Research on the Age of Coal-bearing Strata in Beishan basin group of Gansu-Inner Mongolia Region

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Abstract. Although the coal measures strata of Beishan Basin group in Ganneng were discovered earlier, due to the low degree of geological work and the lack of comprehensive data system research, the geological age of coal measures strata is not consistent. In order to clarify the age of coal measures strata in the basin group and the exploration prospect of coal, uranium, oil and other resources in the research area, the geological age of coal measures strata in Beishan basin group was researched, based on the systematic summary of paleontology, tectonic evolution, lithologic characteristics and coal and rock industrial characteristics, combined with the analytical and laboratory data supplemented by the research team, the comprehensive analysis shows that: the age of the formation of the coal measures in Beishan basin group should be the early cretaceous of the Middle Jurassic. The geological age of the coal measures in southern of the basin group is the Jurassic, and the northern coal measures are mainly early cretaceous. The western margin of Yinhe basin is adjacent to Beishan basin group, and the coal measures strata are comparable to each other, which can provide the basis for the age of coal measures strata revealed by drilling holes in the western margin of Yinhe basin.

1. Introduction

The structural position of the Beishan basin is located in the southern margin of the Eurasian tectonic belt, and is at the intersection of the Tarim plate, the Kazakhstan and the North China plate, and is located in the connecting position of the South Tianshan suture zone and the Soren suture zone. This area is connected with the Yingen-Ejinan Banner basin, and the west is the Tuha and the Santanghu basin [1]. The boundary between the Jiuanqan basin and the north reaches the boundary of the middle and the north of the research area. The exploration of oil and gas in the periphery of the study area has made a breakthrough, and the inside of the Group Basin of the Beishan basin has been proved to have rich coal and uranium resources [2].

There have always been differences in the age of coal-bearing strata and their nomenclature in the Beishan Basin Group. On the whole, they can be divided into two major viewpoints: one is that the coal measures strata of the Beishan Basin Group are Jurassic strata (Peng Wenwu, 1988; Wu Chuanrong, 1995; Gao Ruiqi, 2001; Deng Shenghui, 2003; Wang Hongxia, 2013); another view is that the coal-based strata should belong to the Early Cretaceous, and belong to the Lower Cretaceous strata (Li Zuwang, 1993; Song Jie, 1993; Zhang Guying 2005; Gao Zhanbin, 2014; Ma Xiaojin, 2015; Zhang Wan, 2016).
2016; Zhang Jinlong, 2017); in addition to these two mainstream views, a few scholars believe that the coal seam of Beishan should belong to the Triassic system (Wu Hongfeng, 1998) or the Permian system (Lujincai, 2013). It can be seen that the coal formation in the Beishan of Gansu-Mongolia is low in the degree of geological work, low in the detection rate of the micro-body, and the lack of the dating data of the lithotria. The understanding of the age of the coal-bearing formation is not consistent.

2. The attribution of formation and its evidence

2.1. Evidence of the early and Middle Jurassic

2.1.1. Hongliu Daquan and Jijitaizi area. In the process of regional geological survey carried out in the 1950s and 1960s in Beishan area, paleontological samples were systematically collected from the outcrop area of coal measures strata. The sedimentary strata of coal-bearing clastic rocks in Hongliu keloid well area are rich in plant fossils. There are 22 species of plant fossils, including ferns (45%), ginkgo (32%), cycads (10%), others such as pine and cypress (9%), most of which belong to the early and Middle Jurassic flora. Abundant freshwater flap Gill fossils have been found in limestone strata comparable to coal measures strata in Amuwusu area (Tutuella cf. altitudeformis Dong, T.cf.elongata Ragozin, Sphaerim sp., Utschamiella sp.). This kind of fossil age belongs to the early Jurassic, and the characteristic can correspond to the lower Jurassic Changliangzi group in the Liaodong area. The earliest fossils found in the strata of the Jijitaizi area as follows: Coniopteris hymenophylloides Brog, Ginkgoites cf. marginatus (Nath.) Florin, Equisetites, Pityospermum. There are 22 genera and 12 species of plant fossils in the Hongliu Daquan area, including 32% of the ferns, 25% of the pine, 21% of the ginkgo, 7% of the Cycas, and 15% of the other gymnosperms and the fossil fruits. Most of the plant fossils are the coniopteris-phoenicopsis plant population. The elements of these plant groups have appeared in the Longfengshan group in the east of Qilian Mountains and in the western part of Qilian Mountains. Therefore, the age of the coal-bearing strata in the Hongliu Daquan area should be the early and middle Jurassic, compared with the Longfengshan group.

