs. Beijing.

6. Supratidal sabkha sediments and carbonate–lithic sandstone beds of saline lake deposits in the Dalinzi Formation, Jinxian, Liaoning.

7. Double crested ripple marks on sandstone bed surface of the Dahongyu Formation of the Changcheng System in Pingquan, Hebei Province.

8. Herringbone cross stratification in glauconite sandstone bed showing the features of tidal channel sediments of tidal flats in the Changlongshan Formation of the Qingbaikou System, Western Hills, Beijing.

B. Illustration for colour photographs on the inside front cover

9. Typical hummocky and swale crosss stratifications in dolomite caused by earthquake–tsunami storm in the Wumishan Formation, Ming Tombs, Beijing.

10. Mound–building structure formed by by earthquake–tsunami storm in the Wumishan Formation, Ming Tombs, Beijing.

11. Intraformational fold structure caused by earthquakes in the Wumishan Formation, Ming Tombs, Beijing.

12. Dispersed plate–spiny breccias in dolomite bed of the Wumishan Formation, Ming Tombs, Beijing.

13. Plate–spiny breccia structure in silicified rock caused by earthquake–tsunami storm in the Wumishan Formation of the Ming Tombs, Beijing.

14. "Dinosaur skin structure" formed by two sets of folds perpendicular to each other, the hammer head indicates the main fold axis direction and the hammer handle shows the subordinate fold axis direction. in the earthquake–tsunami sequence of the Wumishan formation, Ming Tombs, Beijing.

15. Outcrop of Upper Sinian Strata in the Gold–stone Beach, Jinxian, Liaoning Province.

16. Earthquake collapse breccia and accompained water escape lines of the Xingmingcun Formation in the Sinian System, Jingxian, Liaoning Province.

C. Illustration for colour photographs on the inside back cover

17. Synsedimentary fold structure of silicified rock surrounded by silicified sanidine tuff crystals in the Dahongyu Formation, Ming Tombs, Beijing.

18. "Eye structure" formed by agglomeration of oncolites in silicified rocks with algal filaments of *Oscillatoriopsis* in the Dahongyu Formation, Ming Tombs, Beijing.

19. Groups of lenticular–flaser beddings as typical structure of tidal sediments in middle part of the Changzhougou Formation of the Changcheng System, Ming Tombs,

Beijing.

20. Starved ripple marks on dolomite bedding planes of the Gaoyuzhuang Formation, Western Hills, Beijing.

21. Sliding structure in muddy dolostone bed of the Tuanshanzi Formation, Ming Tombs, Beijing.

22. Wall-like stromatolites with muddy fillings in the upper part of the Wumishan Formation, Ming Tombs, Beijing.

23. Intraformational slip breccias in several marl beds of the Jing'eryu Formation, Western Hills, Beijing.

24. Herringbone cross stratification shown by silicific bands in dolomite bed, reflecting tidal channel sediments on carbonatic tidal flats in the upper part of the Gaoyuzhuang Formation, Ming Tombs, Beijing.

D. Illustration for colour Photographs on the back cover

25. The oldest metazoan trace fossil-*Planolites* sp (?) on sandstone bedding planes of the Changzhougou Formation in the Changcheng System, Ming Tombs. Beijing.

26. Old metazoan trace fossil in the Gaoyuzhuang Formation in the Western Hills, Beijing (Song Wu's specimen) .

27. Dolomite beds with chert layers in the Wumishan Formation of Jixian.

28. Macrofossil trace in the Gaoyuzhuang Formation of the Changcheng System, Jixian (Du Rulin's spicemen) .

29. Wave ripples on sandstone bed surface of the lower part of Gaoyuzhuang Formation in Jixian .

30. Symmetric wave ripples accompained by raindrop imprints on sandstone bedding plane of the Changzhougou Formation of the Changcheng System, Ming Tombs, Beijing.

