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Rare earth element and yttrium content of coal in the Banko coalfield, South Sumatra Basin, Indonesia: Contributions from tonstein layers

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ABSTRACT

The South Sumatra Basin is one of the most prolific coal basins in Indonesia. Most of the coal from this area is used as thermal coal. Seredin and Dai (2012) explained the importance and significance of coal deposits as potential sources for rare earth elements and yttrium (REY); the concentrations of these elements in coal are similar to their abundances in conventional REY deposits. Production of the REY in coal deposit is mainly from the coal's fly/bottom ash. Examination of coal with high REY concentrations is becoming a very important issue. The study area is located in the Banko coalfield, Sumatra, Indonesia. This area is one of the best candidates for studying REY in coal because there are tuffaceous mudstone layers (tonsteins) reported by previous researchers that may have enriched the coal in REY. For this study, coal and non-coal beds from the same stratigraphic interval were sampled and analyzed using thin and polished section, X-ray diffraction (XRD), inductively coupled plasma atomic emission spectroscopy (ICP-AES), and inductively coupled plasma mass spectrometry (ICP-MS). Special attention was given to coals near the tonstein layers. Based on the data collected, it was concluded that all the tonsteins studied are of volcanic origin and are silicic and alkali tonsteins. The elements Al and Si are higher in coal samples collected just beneath the tonstein layers and the highest REY concentration found was in a sample beneath a silicic tonstein layer. These data suggest that there is an opportunity to extract REY from coal's fly/bottom ash because the REY content of the ash is as much as 10 times higher than the REY content of the coal feed to power plants.

1. Introduction

Rare earth elements and yttrium (REY) are commodities for which demand has increased significantly in the last few years. The abbreviation “REY” includes the lanthanides plus scandium and yttrium. Seredin and Dai (2012) explained the significance of coal deposits as potential sources for REY because the abundances of those elements in coal are similar to their concentrations in conventional REY deposits. Research on REY from coal has been studied by many authors (Ezkenazy, 1987; Seredin, 1996; Seredin and Finkelman, 2008; Dai et al., 2011; Dai et al., 2012; Seredin and Dai, 2012; Dai et al., 2016; Dai et al., 2017; Zheng et al., 2017; Dai and Finkelman, 2018, and others).

According to Seredin and Dai (2012), there are four types of REY enrichment in coal basins. These types are (1) terrigenous, (2) tuffaceous, (3) infiltration, and (4) hydrothermal. Indonesia has huge coal resources, around 140.47×10^9 tons (Handbook of Energy and Economic Statistics of Indonesia, 2017) and one of the most prolific coal basin is the South Sumatra Basin (SSB). Volcanic activity in Sumatra during Paleogene–Neogene to Quaternary time has been reported to have occurred in three semi-continuous cycles; late Oligocene–mid Miocene, mid Miocene–early Quaternary, and late Quaternary (van Bemmelen, 1949). This activity influenced paleomire and coal deposition not only in the SSB but also across all of Sumatra (see Fig. 1) and may resulted tonstein layer. Tonsteins are thin, distinctive, widespread clay bands or partings that are associated with coal beds (Triplehorn, 1990). Recently, research on tonstein are widely conducted mainly for their composition of tonstein and the effect on mineralogical and elemental variation of coal (Spears et al., 1988; Goodarzi et al., 1990; Ruppert and Moore, 1993; Pollock et al., 2000; and others) and as a marker bed (Zhou et al., 1982; Addison et al., 1983; Lyons et al., 2006). Hower et al. (1999) pointed out that coal near contacts with tuffaceous sedimentary rocks (tonsteins) is enriched in REY. Pujobroto (1997) reported several tonstein layers in the Banko coalfield in the SSB. However, there have been no studies on the geochemistry of the coal near the tonstein layers, thus the objective of this study is to examine the geochemical characteristics of the coals near the

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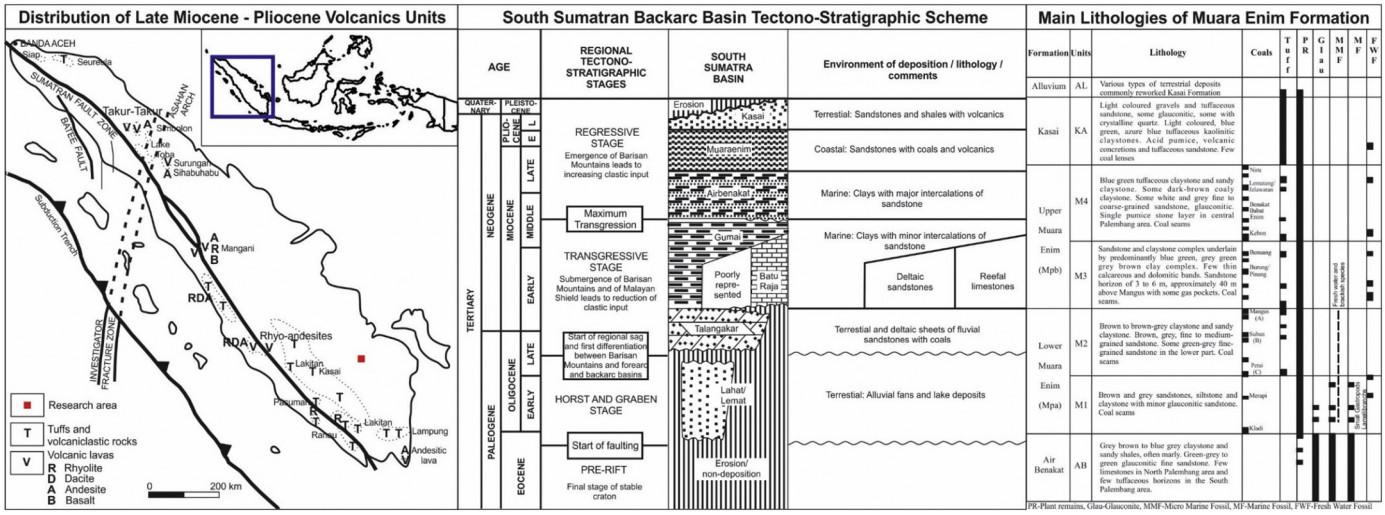