2.1.2. Shalinhaote profile in Black Eagle Basin. There are a large number of paleontological fossils in the Shalinhaote profile, including Phoenicopsis sp, Cladophlebis sp, Ginkgoites sp, Equisetites sp, Desmiophyllum sp, and Neocalamites sp. The first five fossils are common fossils in the early middle Jurassic strata of continental China. The results of cross section sporopollen identification showed that the proportion of ferns was the highest (37.7%), followed by pine and cypress (24.7%) and ginkgo (22.8%). The stratigraphic lithology is dominated by fine clastic sediments with thin coal seam (coal line).

Plant fossils from coal measures of the Xirehada profile in the eastern part of Heiyingshan Basin are very well developed, mainly as follows: Clathropteris meniscioides, Coniopteris hymenophylloides, Sphenobaiera longifolia, The latter two are important molecules of Coniopteris phoenicopsis, and are typical characteristics of early and middle Jurassic flora. Compared with the characteristics of paleontology, lithology and lithofacies formation, this layer should be the same layer as the Dashankou Group in the western part of Jiuquan Basin, and the age should be early-Middle Jurassic.

Coal seams are more developed in the strata of NiuJuanzi-Tongchangkou area in the southern part of TuoMaTan Basin, which is of industrial mining value.

2.1.3. GongPoQuan Basin and TuoMaTan Basin. Coal seams are more developed in the strata of NiuJuanzi-Tongchangkou area in the southern part of TuoMaTan Basin, which is of industrial mining value.

In the northern Tiaohu area of the basin, only two coal groups are developed in the corresponding strata, and the industrial value is low. In the eastern part of the basin, there is only the development of the coal line in the Hongliaogou and the Suoshugou of the GongPo Quan basin, and the coal seam in the salt pool area to the east will disappear completely. The plant fossils in the gravel at the bottom of the
coal seam are Pityophyllum sp. and Cladophlebis sp. The comprehensive analysis shows that the coal-bearing strata in this area and the coal-bearing strata in the northern basin should be early and middle Jurassic sedimentary strata.

2.2. Evidence of the early Cretaceous Epoch

2.2.1. DaHongShan Profile in Black Eagle Basin. A large number of plants, macroleptiles, bivalves, gastropods and other biological fossils developed in the coal measures strata in the northern of Dahongshan profile. According to the comparison of biological characteristics, it is considered that this set of strata should be classified as early Cretaceous [3].

The sampling point (coordinate: x = 4717811, y = 17370946) in the north of the Great Red Mountain was obtained from a large number of mollusk fossils. The fossil assemblage of the ancient and biological fossils, which was identified by the Nanjing Institute of Geological and paleontology of the Chinese Academy of Sciences, belongs to the group of hot river animals, and it is an early cretaceous group and is classified as the Red-gold barrier group (Zhang Guoying, 2005). The age of the spiral-like fossil in the formation of about 600 meters in the south of the sampling point is also the early cretaceous.

2.2.2. GongPo Quan Basin. The geological age provided by the sporo-pollen fossils in Shuangjingnan drilling is still the early cretaceous, which is in the north of GongPo Quan Basin is still early Cretaceous [4].

The sporopollen stratigraphy of 22 core samples from two boreholes (G2709 and K705) in Gongpoquan Basin was carried out, of which 17 samples were rich in sporopollen fossils. The G2709 sporopollen assemblage in the southern part of the basin is monotonous, characterized by the high content of Classopollis (average content 82%), and has the characteristics of late Jurassic sporopollen assemblage. The K705 drilling fossil assemblage in the northern part of the basin is rich, and typical early Cretaceous molecules appear, such as Concentriscopites, Cicatricosisporites, Densosporites, Pilosisporites, Lygodiosporites, Lygodiumsporites and Aequitriradites. This indicates that the coal-bearing strata in the northern part of the basin are in the early Cretaceous.