31. Seasonal rhythmite in silty mudstone in the middle part of the Chuanglinggou Formation, Ming Tombs, Beijing.

32. Teepee structure on marl bedding plane in the Dalingzhi Formation, Jingxian Liaoning Province.

A		B		C		D	
1	2	9	10	17	18	25	26
3	4	11	12	19	20	27	28
5	6	13	14	21	22	29	30
7	8	15	16	23	24	31	32

Abstract

Proterozoic strata are widespread, well exposed and well preserved in North China. The Proterozoic sections of Jixian, Tianjin (Photo 2 on front cover), and of the Ming Tombs, Beijing (Photo 1 on front cover), have been selected for field geological excursions of domestic and international geological conferences. There are 12 stratigraphical formations in the Upper–Middle Proterozoic strata; they are (in ascending order): the Changzhougou, Chuanlinggou, Tuanshanzi, Dahongyu, Gaoyuzhuang, Yangzhuang, Wumishan, Hongshuizhuang, Tieling, Xiamaling, Changlongshan and Jing'eryu Formations. Except the Changzhougou and Chuanlinggou Formations in the lower part of the strata and the Hongshuizhuang, Xiamaling and Changlongshan Formations in the upper part that consist mainly of clastic rocks, all the other formations consist mainly of carbonate rocks, which is particularly the case with the Gaoyuzhuang and Wumishan Formations that are almost all composed of dolomite. This coincides with the sedimentary features in the global magnesium–rich depositional period correlated by stromatolites and microfossils in carbonates and their silicified rocks on a global scale. The Proterozoic sedimentary rocks in North China, however, are unmetamorphosed; therefore their various sedimentary structures and macroscopic and microscopic facies indicators are well preserved. These unique characteristics provides an ideal realm for studying Proterozoic sedimentary environments in China and even in the whole world.

Great progress has been made in the study of the Proterozoic in North China since the 1920's. Domestic and foreign geologists have published a lot of articles with plenty of materials. Here the authors only discuss the main parts of the new achievements made by the authors in the study of Proterozoic sedimentary rocks.

1. Tidal sediments and its facies indicators of Proterozoic strata

The International Symposium on the Late Precambrian was held in September 1983, which was sponsored by the Geological Society of China, the IGCP Chinese Committee, and the Chinese Academy of Geological Sciences. The proceedings include domestic and foreign scholars' articles including the present authors' article entitled "Tidal Sedimentary Structures from Precambrian Rocks of the Ming Tombs District, Beijing" published in "Precambrian Research" in 1985 in Netherlands. Later some of related information was further discussed in 1987 in the monography entitled "Precambrian Sedimentary Rocks in the Ming Tombs District, Beijing". In this monograph authors list 78 sedimentary facies indicators, of which the following facies indicators are reported for the first time in domestic and foreign geological literature. They are:

(1) Double–crested ripple marks on dolomite bedding planes—a facies indicator of carbonate intertidal zones

The appearance of rhombohedral interference ripple marks with double-crested ripples (Plate I -2) on dolomite bedding planes demonstrated that dolomite was not formed by chemical precipitation or by dolomitization and that double-crested ripples were formed as the primary granular dolomite carbonates in the carbonate intertidal zone were influenced by hydrodynamic actions.

This rare geological remains that deserves protection has been taken away. The author wrote a report entitled "Where is the geological remains of the Ming Tombs region?" in the "Beijing Evening News" of 26th December, 1984, which reminds people to regard rare geological remains as ancient cultural remains to take care of them.

(2) Herringbone cross stratification in a dolomite bed— a facies indicator of carbonate tidal channels

Herringbone cross stratification in a silicified dolomite bed (Photo 24, on inside back cover) produced by flood and ebb hydrodynamic forces is rare; it indicates that two groups of foreset laminae made up of dolomitic pelletic grains in tidal channels were formed on carbonate tidal flat. The thickness of one group of tidal sediments is 25cm, which is quite close to the thickness of a clastic tidal channel sedimentary bed.

(3) Starved ripple marks on dolomite bedding planes and lenticular-flaser bedding in a dolomite bed—a facies indicator of carbonate intertidal-subtidal zones

Not only typical clastic lenticular-flaser bedding (Photo 19, on inside back cover) but also starved wave ripples on dolomite bedding planes (Photo 29, on inside back cover) and lenticular-flaser bedding within dolomite beds have been discovered in the Proterozoic strata of North China. Three dimensional observations suggest that the starved wave ripples on the bedding surface of clastic rocks and the lenticular-flaser bedding within a bed are the same thing but different aspects, representing intertidal-subtidal sediments. Therefore the starved wave ripples and lenticular-flaser bedding of dolomite belong to the carbonate intertidal-subtidal facies indicator.

(4) Herringbone cross stratification in a glauconite sandstone bed— a special clastic tidal channel facies indicator

There are many reports on herringbone cross stratification in aromite, which is often found in tidal channel sediments. But there are rare reports on the occurrence of herringbone bedding composed of forset laminae of glauconite grains (Photo 8, on front cover, and Plate I -6). In modern oceans glauconite is formed in the relatively deep position of shallow seas, but in Proterozoic time glauconite grains were accumulated in some special tidal channel environments.

