Mineral Association and Spatial Distribution of Rees in Samples of Coal and Coal Adjacent Strata

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Abstract

Rare earth elements (REE) are crucial components to billions of products worldwide. They are relatively abundant in crustal rock, and are found in sufficient quantity, quality, and concentrations in surficial deposits. Despite this, identifying domestic REE resources has proved challenging. Transitioning from foreign to domestic sources of REE requires utilization of both primary (i.e. carbonatites and alkaline igneous rocks, pegmatites, skarn deposits) and secondary (i.e. ion adsorption clays, placer deposits, weathered rock, black and/or oil shales) source materials known to contain viable amounts for industrial processing. Coal-bearing strata have identified as a promising REE secondary resource (i.e. has undergone weathering and sedimentary processes) and is the focus of this study. Understanding the mineral association of REEs in secondary resources is needed to quantify an REE resource volume and identify viable mineral separation and processing techniques. Within primary and secondary source deposits, REEs have been documented as concentrated in the minerals: bastnasite, monazite, xenotime, loparite, apatite, and clays. Bastnasite, monazite, and xenotime from both primary and secondary sources make up 95% of the world's REE reserves . To better understand REE-bearing minerals and their spatial distribution in coal and coal adjacent strata, ten REE-enriched samples were selected that contain >750 ppm REEs as measured by pXRF. Scanning electron microscopy (SEM – FEI Quanta instrument) was used to image different fields of view of samples. Specifically, backscatter electron (BSE) images revealed micron- to nano-scale mineral density and morphology that allow for mineral identification. BSE images were coupled with elemental maps of the same field of view, generated using Energy Dispersive X-ray Spectroscopy (EDS/EDX). SEM-EDS data interpretation allows for a determination of REE-mineral association in the REE-enriched sample dataset. Preliminarily, REE-enrichment in coal and shale samples is found in 1) a coarser grain size fraction (10 – 50 μm) of Ba- and Ti-enriched grains, and 2) a finer grain size fraction (< 4μ) dispersed in the sample matrix. Findings suggest possible REE enrichment from silt to sand size detrital grains, clay minerals and organic matter sources.