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Geochemistry and mineralogy of coal in the recently explored Zhundong large coal field in the Junggar basin, Xinjiang province, China

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A B S T R A C T

The Zhundong coalfield is a very large coal deposit, currently under exploration, and promises to be an important coal mining resource in Western China. The coal reserves amount to 164 Gt. At Xiheishan and Wucaiwan, the coal-bearing units are the Badaowan (Lower Jurassic) and, especially, the Xishanyao formations (Middle Jurassic). These contain from one to 31 coal seams (one to 10 workable coals reaching the rank of high volatile A bituminous) with an accumulated workable coal thickness of 20–87 m. These recently explored coal reserves are of a high quality and are characterized by low ash, aluminum, iron, sulfur, and trace element contents. The minerals present in this coal are mainly quartz, kaolinite, siderite, and pyrite. The trace element contents in both Xiheishan and Wucaiwan coals are much lower when compared with the usual concentration ranges present in Chinese coals, with the exception of Ba and Sr. Thus, Ba contents in Xiheishan coal are higher than Swaine's worldwide concentration range. A large number of elements have mainly aluminosilicate affinity, and occur in clay and other detrital coal minerals. Ca and Mn have mainly carbonate affinity; Fe and S have mainly sulphide affinity in Wuchaiwan coal. In Xiheishan, Fe, Mn and Mg have mainly carbonate affinity (siderite), and probably, B, Co, Ni and S have an organic affinity.

Thus, the Zhundong coalfield contains coal with a very high quality and very low levels of impurities. The very low ash yields, S, Fe, and trace element contents may be attributed to the sedimentological setting, with intensive peat bog aggradation in a very shallow lake environment with a low detrital supply. The very low sulfur content, the relatively high Ba-sulfate (barite) content and the high siderite occurrence in Xiheishan coal (in contrast to the pyrite occurrence in Wucaiwan coal) may be attributed to the rapid aggradation of peat with the consequent oxidation and leaching of minerals, elements, and degradation of organic components. Under this scenario, sulfate is trapped by the continuous precipitation and accumulation of barium sulfate (very low soluble).

1. Introduction

The geochemistry and mineralogy of coals from coalfields in eastern and southwestern China have been documented by many authors (Dai et al., 2004, 2005a,b, 2007, 2008a,b,c; Ding et al., 2001; Huang et al., 1999, 2000; Liu et al., 1999; Liu and Yang,1999a,b; Querol et al., 2001; Ren et al., 1999a,b; Wang et al., 1996; Zeng et al., 2005; Zhang et al., 2004; Zhuang et al., 1999a,b, 2000, 2003; among others), but little information is available from the coalfields in Western China, especially in Xinjiang Province, where coal exploration is still ongoing.

This paper summarizes the results of geochemical and mineralogical research on samples from coal collected in two exploration areas (Wucaiwan and Xiheishan) from the Zhundong coal field, located in the eastern coal-bearing area of Junggar basin, Xinjiang province (western China; Fig. 1). Since 2004, in this vast region, located in Northwest China, a total area of 3831 km^2 is being prospected by a number of domestic investment companies. To date it has been estimated that the coal reserves amount to 164 Gt. Current coal exploration shows that this coalfield is an important area for further mining of large coal resources in China. The results presented here are the summary of the geochemical and mineralogical data of coals obtained from two boreholes in the Middle-West and the Southeast areas of the coal field.

2. Geological setting

Zhundong coal field, Junggar basin, comprises the Upper Permian Xiachangfanggou group (P_2ch^a), the Middle–Upper Triassic Xiaoquangou group ($T_{2-3}xq$), the Lower Jurassic Badaowan (J_1b) and Sangonghe formations (J_1s), the Middle Jurassic Xishanyao formation (J_2x), the Middle–Upper Jurassic Shishugou group ($J_{2-3}sh$), and the Pliocene Dushanzi formation (N_2d). The main coal-bearing strata are interbedded