2. Discovery of the oldest metazaon trace fossil

It was reported by "China Geological News" in 8th October, 1984, that the oldest metazaon trace fossil was discovered, in the Ming Tombs District, Beijing; meanwhile, the note from editors pointed out that the discovery of the 1900Ma B.P. metazaon trace fossil in the Ming Tombs District is of important scientific significance.

This is a typical and very valuable geological section, which should be protected as carefully as cultural remains. Huang Tianxian, a scientific reporter, wrote a comment entitled "When did the history of the animals begin— discovery of ca. 1990 Ma old metazaon trace fossils in the Ming Tombs District, Beijing" after his in-situ visit, which was published in the "Beijing Evening News" of 12th December, 1984 with a photograph taken in- situ. Later, two papers about this metazaon trace fossil were published respectively in the "Acta Sedimentological Sinica" of 1985 and the "Kexuetongbao" (Chinese Science Bulletin) of 1986 (both Chinese and English editions) (Photo 25, on back cover), which demonstrated that this metazaon trace fossil is 1000Ma older than the *Edicara* fauna and its trace fossils in the ca. 700 Ma old strata. In the beginning some of Paleontologists doubted of this discovery, but later successive discoveries of this kind of metazaon trace fossils in other regions in corresponding stratigraphic sections attracted great attention and interest of domestic and foreign geologists.

3. Discovery of 1600Ma old algal filaments

It was reported that algal filaments exist in the ca. 1300Ma Wumishan Formation in the Ming Tombs District, but the discovery of algal filaments in the 1600Ma Dahongyu Formation was reported in both the Chinese and English editions of the "Chinese Science Bulletin" for the first time. Those algal filaments occur in "eye structure" (Photo 18, on inside back cover), of silicified dolomite. It is considered that the rock is formed by oncolite silicification, accompained by synsedimentary folding (Photo 17, on inside back cover), reflecting the facies indicator of the carbonate subtidal zone.

4. Establishment of the earthquake–tsunami sequence

This topic was first discussed in the paper "On the message of ancient earthquake in sedimentary strata", which is included in the book "Progress in Astrogeology" published in 1986. Later, more detailed information was introduced in the Journal of the "Chinese Science Bulletin" (No.8, 1988 for the Chinese edition and Vol. 33, No. 13 of the English edition). The earthquake–tsunami sequence in the Proterzoic carbonate strata may be divided into five basic units: a. sawtooth fold, b. plate- spiny breccia, c. interformation fold, d. cross superposed fold, and e. mound-building structure with graded bedding and hummocky cross stratification (Photo 14, on inside front cover).

5. Establishment of the sedimentary model of epicontinetal tidal flats

A paper entitled "A sedimentary model of epicontinental tidal flats" was published in "Acta Sedimentological Sinica", Vol. 6, No. 2, 1988. This model is based on the Wumishan Formation of Proterozoic strata in the Jixian area, including transgressive and regressive sequences. Five layers have been listed according to the petrological facies indicators and other features; they are the top layer, upper layer, middle layer, lower layer and bottom layer. It has been demonstrated that the top layer and bottom layer represent the supertidal to intertidal zones and that the other three layers should mainly represent subtidal sediments, while the siliceous bands and chert layers occur in the upper layer and

lower layer (Photo 27, on back cover).

6. Determination of Early Proterozoic ancient rivers

According to the orientation of pebbles and grain-size analysis of sandstones it is concluded that in the Changzhougou Stage of the Proterozoic ancient rivers were formed along the NE-trending troughs as the basement dips to the west under the influence of the NE-trending faulting. The main river channel was distributed in a NE direction from Changzhougou of Jixian through Yamenzi of Kuanchen to Linyuan. There were at least two branches, one is 100km long and the other is less than 50km long. These new ideas were presented for the first time at the International Symposium of Late Precambrian in 1983, and reported in the proceedings.

In the late Changzhougou Stage the sea covered the Malanyu uplift, and by Dahongyu Stage the typical facies indicators of clastic tidal flat environment--double-crested ripple--appeared on the sandstone bed surface (Photo 7, on front cover). In the Gaoyuzhuang Stage there appeared widespread linear ripples on the sandstone bed surface at the bottom of the Gaoyuzhuang Formation representing the facies indicator of the coastal-beach sedimentary environment (Photo 29, on back cover).

