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Geochemistry of trace elements in coals from the Zhuji Mine, Huainan Coalfield, Anhui, China

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ABSTRACT

The abundances of nine major elements and thirty-eight trace elements in 520 samples of low sulfur coals from the Zhuji Mine, Huainan Coalfield, Anhui, China, were determined. Samples were mainly collected from 10 minable coal seams of 29 boreholes during exploration. The B content in coals shows that the influence of brackish water decreased toward the top of coal seams; marine transgression and regression occurred frequently in the Lower Shihezi Formation. A wide range of elemental abundances is found. Weighted means of Na, K, Fe, P, Be, B, Co, Ni, Cr, Se, Sb, Ba, and Bi abundances in Zhuji coals are higher, and the remainder elements are either lower or equal to the average values of elements in coals of northern China. Compared to the Chinese coals, the Zhuji coals are higher in Na, K, Be, B, Cr, Co, Se, Sn, Sb, and Bi, but lower in Ti, P, Li, V and Zn. The Zhuji coals are lower only in S, P, V and Zn than average U.S. and world coals. Potassium, Mg, Ca, Mn, Sr, As, Se, Sb and light rare earth elements (LREE) had a tendency to be enriched in thicker coal seams, whereas Fe, Ti, P, V, Co, Ni, Y, Mo, Pb and heavy rare earth elements (HREE) were inclined to concentrate in thinner coal seams. The enrichment of some elements in the Shanxi or Upper Shihezi Formations is related to their depositional environments. The elements are classified into three groups based on their stratigraphic distributions from coal seams 3 to 11-2, and the characteristics of each group are discussed. Lateral distributions of selected elements are also investigated. The correlation coefficients of elemental abundances with ash content show that the elements may be classified into four groups related to modes of occurrence of these elements.

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1. Introduction

Eighty-six elements have been detected in coals and desorbed gases, and among them 24 trace elements are of environmental concern (Swaine, 1995). Environmental impact of trace elements is generally related to concentration, toxicity, and mobility (modes of occurrence) of these elements in coals (Finkelman, 1995; Dai et al., 2005). The elemental abundances in coals are related to coal-accumulating peat-swamp environments, geological processes during deposition and post-deposition, as well as the properties of bedrocks (Cohen et al., 1984; Goodarzi and Swaine, 1994a). The major minerals in coals are silicates, carbonates, and sulphates. Most elements are concentrated in these minerals. However, Ge, B, Br, Be and Cl are usually associated with the organic matter (Finkelman, 1995).

Many publications have reported the concentration, distribution and origin of hazardous elements in Chinese coals from different coal mines, coalfields and coal-bearing regions (Dai et al., 2004a,b, 2005; Liu et al., 2005a,b; Zhuang et al., 2006; Dai et al., 2006a,b, 2007a,b; Zheng et al., 2007; Liu et al., 2007a,b,c; Du et al., 2009). However, most publications paid attention to the environment-sensitive elements such as As, Cl, Cr, F, Hg and Pb in several districts located at southwestern and northeastern China with anomalous trace-element enrichment (Liu et al., 2007c; Qi et al., 2008; Zheng et al., 2008a,b,c). Moreover, the number of samples analyzed was inadequate. For example, high concentrations of some elements in a bench layer within a seam or a whole seam are sometimes improperly used to imply that all coals in a coalfield are high in these elements (Goodarzi et al., 2009).