Fig. 1. Distribution of late Miocene–Pliocene Volcanic Units (Crow, 2005), South Sumatran Backarc Basin Tectono–Stratigraphic Scheme (de Smet and Barber, 2005), and Main Lithologies in the Muara Enim Formation (Shell Minjbouw, 1978).

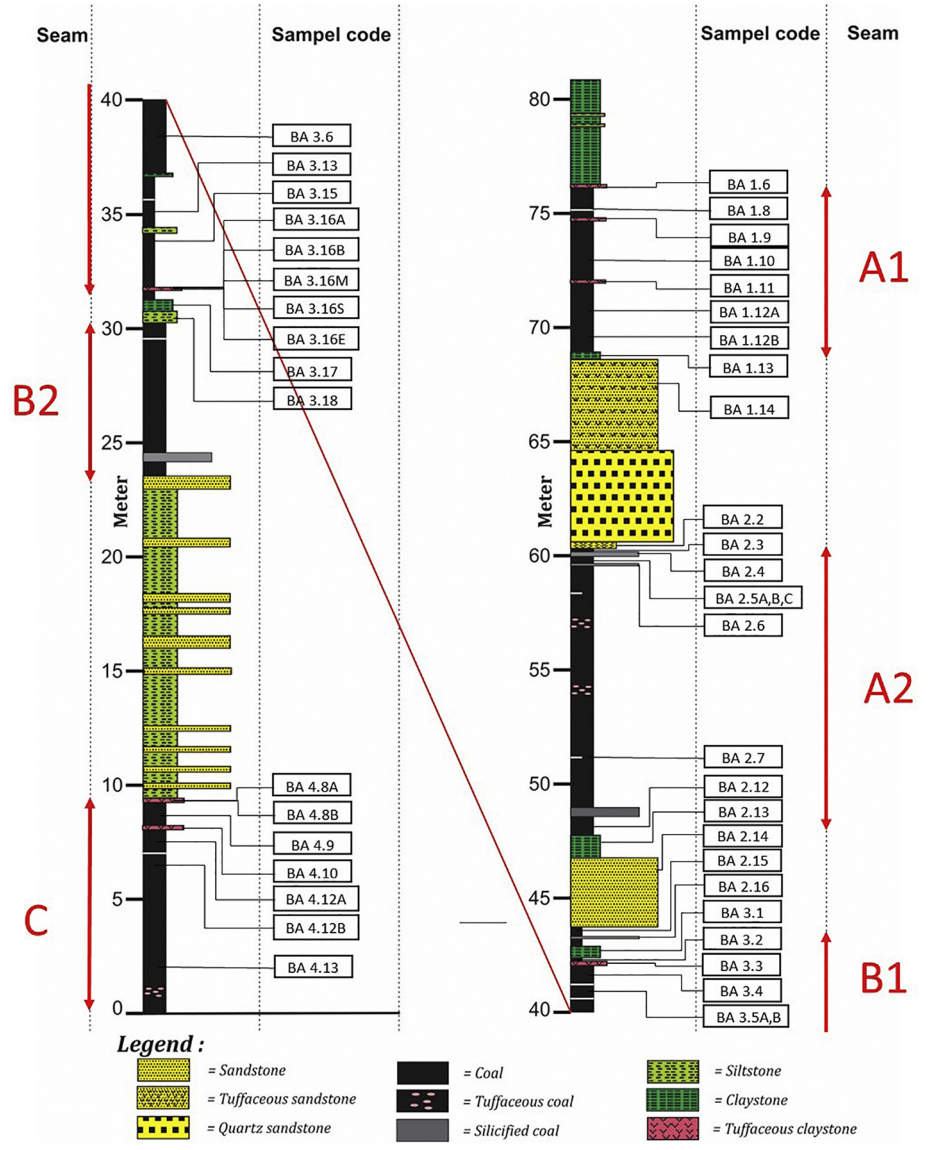

Fig. 2. Measured section for a portion of the Muara Enim Formation in the Banko coalfield showing the named coal seams (A1, A2, B1, B2, C). Sample locations are indicated by the "BA" numbers.