

Minerals and potentially hazardous trace elements in the Late Triassic coals from the Qiangtang Basin, China

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ABSTRACT

The Tumen coal mine has the largest coal resources in Tibet, which have been developed and utilized as an important energy source in the last decades. It has raised some health problems during the coal exploration and utilization in Tibet. Fifty Late Triassic coal (or coaly) samples were picked up from the Qiangtang Basin (Tumen mine, Woruoshan and Hongshuihe areas) to determine the minerals, potentially hazardous elements and their mode of occurrence and possible sources. Coal samples from the Qiangtang Basin have medium- and high-ash yields (15.20–47.88%) with low or medium-high total sulfur content (0.04–4.86%). Minerals in Qiangtang Basin coal include clay minerals, dolomite, quartz, pyrite, siderite, and hematite, and trace amounts of halite, feldspar, anhydrite, barite, chromite, and galena. Potentially hazardous trace elements in coal samples include As, Hg, Pb, and Se. Arsenic is controlled mainly by aluminosilicate minerals. Mercury occurs mainly as an organic-bound form. The organically bound Pb is dominant. Selenium is controlled mainly by Fe-bearing (probably pyrite). A proportion of the elevated concentrations of As, Hg, Pb and Se in Qiangtang Basin coal may be related to underlying shale bed. These elements might have been eroded or leached from the shale bed, which were subsequently transported and accumulated syngenetically in the coal-forming peat swamps. The enrichment of As, Hg, Pb, and Se in Qiangtang Basin coal, however, is also partly to be related to magmatic/hydrothermal fluids.

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1. Introduction

Tibet, with no commercial accumulation of oil and/or gas, has a limited energy source compared to its neighboring provinces such as Sichuan, Qinghai and Xinjiang. The Tumen coal mine has the largest coal resources in Tibet. In the last decades, the coal from the Tumen mine had been developed and utilized as an important energy source. The coal (or coaly) deposits of the Tumen mine are the Late Triassic sequences, which are widespread in the Qiangtang Basin and the eastern part of Tibet, containing about 0–10 m (some places up to 20 m) and 0–5 m of coals (Wang et al., 2009), respectively. Currently the Tumen coal mine has been shut down due to bad weather, traffic inconvenience, and poor quality of coal. However, the Late Triassic coal is still one of the primary energy sources for many people around the mines in the Qiangtang Basin and the eastern part of Tibet today. Additionally, several Late Triassic coal mines are still working in the Sichuan province, south-west China.

It has raised some health problems during the coal exploration and utilization in Tibet, especially for those living in the vicinity of the

coalfield (Notes of Survey Team, 2009). The ground water resources have been deteriorated in the Gangni country around the Tumen coal mine. Lung disease cases have also been reported for miners in the Tumen mine (Notes of Survey Team, 2009). These environmental and human health problems may result from potentially hazardous elements in coal (e.g., Bencko and Symon, 1977; Dai et al., 2008, 2012a; Ding et al., 2001; Finkelman et al., 1999; Zhao et al., 2008). Gupta (1999) proposed that some potentially hazardous elements are immobile in the pre-mining stages, but with the initiation of mining activities, they tend to be dispersed into the surrounding environment and contaminate the soil, atmosphere, and surface and ground water resources of the area. Systematic studies of the potentially hazardous elements in coal are therefore necessary to determine the possible environmental impact of coal exploration and utilization.

In this paper, the contents of 41 trace elements in coals from the Qiangtang Basin are firstly reported. The objective of present study is to determine the minerals, potentially hazardous elements and their mode of occurrence in coal from the Qiangtang Basin, which is helpful to determine possible environmental and health impacts of coal exploration and utilization. Meanwhile, it can provide references for environment-friendly utilizing the Late Triassic coals. The present study also aims to generate scientific information on the trace elements in the Late Triassic coal which is of interest for coal geochemist. The enrichment sources of trace elements in Qiangtang Basin coal are also explored in this study.

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2. Geological setting

The Qinghai–Tibet Plateau constitutes a collage of continental blocks or terranes which are from north to south, the Kunlun–Qaidam terrane, Songpan–Ganzi flysch complex, Qiangtang terrane and Lhasa terrane. These terranes are separated by the east–west striking Anyimaqen–Kunlun–Muztagh, Hoh Xil–Jinsha River and Bangong Lake–Nujiang River suture zones, respectively (Fig. 1a). It is generally accepted that the Palaeo-Tethys Ocean represented by the present-day Jinsha River suture opened in about the Early Carboniferous and was closed by the Permian to latest Triassic (Dewey et al., 1988; Kapp et al., 2003; Nie et al., 1994; Pearce and Mei, 1988). A Meso-Tethyan seaway between

the Lhasa and Qiangtang terranes was open by the Early Jurassic and closed along the Bangong Lake–Nujiang River suture during the Late Jurassic (Girardeau et al., 1984; Kapp et al., 2003; Pearce and Mei, 1988; Tang and Wang, 1984; Yin and Harrison, 2000).