The Zhuji Coal Mine is located in the northwestern Huainan Coalfield, Anhui province, China (Fig. 1). The coal is medium to high volatile bituminous, with low sulfur content (an average of 0.44%), medium calorific value and ash yield (Sun et al., 2010). The coal resources in the Huainan Coalfield are approximately 44,000 Mt. The coal is mined mainly for power generation. There is little knowledge

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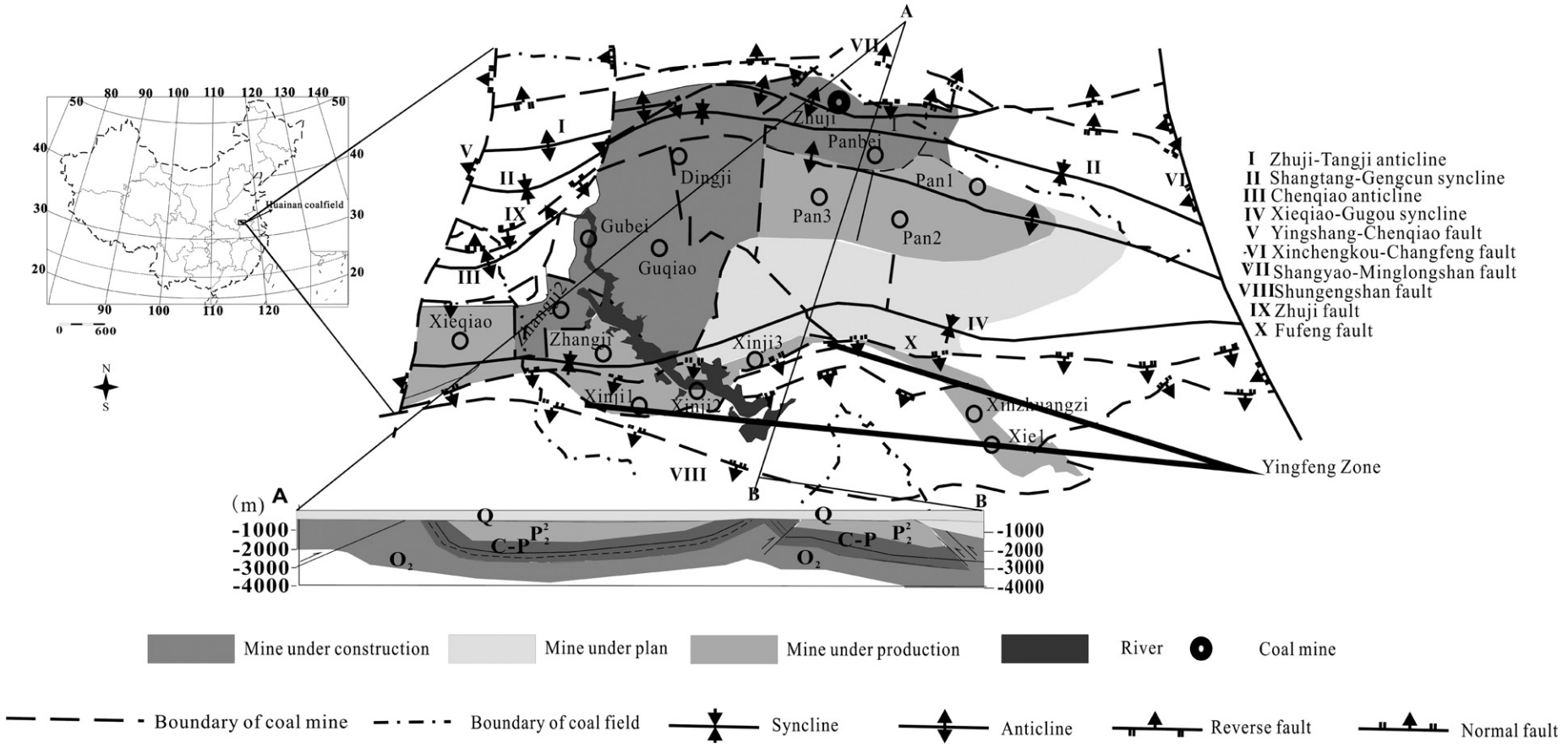

Fig. 1. Geologic map of Huainan coalfield. Note that the Zhuji exploration area is located in the northern part of the coalfield, with Zhuji–Tangji anticline and Shangtang–Gengcun syncline cross it and old strata outcrop at the margin.

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