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Geochemical baselines and metal deportment in the upper Olifants Primary Catchment by using stream sediment geochemistry, Witbank Coalfield, South Africa

Netshitungulwana, R.[1], Gauert, C.[2], Vermeulen, D.[3], Yibas, B.[1], Novhe, N.O[4]

[1]Department of Economic Geology, Council for Geoscience, 280 Pretoria Road, Silverton, 0184 South Africa

[2]Department of Geology, University of the Free State, 205 Nelson Mandela Drive, Parkwest, Bloemfontein, 9300

[3]Institute for Ground Water Studies, University of the Free State, 205 Nelson Mandela Drive, Parkwest, Bloemfontein, 9300

The Olifants primary catchment area, consists of nine sub-catchments marked from B1 to B9, extends over the border between South Africa and Mozambique, and has a total area of approximately 87000 Km^2. The B1 catchment, where most of the mining activities surround the major towns of Witbank (Emalahleni) and Middleburg, in turn straddles the provinces of Mpumalanga and Limpopo. Although industrial and agricultural activities are also important, the contribution of contamination from the mining activities within the catchment is significant as the result of intense mining of various mineral commodities such as coal and from ferrochrome processing plants located in Emalahleni and Middleburg towns within the catchment area and yet not fully quantified.

This paper investigates the metal baselines and deportment with implications on the severity of the mining impacts on the water resources and the ecosystem of the catchment area in particular. The paper discusses the results of research, which focused, on deciphering the severity and the sources of water contamination, and on the relationship of the water quality and metal loadings on the sediments. Stream sediment and water samples have been collected and analysed. The sediments were analysed by Simultaneous X-Ray Fluorescence technique for metal loadings. The areas were marked by anomalous level determined at 50th percentile threshold of Fe, Mn, Ni, Cr, Co, V, Pb in Emalahleni and Al, Fe, Mn, Cr, As, Zn, Pb and U in Middleburg. The ICP-MS and IC analytical techniques were used in the assessment of water quality data. From the stream sediments regional geochemistry at catchment level and for this investigation, the sediments that were found marked by high levels of Na, K, Mg, Al, Ca, Mn, and Fe signature, can be attributed to the coal mines as a probable source. Whereas the sediment quality of the areas like Emalahleni and Middleburg towns, where mining of coal (with many abandoned mines) and ferrochrome processing is happening simultaneously, there are anomalous level of Cr, Ni, V and As, which is a signature of the Bushveld PGE mines material.

The study shows that the stream water and streambed sediments are impacted by operating mines, abandoned mines and the unattended mine residue deposits up-stream. The sediments with anomalous concentration of Al, Mn and Fe are probably sourced from coal whereas Cr, Ni and V are indicative of mafic rocks sources. The water samples form the most streams in the catchment has pH that is ranging from near neutral to alkaline conditions and at this condition most metals get adsorbed onto the sediments. Streams like Brugspruit and Klipspruit show low levels of Mn in the sediments, which may suggest most of the Mn is still in concentrated in water. The uranium anomaly of between 452 mg/kg and 1898 mg/kg located in Area A of the B1 catchment area may be derived from the processed Bushveld material upstream. The $SO4^{2-}$ concentration of above 500 mg/kg on the water quality, which has exceeded the Department of Water Affairs water quality guideline for domestic and industrial use, is

an evidence for contamination. The approach adopted herein suggests that the stream sediment and water quality data can be used in characterizing or fingerprinting impacted areas.