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The relationships between trace elements and organic matter in coals

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Trace elements (TEs) in coals have aroused constant concern of coal geologists and geochemists globally, especially environmentally sensitive or economically valuable elements. Related scientific issues such as their contents, distributions, modes of occurrence, and origins have been studied extensively [1,2]. Among them, modes of occurrence of TEs answer how elements occur in coals, which can help to minimize their hazardous release into the environment during coal utilization, and are also key parameters to consider when attempting to develop potential extraction procedures for precious metals (e.g., Ge, Ga, Li, REY and PGEs) from coal or coal combustion byproducts [3]. In general, trace elements present inorganic, organic, and mixed associations with coal components. For most TEs, much more is known about the mineral matter associations than about the organic associations in coal. In contrast, for the relationships of organic matter with TEs in coals, what we known are limited.

The occurrence of TEs in organic components of coals is often inferred from indirect methods including correlation coefficients analysis, density fractionated experiment, and sequential chemical extraction procedures, etc. Some microanalysis techniques usually performed on macerals, such as electron and ion-beam methods, as well as spectroscopy methods, can provide useful information about the chemical associations, and even the bonding and local structure of a TE in coals [4]. Although some organic functional groups, mainly carboxylic acid, phenolic hydroxyl, and other polar ligand donors, are postulated to bond trace elements in coals, direct evidences are still deficient so far.

A majority of TEs show more or less associations with organic components in coals. Based on the current research advances related to the relationships of organic matter with TEs in coals, it can be concluded that some TEs such as Ge, U, Ga, REEs, Be and B in coals have close organic relationships, and their occurrence, distribution, and enrichment are even controlled by organic matter under certain geological conditions [5,6]. A few TEs including Rb, Cs and Tl show scarcely affinity to organic matter. Other many TEs such as Li, Sr, Ba, Cr and Hg have both organic and inorganic associations in coals. Normally, the active role of organic matter on the accumulation of TEs played during the peat accumulation and/or humification–gelification stages, however, can also happened in the later coalification process. This review may help the understanding of the organic associations with trace elements in coals and provide suggestions of the future studies.

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