2.2.3. TuoMaTan basin. A total of 73 micropaleontological samples were identified in the northern TuoMaTan basin of Beishan basin group (latitude 41 °40 ≤ 41 °48 N, longitude 96 °27 °96 °52'E). 32 species belonging to 23 genus were identified, with a total of 8187 sporopollen. The total number of pollen 7055 is 86.17%, the spore-pollen is 1072, the total number is 13.10%, and the total number of algae is 0.73%. Among them, Cycadopites and Piceapollenites accounted for 4.53%, 4.63% and 16.36%, respectively. The content of these three kinds of sporopollen was significantly lower than that in Jurassic strata. The sporo-pollen (including the genus Cicatricosporites), which is 0.1%, has been widely distributed in the Cretaceous strata, especially in the early cretaceous period, which is the prosperous period of the Lygodiumsporites. So as to obtain the evidence that the age of the coal-containing formation is the early cretaceous[5]. It is confirmed that the "TuoMaTan formation" belongs to the early Baiping age with enough paleontological materials, and may belong to the middle early white period, which is roughly corresponding to the Hauterivia Barremian period in Europe.

2.2.4. LaoShuWo Profile in ZhongKouZi basin. In the middle-middle gray-black mudstone sample of the LaoShuWo Profile in ZhongKouZi basin, the abundant mopping-powder fossils were analyzed, and the Piceites-Rotundipollis-Verrucossporites pollen assemblage was established. The pollen of gymnosperms was dominant (13.4% ≤ 72.8%, average 46.4%), followed by pteridophyte sporopollen (3.3% ≤ 39.4%), and algae accounted for higher (0 ≤ 83. 3%, average 30.3%). The pollen of gymnosperms was mainly airbag differentiated pollen. By analyzing the geological history distribution of important sporopollen species in the combination and comparing it with the characteristics of sporopollen at home and abroad, it is determined that the geological age of the LaoShuWo group in which the sporopollen combination is located is the early early Cretaceous.
2.3. Evidence of other geological times

2.3.1. Evidence of Triassic. Zk5005 of the boreholes in the northern GongPoQuan basin of Beishan basin sent seven samples for paleontology analysis (Wu Hongfeng,1998). Among them, six of them were very few sporopollen particles, only 24 samples were rich in fossils, 74 sporopollen particles were detected, of which gymnosperms pollen accounted for 55.4%, pteridophyte sporopollen was relatively less than 44.6%, and a small number of sporopollen molecules were found in Triassic strata.

2.3.2. Evidence of Triassic. The outcrop period of XiReHaDa coal mine in the northwest of Beishan Basin is Jurassic Dashankou Group, while 15 zircon blocks of tuff sandstone samples from well Yingqian 1 in the basin. The age weighted average value of 15 measuring points is 303.4Ma ±2.8Ma (95% conf.,MSWD= 1.05, 1 σ), 18 zircon in Yb4 well subsidence volcanic breccia, and (295.0 ±1.3) Ma (95% conf.,MSWD=0.28,1) in 18 measuring points. The samples of the two wells are equivalent to the Xiaodushan stage of the Upper Carboniferous, and the corresponding formation units are the Ganquan formation of the Upper Carboniferous and Lower Permian [5].

3. Discussion on the geological age

3.1. A comparative study of the paleontology

The analysis and test results of a large number of micropaleontological sporopollen samples in coal measures strata of Beishan Basinshow that (Figure 1.): There are no Taeniaesporites and Aratrisporites, which is common in Triassic strata, and the pollen content of gymnosperms is obviously higher than that of pteridophytes. Therefore, it is considered that the age of coal measures strata in this area is not likely to belong to Triassic. Secondly, Lygodiumsporites and Cicatricosisporites were found in Laoshuwo profile, TuoMaTan basin, G2709 wells in GongPoQuan basin and ShuangJingNan area sporopollen samples, and it was considered that the strata age in these areas was mainly early Cretaceous. In addition, Osmundacidites and Classopolis meyeriana were found to be found in both the well of XiReHaDa area and H1 drilling samples in ZhongKouZi basin. Sizaeibisporites jiaguanensis, which are present in TuoMaTan basin and well of XiReHaDa area, are the most common symbolic species of the middle Jurassic in the northern part of China and the new formation. The data of the Permian system, which is reflected in the data of the rock and stone, can't actually reflect the geologic time of the formation of the formation, which can be caused by the source of the deposit, which is based on the division of the coal-bearing formation into the Permian system and is not credible.

