Geochemical Investigation of Metals and Trace Elements around the Abandoned Cu –Ni Mine Site in Selibe Phikwe, Botswana

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Metals and trace elements may occur naturally in rocks and soils, but elevated quantities of them are gradually released into the environment by anthropogenic activities such as mining. In order to address issues of trace element water and soil pollution, a distinction needs to be made between natural and anthropogenic anomalies. The current study aims at characterizing the spatial distribution of trace elements and evaluate site-specific geochemical background concentrations of trace elements in the mine soils and river sediments and also to discriminate between lithogenic and anthropogenic sources of enrichment around a copper-nickel mining town in Selibe-Phikwe, Botswana.

A total of 43 soil, 30 river sediments, and 9 river water samples were collected from an area of 500m2 within the precincts of the mine. The total concentration of Cu, Ni, Pb, Cr, As, and Co in soils and sediments were determined using ED-XRF while river water samples were analyzed by ICP-AES. Geochemical pollution indices such as Geo-accumulation Index (Igeo), Enrichment Factor (EF) and Integrated Pollution Index (IPI) were employed for the assessment of metal and trace element contamination. The average metal concentration in soil of Cu, Ni, Pb, Cr, As, and Co in the study area were 73.27, 78.10, 25.83, 61.43, 4.28 and 6.43 mg/kg, respectively. To calculate the geochemical baseline, Relative cumulative frequency curves and the 4 s -outlier test methods suggested by Matschullat (2000) were incorporated. The estimated average baseline concentrations of Cr, Cu, Ni, Co, Zn and As are 53.8, 51.85, 53.95, 5.6, 32.36 and 4.27 mg kg 1, respectively. Soil leachate, sediment leachate, and river water pH levels ranged from basic (9) to very acidic (3) in areas closer to the mine. There is high variation in heavy metal concentration, eg. Cu, depicting regional natural background concentrations while others depict anthropogenic sources. The calculated Igeo values revealed moderate pollution level by the same metals. The result of integrated pollution indices suggested a generally deteriorating site quality. The results of chemical analysis also indicate that the trace elements in soils decreased with respect to distance from the mine; controlled mainly by water movement, wind direction, and topography.

Keywords: Soil Contamination, Geochemical baseline, Pollution indices, Trace elements

