

The Difference between Paleontology and Palaeobotany in the Central and South of North China

Wen Yang, Yu Zhang, Chengpu Liu, Xinzhi Yu, Mingxuan Zhou

College of Geoscience and Surveying Engineering, China University of Mining & Technology
Beijing100083, China
751334348@qq.com

Abstract - Carboniferous-Permian of North China plate is China's important coal-accumulating period in geological history. Its boundaries division has traditionally been discussion. In order to make sure the boundaries of the centre of North China and the south of North China, this article selects the typical profiles: western Henan, Huainan & Huaibe in the south of North China and Ordos-center Shanxi in the center of North China, through the paleontology and palaeobotany distribution characteristics, verified that the North China plate coal bearing strata and migration of rich coal belts associated with regressive process from north to south. Combined with the stratigraphic chart of China, contrast of rock strata in the region and paleontology and palaeobotany fossils refined the boundaries division of Late Carboniferous and Early Permian, the central and south of North China.

Keywords: the Center & South of North China; Late Carboniferous-Early Permian; Paleontology and Palaeobotany; Boundaries division

1. Introduction

As important coal accumulating period, geologists have done lots of research on Carboniferous-Permian coal-bearing strata in North China, published their own views of the boundary problem based on the transverse comparison of fusulina, conodonts, palaeobotany. Wang Zhongtang (1959) made top surface of Dongdayao limestone or bottom of Beichagou sandstone as the Permian boundary; Zhang Zuxi (1987) think the first appeared of honeycomb layer spin as the biostratigraphic boundary of Carboniferous-Permian; Zhang Zhicun (1991) with the bottom of *Misellina* (lavrov) range zone as the biostratigraphic boundary of Permian; Huang Jiqing and Wang Zengmeng (1995) take the appeared of *Pseudoschwagerina*, *Sphaeroschwagerina*, *Chalaroschwagerina* and *Perocanoidospora clatrata*, *Radizonatus solaris*, *Striolatospora lucidus* as the boundary of Permian; Kong Xianzhen (1996) and Zhang Linxin (2000) put the conodonts *Streptognathodus isolatus* first appeared as the Permian stratigraphic boundaries.

For the complexity of the strata and limited understanding, there were many questions about the boundary division of Carboniferous-Permian in north China plate, such as the degree of research unbalanced, not unified the precision of strata division and contrast, fill in the methods of research, failed to reach the International standard and accuracy, obscure to the stratigraphic unit definition or the lack of large area comparability. In this paper, on the basis of predecessors' research to discussion the late Paleozoic biota and boundary of Permo-Carboniferous in middle and southern part of the north China.

2. The regional situation

Based on the characteristics of coal-bearing strata development, distribution, sedimentary, coal-bearing property and thickness changes, follow the principle of homogeneity take rock strata of late Paleozoic coal accumulating basin in north China, from north to south, divided into three partitions: north partition, centre partition and south partition of north China plate (2014). The partitions of centre and south are roughly bounded by 35°N line, including Ordos basin, Shanxi province, Hebei province, north of Henan province, Shangdong province, south of Liaoning province and Helan mountain in the north partition, while west of Henan, Huainan and Huaibe areas and Xuzhou region in the south partition (figure 1).

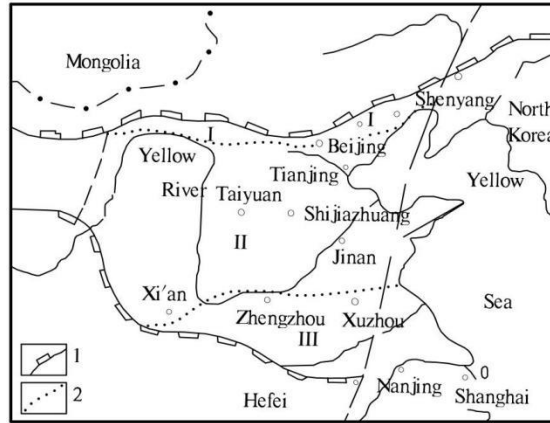


Fig. 1: Schematic diagram of rock-stratigraphic division of North China late Paleozoic Era (From Wang Zengmeng, 1996).
1. Study area boundary; 2. Rock-stratigraphic boundary.