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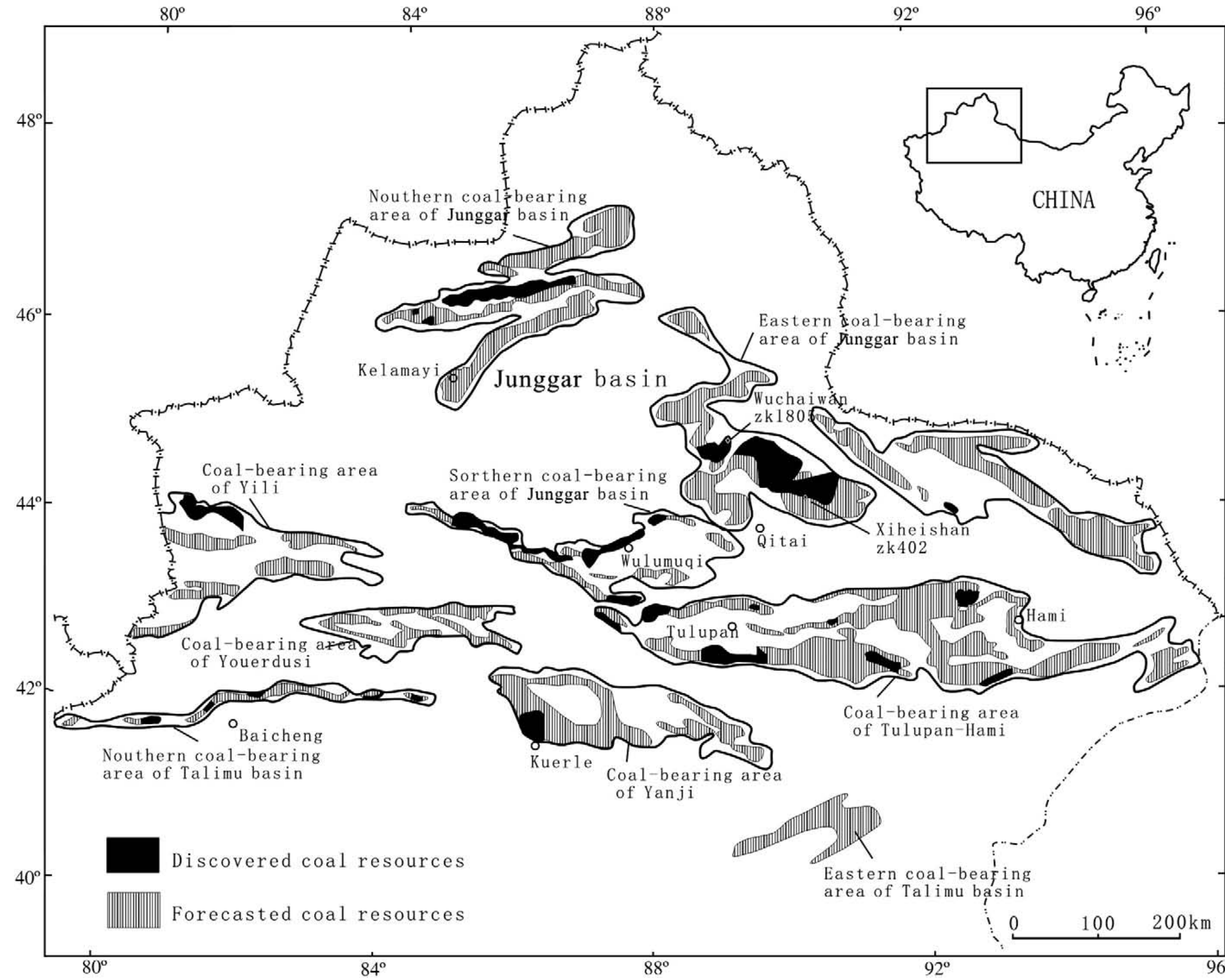

Fig. 1. Distribution of Jurassic coal fields in Xinjiang province, with locations of samples (after Mao and Xu, 1999).

in the Lower Jurassic Badaowan (J_1b) and the Middle Jurassic Xishanyao formations (J_2x). The latter formation contains the main workable coal seams of the basin, whereas the Badaowan formation consists locally of workable coal seams in the Zhundong coalfield. The Xishanyao formation is subdivided into the Upper and Lower Members.

The Lower Member is mainly made up of sandstone, siltstone, silty mudstone, mudstone, and coal. The thickness of this member ranges from 40 m to 200 m, and increases from north to south and in the southwest. It contains one to 31 coal seams (one to 10 workable coals) with an accumulated workable coal thickness of 20–87 m. The number of coal seams varies widely according to the location. In the middle-west part of the coalfield (Fig. 2), only one very thick coal seam (thickness ranges from 40 to 87 m) is developed, whereas in the southeast area (Fig. 3) a number of coal seams occur with much reduced thickness (accumulated coal thickness ranges from 20 to 60 m). The upper Member is mainly made up of sandy conglomerate, sandstone, siltstone, silty mudstone, and mudstone with few thin coal seams. This member, with preserved thickness of 10–80 m, was preserved incompletely due to denudation before deposition of the Shishugou group.

The Xishanyao formation coal seams (Middle Jurassic) were deposited in a shallow lake environment, with a few intercalations of braided fluviatile facies (Zhang et al., 2009). In Wucaiwan, the Xishanyao formation contains only one thick coal seam, whereas in Xiheishan, a number of thinner coal seams are interlayered among fluviatile and shallow lake detrital deposits. The shallow lake sedimentological patterns of the Wucaiwan and Xiheishan coal seams show that peat accumulation was equal to or slightly higher than subsidence in Wucaiwan, and lower than subsidence of the base of basin in Xiheishan. Thus, detrital layers are more abundant in Xiheishan, than in Wucaiwan. The relatively higher detrital influence in the shallow lake coal seams of Xiheishan, with respect to Wucaiwan, is evidenced by the lower coal thickness, higher proportion of detrital facies, and somewhat higher ash yields. The slower rate of subsidence at Wucaiwan allowed the equilibrium of rate of subsidence with peat bog growth and a continuous and thick coal seam developed. However, the higher subsidence at Xiheishan accounted for the intercalation of detrital sediments in the coal, and the reduced thickness of individual coal seam.

The Badaowan formation (Early Jurassic) is made also of mudstone, sandstone, conglomerate and thin and local coal seams developed in a shallow lake between braided river delta. The Sangonghe formation (Early Jurassic) is interlayered between the coal-bearing units (Xishanyao and Badaowan Fm.), and it is made by mudstone and sandstone deposits originated in more deep lacustrine deposits. This means that between the two coal formations a period of high water table, avoiding peat bog development occurred. The coal formation finished after the Middle Jurassic Xishanyao formation due to a land elevation period