7. Discovery of tuffite in Dahongyu Formation in the Ming Tombs District

It was reported before that plenty of volcanic rocks are contained in the Dahongyu Formation in the Pinggu area, but the existence of volcanic rocks in the Dahongyu Formation in the Ming Tombs District was reported for the first time in a paper entitled "Discovery of Tuffite in the Dahongyu Formation of the Changcheng System in the Ming Tombs District, Beijing" in the "Journal of Petrology and Mineralogy" in 1988. The petrochemical data listed in the paper show that the tuffite belongs to trachytic volcanic ash sediments rich in alkaline elements, which conforms to the results of the chemical analysis of the volcanic rocks at the same horizon in Pinggu and its neighbouring area. Sanidine and zircon crystals fragments were found under the microscope (Plate V - 1, 2, 3, 4).Tuffaceous clay minerals were determinated by X-ray diffraction and differential thermal analysis. Of these minerals the main mineral is montmorllonite. It may be thus inferred that volcanic activity effected not only the deposition of Dahongyu Formation but also the deposition of the Gaoyuzhuang, Wumishan and Yangzhuang Formations. The carbonate rocks of the latters contain montmorllonite in their unsoluable components. The same possible reason may be that siliceous bands and chert beds are well developed in those formations.

8. Discovery of typical cosmic spherules (dust)

The existence of cosmic dust spherules in Proterozoic sedimentary rocks was reported before, but photos of typical surface structure of cosmic spherules are seldom seen. In the "Journal of Petrology and Mineralogy" Vol. 12, No. 4, 1988, the discovery of the cosmic spherules with typical surface structure in the Changzhougou Formation of Taoyuan, Jixian, and the Ming Tombs (Plate Ⅸ-5, 6, 7, 8, 9, 10, 11) was for

the first time reported. These surface structures of cosmic spherules are very similar to those found in other areas in China and abroad. A series of data of electron probe analysis indicate that the Proterozoic cosmic spherules mainly belong to the iron–meteorite system.

9. Discovery of mixed–layer montimorillonite–chlorite

Mixed–layer minerals are a kind of special clay minerals. The oldest geological age of their occurrence is still unknown. The paper entitled "A montimorillonite–chlorite regular interstratified mineral in the Gaoyuzhuang Formation of the Nankou System, Jixian" in the "Bulletin of the Institute of Geology, Chinese Academy of Geological Sciences" reported the oldest horizon, in which this mixed–layer clay mineral occurs. This mineral was determined by X–ray diffraction analysis and differential thermal analysis.

10. Systematic study on different types of sedimentary rocks

Through a systematic study carbonate rocks, mudstone– siltstones and conglomerate–sandstones in Proterozoic strata of North China, more detailed and systematic information has been obtained.

11. Correlations of the contents of elements in Proterozoic strata and rocks

On the basis of the Proterozoic representative sections in Jixian of Tianjin and the Ming Tombs of Beijing, the element contents were correlated separately according to different stratigraphical formations and types of sedimentary rocks by using such techniques as the inductive coupled plasma spectrum analysis. On that basis, the position of the sedimentary basin, the influence of various sedimentary rock types on common elements and trace elements and their implications on sedimentary metallogenesis are discussed.

12. Study on the rare element (REE) distribution pattern

Neutron activiation analysis was made on the purified clay minerals with a grain size of less than 0.002mm from the mudstones of the Changzhougou, Chuanglinggou, and Hongshuizhuang Formations to determine the difference of REE contents therein. The clay minerals of mudstone in the Changzhougou Formation adsorb more REE probably indicating proximal sediments; whereas the clay minerals of the mudstone in the Hongshuizhuang Formation adsorb less REE, probably indicating distal sediments. It is concluded after the NAS (North American Shale) standardization for all the above REE data that the Chuanglinggou mudstone is a typical mudstone.

13. Study on the Ir content

In order to avoid of the influence of the mixing of the Pt–group associated heavy minerals, the clay minerals with a grain size less than 0.002 mm from the mudstones of the Changzhougou, Chuanglinggou, and Hongshuizhuang Formations were used in the analysis of the Ir content so as to judge the possibility of the appearance of Ir anomaly geological events. It has been demonstrated by several analytic methods that the Ir content is as high as 0.5 ppb in the clay minerals of the Chuanglinggou Formation, but the Ir content in the other formations is below this limit. Nevertheless, this Ir content is still not high enough to reflect a geologic event of Ir anomaly.

14. Study on carbon and oxygen isotopes

The distribution of $\delta^{13}C$ and $\delta^{18}O$ in Proterozoic carbonate rocks shows that their sedimentary environments are mainly the subtidal, intertidal and supertidal zones, sabkha zones, and zones of influence of evaporite and fresh water. The $\delta^{18}O$ values tend to be towards the negative end owing to the influence of diagenesis.