The Qiangtang terrane, bounded by Hoh Xil–Jinsha River suture zone to the north and the Bangong Lake–Nujiang River suture zone to the south, consists of the South Qiangtang depression, the central uplift and the North Qiangtang depression (Fig. 1b). Between the Qiangtang block to the south and Eurasia to the north was the Paleo-Tethys Ocean. This ocean was consumed by northern subduction beneath the Kunlun terrance during the Permo-Triassic time and southward subduction beneath the Qiangtang terrance during the Middle–Late Triassic

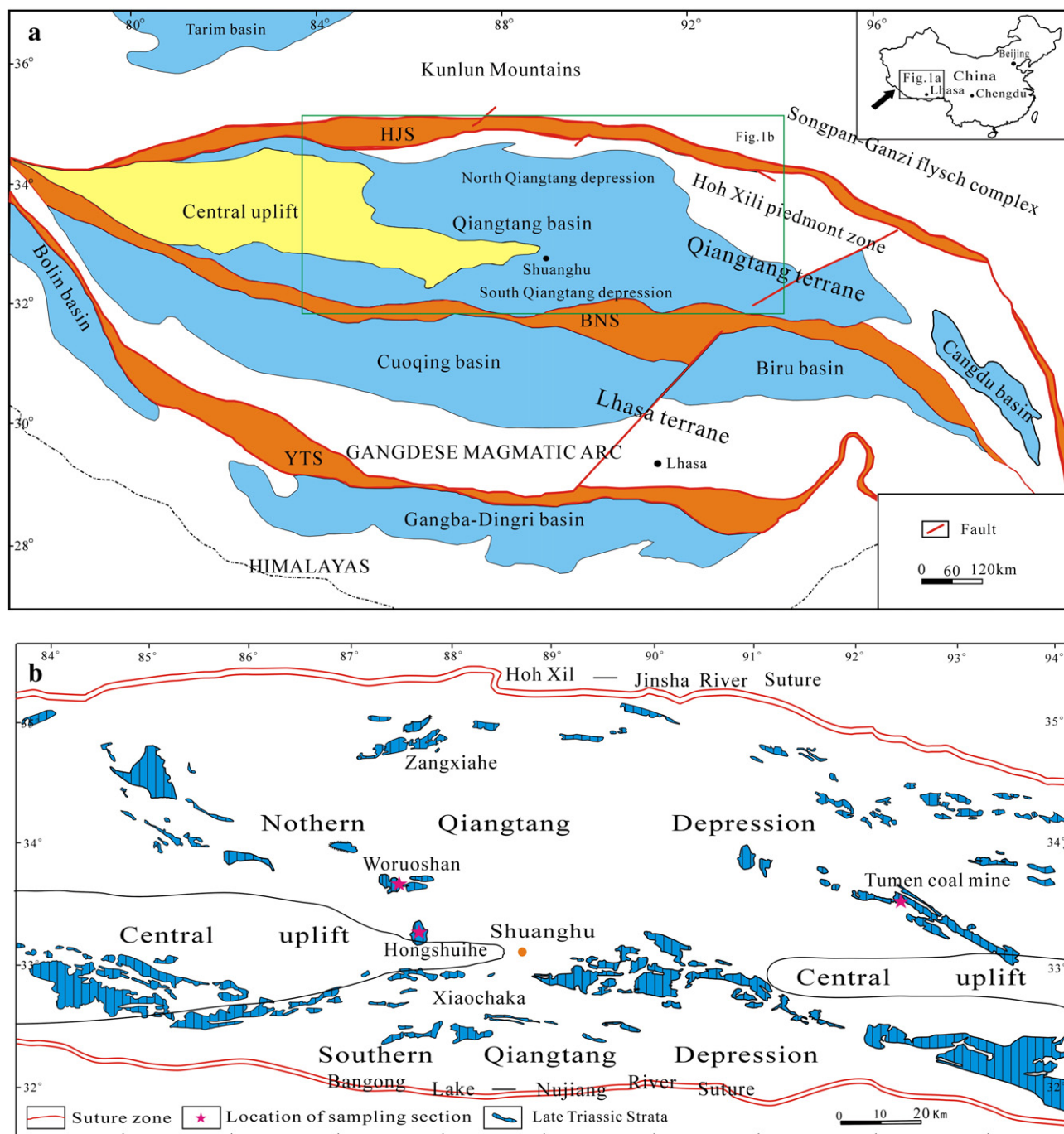


Fig. 1. (a) Map of the Qinghai–Tibet Plateau showing major terranes and terrane boundaries. HJS, Hoh Xil–Jinsha River suture; BNS, Bangong Lake–Nujiang River suture; YTS, Yarlung Tsangpo suture. (b) Distribution of the Late Triassic strata in the Qiangtang Basin showing the location of sampling section.

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