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Extraction of uranium associated with Springbok Flats coal samples

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ABSTRACT

The presence of coal in the Springbok Flats Coalfield (SFC) has been known since the beginning of the 1900's. The SFC has not been mined to any degree of economic profit, in part because of the presence of uranium (U) present in the coal. The motivation behind this study is the limited research on the amount of U that is associated with coal, as well as the quality of coal that is associated with the U. Concurrently, there is limited research focusing on the leaching of U from southern African coals in separating the two commodities.

Five boreholes (BH) were drilled in the SFC (BH1 to BH5); BH5 had two coal zones, an upper coal zone (UCZ) and a lower coal zone coal (LCZ). Coal samples were collected, selected and characterized. The U content in the coal samples was determined using Inductively Coupled Plasma Mass Spectrometry, Instrumental Neutron Activation Analysis, and X-Ray Fluorescence. Thereafter, coals with U content greater than 10 mg kg^{-1} were selected, and an extraction/leaching process was applied using sulfuric acid.

Coal samples from BH1, the UCZ in BH5, and the LCZ in BH5 has an ash content over 50% average. These boreholes samples were considered to be primarily carbonaceous mudstones. BH2 resembled a typical South African bituminous coal, recording a carbon content ranging from 27.88% to 65.28%, averaging 44.6%; volatile matter and calorific values averaged 24.3% and 18.2 MJ/kg respectively. BH3 and BH4 had horizons with relatively good quality coal, where the carbon content and volatile matter averaged 38% / 39.7% and 22.4% / 15.1% respectively. BH3 had the highest U content average of all the borehole coal zones, registering 33 mg kg^{-1}, followed by BH2 (26 mg kg^{-1}) and BH1 (14 mg kg^{-1}). BH4, the UCZ in BH5, and the LCZ in BH5 all had U content averages less than 10 mg kg^{-1}. 11 samples containing U content higher than 10 mg kg^{-1} were selected for leaching. The samples were successfully leached with U content ranging from 4 μg L^{-1} to 1789 μg L^{-1} obtained in the leachates. Three samples with a U content higher than 50 mg kg^{-1} were selected to be leached under optimal conditions; U extraction increased under optimal conditions. The highest increase in U content was 106% from 1186 μg L^{-1} to 2438 μg L^{-1} leached into solution. Cake results displayed the U was successfully extracted using sulfuric acid, reaching a maximum of 50.7%, when leached at 5 M, and a 67.3% maximum when sample were leached at 10 M.