15. Study on silicon isotopes

The $\delta^{30}Si$ values in siliceous rocks can reflect the difference of sedimentary environments. The $\delta^{30}Si$ value for siliceous rocks occurring in shallow-water and evaporite sedimentary environments tend to be high and positive, which conforms to the facies indicators of siliceous rocks of Proterozoic siliceous rocks in the Ming Tombs, Beijing; however those siliceous rocks influenced by volcanic activity have lower $\delta^{30}Si$ values; for example, the value of the Dahongyu Formation siliceous rocks is the lowest among all of the measurements.

16. Sedimentary minerogenetic series and ore prospects

There are two sedimento-minerogenetic series in Proterozoic strata of North China; the mechanical- sedimento- minerogenetic series and the chemical- sedimento-minerogenetic series. According to a series of information and data, one should pay attention to the environments favourable for the concentration of the U-Th and Ce group, silicon sands and glauconite sands and their facies indicators in the mechanical- sedimento- minerogenetic series, and the relative strata and laterally migrating horizons that host Mn-Fe, Pb-Zn-Cu, Li-Ba-Sr, oil-gas, evaporites, melting solvents and building materials in chmical-sedimento-minerogenetic series in the ore prospect areas of North China, particularly in the margins of the platform and hidden areas.

前　言

本书系地质矿产部"七五"重点攻关科研项目："我国北方前寒武纪成矿区域地质背景和找矿远景区预测"中的一项课题的研究成果。

该课题的研究任务是对中国北方中、晚元古代沉积岩特征、成岩机理和含矿岩系的相标志进行研究，是以基础科学为手段对找矿远景预测提供资料。研究工作由1986年开始，于1989年完成。

由于华北燕山一带中、晚元古代地层出露良好，地层层序齐全，而且岩石基本未发生变质，因此华北的中、晚元古代沉积岩不仅是中国北方的典型，也是全国甚至全球的典型地层区。为了补充晚元古代震旦系的沉积岩特征，选择了辽宁金县震旦系上部做为研究对象，进一步丰富了若干典型的沉积相类型。金县金石滩地区有极为丰富的沉积、构造现象，详细材料在乔秀夫、宋天锐和许志琴等《金石滩沉积地质与构造运动》的专著中论述。

在以往的年代里，许多单位的地质学家，曾经在地层学、古生物学、构造地质学和岩石地球化学方面进行过大量调查和研究工作，发表过很多各类有关论文，对于所含矿产，如铁矿、锰矿、铅、锌矿、磷矿、海绿石矿、玻璃原料、建筑石材和金、铀等矿产，也进行过普查或勘探，有的地方还在进行开采。各地质矿产部门和科研单位、大专院校等，都曾在不同规模的范围内举办学术会议，研讨各类学术问题。多次国际会议的讨论，涉及华北中、晚元古代的问题，许多外国著名地质学家参观了具有代表性的蓟县剖面和十三陵剖面。因此，华北一带中、晚元古代的研究程度是很高的。

鉴于以上背景情况，本项目的领导部门多次下达指示，要求研究工作应力求在不重复已有资料的前题下开拓新领域，同时，也考虑到研究经费的限制，野外和室内研究必须突出重点，尽量在原有水平上再加提高。

本研究课题的成果着重探讨了如下十个方面的问题：

1. 侧重北京十三陵和西山的中、晚元古代沉积岩研究和沉积相分析；
2. 重点补充河北蓟县中、晚元古代沉积岩特征和沉积序列的典型剖析；
3. 选择地研究了辽宁金县震旦系上部的沉积岩及沉积相标志；
4. 较系统地选送了中、晚元古代沉积岩样品进行等离子光谱分析；
5. 较系统地进行了砂岩粒度-环境分析和重砂矿物研究；
6. 重点进行了 $\delta^{18}O$、$\delta^{13}C$ 和 $\delta^{30}Si$ 的同位素研究及解释；
7. 重点进行了事件地质学的野外和室内研究工作；
8. 较系统地进行泥岩的物化特征研究；
9. 选择性地研究了中子活化分析的样品；
10. 初步探讨了沉积成矿系列和碎屑物综合结构性质的关系。

本研究课题的原设计包括下列参加人员：

宋天锐、赵震、王长尧、杨慧宁、刘仲秋、须湘官、王琳、蒋汶田、赵嘉农和柳永清。后因种种原因，下列人员未参加本科研成果的总结讨论、本书编写工作和有关整理工