Affected by transgression of time and space and non-isochronism, the coal accumulating center of south and centre of north China coal bearing strata was migration one by one, with sedimentary diachronism. The distribution of late Carboniferous - early Permian coal-bearing strata is progressive and gradual in space and continuous in time, but also migration at the same time. Inconsistent in sedimentary environment, transgressive and regressive, tectonic evolution and palaeontological, took the south and centre partitions differences in rock characteristics, coal seam strata, boundary division and paleontological fossils^{[6][7]}.

On the division of rock strata from bottom to top in the centre partition and south partition of north China, there are Hutian formation, Taiyuan formation, Shanxi formation, Shihezi formation and Shiqianfeng formation. The rock strata in south of north China revising Dafengkou formation on the top of Shiqianfeng formation. As to the coal-bearing property, coal-bearing accumulation is good for Dafengkou formation in south of north China, but the relative strata of Shihezi formation in the centre of north China was absent. Geologists believed that the era of Taiyuan formation in the centre of north China partition is C_2 - P_1 , while the strata all belong to the Permian era in south of north China partition. On the contrast of biological combination, *Fusulina-Fusulinella* zone was founded in Taiyuan area, Shanxi province, while in the relative strata founded *Triticites simplex* zone in Yuzhou area, Henan province; Wang Zhihao (2004) published that *Streptognathodus parvus* - *Idiognathodus magnificus* zone in Shanxi province belong to Darla stage fossils zone, Wang Chengyuan (2004) viewed that *Streptognathodus barskovi* zone in Henan province belong to Zisongian Stage, both of them to be a consensus in era.

3. Fusulina

China stratigraphic table (2014)^[8], including Zisongian stage (P_1^1) and Longlinian stage (P_1^2) in Chuanshanian Series of Permian. *Pseudoschwagerina uddeni*-*P.texana* zone and the disappearance of *Sphaeroschwagerina* range zone as the top boundary of Zisongian stage. Both *Sphaeroschwagerina* and *Pseudoschwagerina* were stopped by Beichagou sandstone, so the top of Beichagou sandstone was the top boundary of Permian, the chronostratigraphic boundary is consistent with stratigraphic boundaries and lithostratigraphic boundaries.

Paleontology in the centre of north China and south of north China can contrast in partition. In south of north China, *Fusulina-Fusulinella* zone and *Profusulinella* zone are common development in Taiyuan formation, *Pseudoschwagerina* zone main development in the upper section, corresponding to Zisongian stage while *Triticites-Montiparus* zone in Xiaoyiaoan Stage was missing. The appeared to *Rugosofusulina complicate* and *Pseudofusulina watanabei* on the behalf of the bottom of Zisongian stage, *Pseudoschwagerina* zone main development in the upper of Taiyuan formation. The top boundary of Zisongian stage in the west of Henan province was lined in the middle of mudstone section and upper of limestone section^[9]. *Fusulina-Fusulinella* zone and *Profusulinella* zone in the bottom of Taiyuan formation in Darla stage were established in the north and west of Henan province and Xuzhou area. In the centre of north China, only development *Triticites* zone in the bottom of Taiyuan formation in Shanxi province, its strata was higher than the zone in the south of north China. Asides development of *Pseudoschwagerina* zone, *Triticites-Montiparus* zone also has in the upper of Taiyuan formation (Table 1).

Table 1: fusulina, conodonts and stratigraphic classification in the south of north China and the centre of north China.

Epoch	Stage	the centre of north China		the south of north China					
		Fm	centre of Shanxi province	Fm	West of Henan province	Huainan and Huaibei			
Early Permian	Zisongian stage	Taiyuan Formation	<i>Triticities- Montiparus</i> belt		Taiyuan Formation	<i>Staffella</i> belt	<i>Boultoniadadunensis-Rugosochusenella</i> sub belt		
			<i>Pseudoschwagerina</i> a belt	<i>Pseudoschwagerina texana</i> - <i>Pseudofusulina valida</i> sub belt				<i>Sphaeroschwagerina Moelleri</i> belt	
				<i>Dumbarinella nathorsti</i> - <i>Dumbarinella nathorsti laxa</i> - <i>Rugosofusulina alpina</i> sub belt					<i>Robustoschwagerina shanmianensis</i> belt
				<i>Fusulina-Fusulinella Profusulinella</i> belt	<i>Sphaeroschwagerina subrotunda-Rugosofusulina compliceata</i> sub belt				
Late Carboniferous	Xiaoyiaoaan Stage		<i>Triticities simplex</i> belt			Benxi Formation	Missing	Missing	

