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Native neutrophilic coal bacteria- A potential tool for extraction of trace elements and Rare Earth Elements

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Coal is an abundant fossil fuel composed of inorganic and organic matter. The inorganics host variable concentrations of environmentally sensitive trace elements. During combustion, trace elements are liberated as gas, while majority concentrates in ash, contaminating the soil and local water bodies through leaching. Although the concentration of REEs in coal is usually much lower than the current commercial deposits. However, some coal and coal byproducts have elevated concentrations of HREEs. HREEs are the least abundant, have high rankings for criticality and price, and are anticipated to undergo an increased demand. As a result, coal and its products could be attractive targets for REE recovery. Coal remediation is aimed to reduce the inorganic content of coal, remove potentially hazardous elements, extracts economically valuable elements and also increase the calorific value of coal.

Bacteria is an eco-friendly remediation tool. Neutrophilic bacteria facilitate the treatment at mild pH and ambient temperature. Native bacteria expedite the process by readily adapting to the substrates. In this study, the remediation potential of three native neutrophilic coal bacteria have been investigated. In six days of treatment, the *Bacillus* sp. has reduced ash yield by 15.96%, trace element by 26% to 75%, and REE by 24% to 50%. *Bacillus anthracis* has exhibited reductions in ash yield of 22.6%, trace element of 6.4% to 70.5%, and REE of 8.4% to 37%. Maximum ash yield reduction of 22.91% was attained by the *Cronobacter* sp., including reduction of 8.1% to 73% of trace elements and 26% to 48% of REEs. The FTIR spectra exhibits shifting in peak position and intensity of several functional group corresponds to the removal of element, formation of new bonds, and the elimination of few functional groups due to treatment. In XRD spectra, appearance of Jarosite and metal sulphate precipitates in treated coal samples, exhibit the signature of the bio-oxidation of pyrite. Considering an encouraging result with these experiments, these neutrophilic native bacteria can be considered a potential tool for REE and trace elements extraction. Nevertheless, the obtained results encourage further research on the effectiveness of these bacteria on diverse coal types to assess their performance.