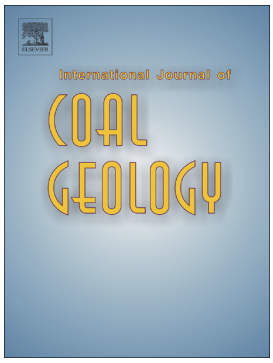

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Enrichment and distribution of elements in the Late Permian coals from the Zhina Coalfield, Guizhou Province, Southwest China

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Abstract

This paper investigates the mineralogy and geochemistry of four coal beds (WJB-6, WJB-7, FHS-23 and FHS-27 Coals) of the Late Permian in the Zhina Coalfield, western Guizhou Province, China. The investigated coals reach the semianthracite -anthracite coal rank and have super-low to low ash yields. The sulfur contents vary considerably through coal sections and are mostly in the range of medium-high sulfur coal. The mineral assemblage present in the FHS-23 and FHS-27 Coals is mainly made up of pyrite and rectorite; the WJB-6 and WJB-7 Coals have different mineralogy, with kaolinite and rectorite dominant in the former as well as quartz and rectorite in the latter. These coals contain high concentrations of Nb and Ta, but Li is only enriched in the WJB-6 Coal. Rectorite and anatase in these coals are important hosting phases of Nb and Ta while kaolinite, and to a lesser extent chamosite in the WJB-6 Coal, are dominant carriers for the elevated Li concentration.

The terrigenous material input, the marine influence and the effect of circulating hydrothermal solution are the pivotal geological factors causing geochemical anomalies in coals investigated. The high-sulfur coals were subjected to an enhanced marine influence in the depositional environment, as well as to a higher terrigenous influx, when compared with the medium-sulfur and low-sulfur coals, resulting in higher concentrations of S-Fe-As-Mo-U-Hg in the former coals than in the latter ones. The anomalous enrichment of Nb and Ta in these coals, as well as of Li in the WJB-6 Coal, is the result of the contributions from ascending hydrothermal solutions, although source rocks (e.g., high-Ti basalt) may provide relatively high background abundances of Nb, Ta and Li.

Key words: Geochemistry; Longtan Formation; Late Permian coal; western Guizhou Province

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1 Introduction

The anomalous enrichment of some rare-metal elements (e.g., rare earth elements, Nb, Zr, Hf, Ga) in the Late Permian tonsteins preserved within coal-bearing strata in southwestern China has been extensively documented by Burger et al. (1990), Dai et al. (2010, 2011, 2014a), Zhao et al. (2017) and Zhou et al. (2000) and references therein. However, the tonstein-hosted rare-metal deposits attracted little attention as raw materials of rare metal recovery, due to the thin thickness (generally 3-10 cm) of intraseam tonstein layers (Dai et al., 2016a; Hower et al., 2015a; Seredin and Dai, 2012), but it probably provides a basis for predicting the occurrence of tuffaceous polymetallic deposit of volcanic ash outside of coal seams (Dai et al., 2011; Seredin and Finkelman, 2008). For example, linked to tonstein studies, Dai et al. (2010) found the Nb-Zr-REE-Ga polymetallic mineralization in tuffaceous horizons with thickness up to 10 m in eastern Yunnan Province, and subsequently, such rare-metal deposits were investigated by Zhao et al. (2016a, 2016b, 2017). Meanwhile, the Late Permian coals in southwestern China are also reported as having the highly-elevated concentrations of REEs, Nb and Zr in the Huayingshan Coalfield (Zhuang et al., 2012; Dai et al., 2014b), Songzao Coalfield (Dai et al., 2007), Guxu Coalfield (Dai et al., 2016b), and Moxinpo Coalfield (Dai et al., 2017), and of Ti, Nb and Ta in the Liuzhi Coalfield (Li et al., 2016), as well as of U-Mo-V-Cr-Co in the Yanshan, Heshan, Guiding and Moxinpo Coalfields (Dai et al., 2008a, 2012a, 2013, 2015a, 2016a, 2017; Liu et al., 2015; Shao et al., 2003; Zeng et al., 2005). Recently, Dai et al. (2016c)