4. Palaeobotany and Sporopollen

Sporobolus in Late Paleozoic can be divided into three stages: the initial state of the late Carboniferous, the rise stage of early to middle Permian, and the flourishing state of the late Permian. Its largest sporophore combination difference in the centre and the south of north China was in late carboniferous epoch. For example, *Pustula-tisporites verrucifer-Cyclogranisporites aureus* A.Z. and *Laevigatosporites* peak-zone where development in the centre of north China but missing in the south of north China. *Thymospora thiessenii- Perocanoidospora clatrata* A.Z. and *Gulisporites cochlearius-Sinulatisporites shanxiensis* A.Z. were both development in two partitions (Table 3).

Characteristics of palaeobotany combination in late Paleozoic are the prosperous of *lepidodendron* and *Pecopteris*, plenty in *Filicinae* and *Pteridosperms*. The combination of Taiyuan formation and Shanxi formation in the centre and south partitions is *Emplectopteris triangularis-Cathaysiopteris whitei*, but inconsistent in its majority molecules and the era.

The topic palaeobotany of Taiyuan formation (C₂-P₁) in the centre of north China is *lepidodendron*, *NewropterisovataHoffm* and *allipteridium*. And the combination of Shanxi formation (P₁^s) is *Sphenophyllum verticillatum-Taeniopteris multinervis* zone and *Emplectopteris triangularis-Odontopteris subcrenulata* zone. However, the combination of Taiyuan formation (P₁^l) in the south of north China was the subject of *Neuropteris ovata-Lepidodendron posthumii-Taeniopteris sp.* and *Emplectopteris triangularis-Emplectopteridium alatum- Cathaysiopteris whitei* zone in Shanxi formation (P₂^s).

Palaeobotany combination of Taiyuan formation (P₁^l) in Huainan-Huaibei was *Neuropteri ovata-Lapidodendron posthumii* belt, with important molecular as *Lepidodendron oclusfelis*, *Sphenophyllum oblongifolius*, *Tingia hamaguchii*, *Annularia pseudostellata*, *Cordaites prineipalis*. In Shanxi formation, the combination was *Emplectopteridium alatum-Taeniopteris multinervis-Lobatannularia sinensis* belt, absence of *Emplectopteris triangularis*, with important molecular as *Lepidodendron oclusfelis*, *Sphenophyllumthonii*, *Pecopteris arborescens*, *P.cyathea*.

5. Boundary division of late carboniferous to the early Permian

Carboniferous-Permian boundary strata have a discussion for a long time. North China carboniferous stratigraphic correlation scheme has great differences, investigate its reason for lack of reliable comparison sign in a large area. Coal-bearing strata division and correlation usually involves in the coal-bearing strata unit of diachronism and non diachronism, boundary, distribution scope and its content contained. From the view of rock strata contrast, Taiyuan and Shanxi formation in west of Henan province in the south of north China is both developed in the Permian, are owned to P₁ and P₂.

However, Taiyuan formation in the middle of Shanxi province in the centre of north China belongs to C₂-P₁^t, Shanxi formation belong to P₁^s (table 2).

Table 2: stratigraphic correlation of late carboniferous to the Permian in the centre and south of north China.

Chronostratigraphic		the south of north China			the centre of north China				
		the west of Henan province			the centre of Shanxi province				
system	stage	system	Fm	section		system	Fm	section	
P ₁	Xiangboan Stage	P ₂	Shanxi Formation	Limestone section		P ₁	Shanxi Formation	1# coal section	
	Longlinian Stage			Sandstone section					
				Sandstone section					
P ₁	Zisongian Stage	P ₁	Taiyuan Formation	Limestone section	L ₁₀ -L ₇	P ₁	Taiyuan Formation	Xishan section	
				Sandstone section	L ₆ -L ₅				Dongdayao Limestone
				Limestone section	L ₄ -L ₁				Xiedao Limestone
				Maoergou Limestone					
C ₂	Xiaoyaoan Stage	C ₂	Benxi Formation			C ₂	Benxi Fm	Miaogou Limestone	
								Jinci Sandstone	
							Jinci Section		

In recent years, the international Carboniferous-Permian task force make some opinion on the carboniferous and Permian boundary division. C.A.Ross (1989) submitted to that the bottom boundary of the Permian system should be built on the appeared of *Pseudoschwagerina* as the standard, this boundary was clear and feasible. L₁₀

