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The use of sequential extraction to determine the distribution and modes of occurrence of mercury in Permian Huaibei coal, Anhui Province, China

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Abstract

Sequential extraction tests using a Flow Injection Mercury System (FIMS) were done on 34 samples collected from the number 3, 4, 5, 7, and 10 coal seams in the Huaibei Coalfield; average total mercury (Hg) concentrations for the seams were 0.13, 0.18, 0.54, 0.34, and 0.19 mg/kg respectively. The average value for all of the coal samples was 0.26 mg/kg, which is higher than most Chinese and U.S. coals. Six modes of Hg occurrence were recognized, including: water-leachable, ion-exchangeable, organic-bound, carbonate-bound, silicate-bound, and sulfide-bound Hg. With rare exception, little Hg was found in water-soluble, ion-exchangeable or carbonate-bound forms. Sulfide-bound Hg and organic-bound Hg dominated seams 3, 4, and 10, whereas silicate-bound Hg dominated seams 5 and 7. The relatively high Hg values observed in seams 5 and 7, especially in parting samples, are attributed to Hg enrichment by magmatic intrusions.

Keywords: Mercury (Hg); Modes of occurrence; Sequential extraction tests; Coal; Huaibei Coalfield

1. Introduction

In recent years, Hg in coal has been intensively studied due to its volatility, persistence, toxicity, and tendency to bioaccumulate through the food chain (USEPA 1996, 1997; Horvat et al., 2003; López-Antón et al., 2006). These studies are difficult because Hg is among the least abundant elements in coal and consequently, is difficult to detect and measure (Yudovich and Ketris, 2005).

Despite the low levels of Hg in coal, huge amounts of coal are burned to generate electricity and coal combustion is responsible for a significant portion of anthropogenic releases of Hg into the environment. This

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is because Hg is volatile and readily escapes to the atmosphere with combustion gases. Indeed, coal combustion is consistently cited as one of the largest anthropogenic Hg sources to the global atmosphere (Nriagu and Paeyna, 1988; Slemr and Langer, 1992; Toole-O'Neil et al., 1999; Pacyna et al., 2003; Seigneur et al., 2004a,b; Pacyna et al., 2006). Streets et al. (2005) reported that during 1999, China consumed 1.46 Pg of coal and coal products, resulting in 202 Mg of Hg emissions; this represents about 10% of global anthropogenic Hg emissions. For example, Seigneur et al. (2004a) estimated that current global Hg emissions were about 2143 Mg/year, with Asia, Europe, Africa, North America, Central and South America, and Oceania respectively contributing 1138, 326, 246, 209, 176, and 48 Mg/year. The behavior of Hg during coal combustion, its redistribution in combustion products, and environmental fate are active areas of research (Diehl et al., 2002; Meij et al., 2002; Staudt and Jozewicz, 2003; Goodarzi and Goodarzi, 2004). Some studies noted the possibility of reducing Hg prior to combustion (Swaine, 2000; Liu et al., 2002; Quick et al., 2003; Sakulpitakphon et al., 2003, 2004; Mardon and Hower, 2004). Other studies have examined how understanding the distribution, and mode of occurrence of Hg in coal might improve Hg reduction processing methods (Feng and Hong, 1999; Liu et al., 2002; Zhang et al., 2003; Brownfield et al., 2005). Understanding the distribution and mode of occurrence of Hg in coal may also help to identify strategies to reduce Hg during mining, remove

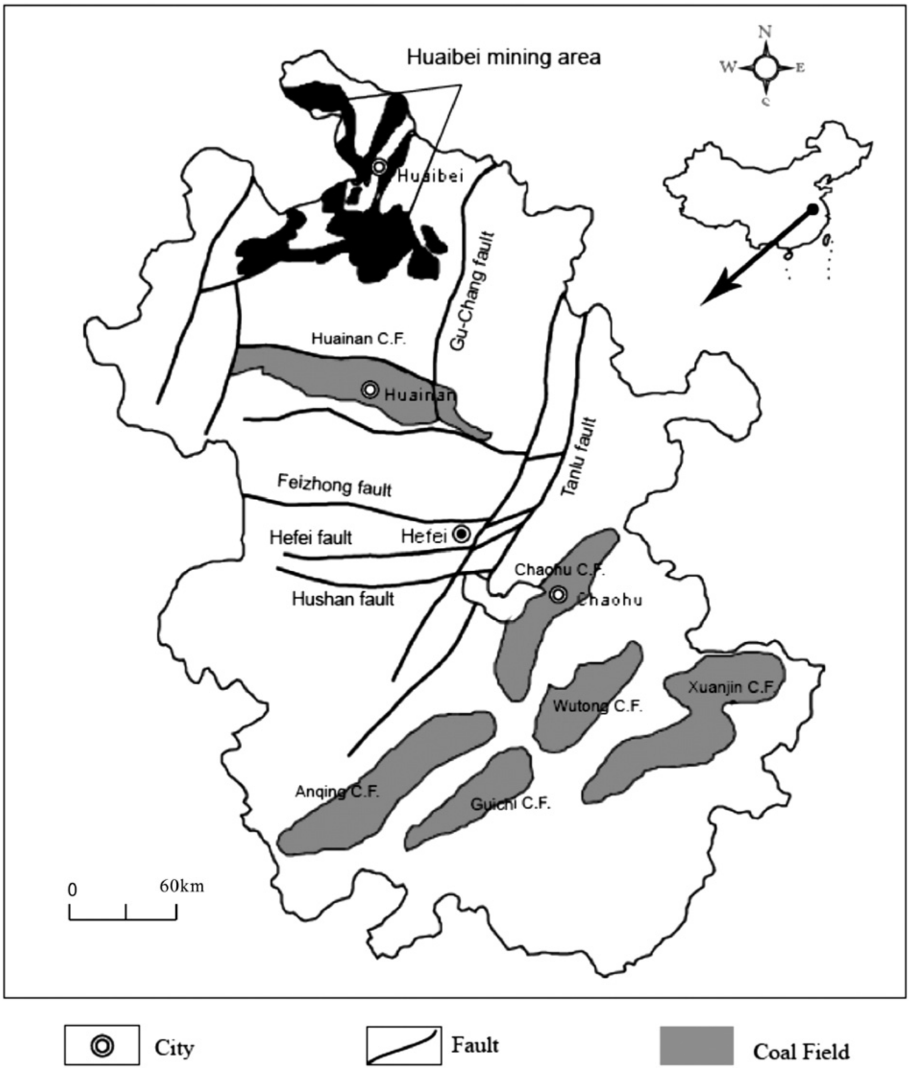

Fig. 1. Location of the Huaibei mining district in Anhui Province, China.