It is considered that the sporopollen assemblage of coal measures strata in Beishan basin group should be Middle Jurassic-early Cretaceous, and the coal measures strata in the southern margin of the basin group are mainly Jurassic, and the northern coal measures strata are mainly early Cretaceous.
3.2 Characteristics of coal and rock industry performance

The analysis of coal quality characteristics of coal and rock (Table 1.) shows that the coal and rock characteristics of Beishan Basin Group are obviously divided into two groups. The coal and rock characteristics of the western margin section and Xiaoqingshan section of Gongpoquan basin in the northwest of the basin group are the same, which are similar to those of the Cretaceous coal seam in the adjacent basin. In the south-eastern part of the basin, the coal and rock characteristics of the Great Spring are the same as that of the Heath-Hadda section, which is similar to that of the typical early-Jurassic coal-rock in the adjacent area, and we have speculated that the geological age should be an early stage. It is considered that the Beishan basin group is developed with two coal measures, which is consistent with the previous research \[1,6\], and it can be determined that the main developing cretaceous coal-bearing strata in the northwest of the basin and the Jurassic coal-series strata in the south.

**Table 1. A Comparison of the Parameters of the Coal Industry in the Beishan Basin**

|                     | ash content (A.d) | sulfur content (St.d) | calorific value (Qgr.ad) | volatile water content (Vdaf) |
|---------------------|-------------------|-----------------------|--------------------------|------------------------------|
| The western of Gongpoquan basin | 15%~40%           | 0.3%~3.0%             | 16~30                    | 41%~45%                      |
| XiReHaDa area       | 5.48%~54.26%      | 0.22%~5.78%           | 10.60~31.46              | 28.95%~52.34%                |
| XiaoQingShan        | 24.09%~30.07%     | 0.41%~2.49%           | 17.35~20.61              | 31.73%~31.83%                |
| HongLiu DaQuan\[7\] | 6.91%~32.28%      | 0.38%~1.33%           | 19.1~29.13               | 34.09%~46.82%                |

3.3 Seismic reflection characteristics

A large number of seismic profiles in Zhongkouzi basin in the south of Beishan basin group show that: Zhongkouzi basin is a superimposed basin composed of Jurassic and Cretaceous sedimentary strata. Jurassic strata and Cretaceous strata are angular unconformity contact relationship (Figure 2.). The exposed strata in the northwest of the basin are mainly Cretaceous strata, and the exposed strata in the
southeast are mainly Jurassic strata. It is further proved that the northwest coal seam of Beishan Basin Group is Cretaceous and the southeast coal measures strata are Jurassic.

Figure 2. Seismic profile of Jurassic-Cretaceous contact relationship in Zhongkouzi Basin

4. Conclusion

1) The comprehensive analysis shows that the coal measures strata in Beishan Basin are very likely to be Middle Jurassic and early Cretaceous, which basically ruled out the Permian and Triassic.

2) The paleontological data, seismic profile data and comprehensive analysis of coal and rock characteristics show that the exposed coal measures strata in the southern margin of the basin group are large in early Jurassic and early Cretaceous in the north.

3) The western margin of Yinhe basin is adjacent to Beishan basin group, and the coal measures strata have certain comparability. It is considered that the coal measures strata revealed by boreholes in the western margin of Yinhe basin should belong to the middle and late Jurassic-early Cretaceous.

Acknowledgments
We gratefully acknowledge the financial support for this study from the National Natural Science Foundation of China [Grant nos 41472004] and the China Geological Survey [Grant nos DD20190092].

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