For the central area of Shanxi province, the boundary division in late Late Carboniferous to early Early Permian in the development of limestone area is in the *Triticites sinuosus-Montiparus minutus* zone and *Sphaeroschwagerina* zone, and under the combination of *Neuropteris ovata-Lepidodendron posthumii*^[11], the boundary division in Xishan section of Taiyuan formation and Shanxi formation in early Early Permian to late Early Permian is in the top of *Pseudoschwagerina* zone, in the middle of *Neuropteris ovata-Lepidodendron posthumii* and *Emplectopteris triangularis-Taeniopteris mucronata-Lobatannu-lariasinensis*.

6. Conclusion

(1) On behalf of fusulina strata show that the bottom of Taiyuan formation in the centre of north China is higher than the south of north China. *Triticites* belt development in north China, equivalent to Xiaoyaoan stage; fusulina combination in the south of north China beginning with *Rugosofusulina complicate*, *Pseudofusulina watanabei*, equivalent to the bottom of Zisongian stage.

(2) *Pustula-tisporites verrucifer-Cyclogranisporites aureus* A.Z. and *Laevigatosporites* peak-zone were development in the centre of north China but missing in the south of north China. *Thymospora thiessenii-Perocanoidospora clatrata* A.Z. and *Gulisporites cochlearius-Sinulatisporites shanxiensis* A.Z. were both developments in two partitions.

(3) Combination of palaeobotany show that the Taiyuan formation in the centre of Shanxi province belongs to C₂-P₁ and Shanxi formation of P₁^s; the palaeobotany combination in the west of Henan province is belongs to P₁^t, and P₂^s for Shanxi formation; P₁^t of Taiyuan formation and P₁^s of Shanxi formation in Huainan-huaipei area. Except the missed by *Emplectopteris triangularis* in Huainan-Huaipei, *Neuropteris ovata-Lepidodendron posthumii* in Taiyuan formation and

Emplectopteris triangularis-Cathaysiopteris whitei in Shanxi formation were both development in the centre and south partitions.

(4) Distribution characteristics and boundaries division of paleontology and palaeobotany verified that the migration of coal bearing strata and rich coal belt in north China basin was associated with the regressive from north to south; both fossils of paleontology and palaeobotany marked with the strata and its corresponding rock stratum can make sure the boundary division of the late carboniferous and the early Permian in the centre and south partitions in the north China.

Acknowledgements

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References

- [1] All China Commission of Stratigraphy, *Stratigraphic Guide of China and China stratigraphic guide manual*. Beijing: Geological Publishing, 2014.
- [2] Amos Salvador International Stratigraphic Guide, *Stratigraphic classification, terminology, and procedures*. Beijing: Geological Publishing, 2000.
- [3] S. Zhang, Y. Zhang, H. Yan, "International stratigraphic chart. Introduction," *Journal of stratigraphy*, vol. 3, no. 11, pp. 1-10, 2009.
- [4] Stratigraphic paleontology research center, *China geological survey. China's geological time stratigraphic classification and correlation*. Beijing: Geological Publishing, 2005.
- [5] All China Commission of Stratigraphy, *China Regional Chronostratigraphic chart Introduction*. Beijing: Geological Publishing, 2002.
- [6] J. Wang, H. W. Pfefferkorn "The Carboniferous-Permian transition on the North China microcontinent-Oceanic climate in the tropics," *International Journal of Coal Geology*, vol. 119, pp. 106-113, 2013.
- [7] Z. Chen, X. Wang, B. Richards, "Multidisciplinary studies of global Carboniferous stage boundaries: towards a better definition and global correlations: an Introduction," *Cambridge University Press*, vol. 151, no. 2, pp. 199-200, 2014.
- [8] China Commission of Stratigraphy editor, *China Commission of Stratigraphy*. Beijing: Geological Publishing, 2009.
- [9] Y. Diao, "Sequence stratigraphy and palaeogeographic research of late carboniferous-early Permian, in South of North China," Shandong University of Science and Technology, 2009.
- [10] G. Shang, "North China platform of late Paleozoic coal geology research," China National Administration of Coal Geology, Shanxi Scientific and Technical Publishers, 1997.
- [11] G. Shen, H. Zhang, "On Division of Series in Carboniferous System of China from the Point of Palaeobotanical View," *Journal of Lanzhou University*, vol. 02, 1982.