

University of Venda  
School of Environmental Sciences  
Department of Mining and Environmental Geology



**Investigation of the Origin, Distribution and Potential Impacts  
of Heavy Metals within and around Polokwane City and  
Ebenezer Dam, Limpopo Province, South Africa**

**By**

**Mundalamo Humbulani Rejune  
(Student No.9906682)**

**A Dissertation Submitted in Fulfillment of the Requirements  
for the Degree of Master of Earth Science in Environmental  
Geology**

**Supervisor: Prof. J.S. Ogola  
Department of Mining and  
Environmental Geology, University of  
Venda**

**Co-Supervisor: Dr. G. Brandl  
Council for Geoscience  
Polokwane**

**June 2010**

**UNIVEN LIBRARY  
Library Item : 20103542**



## ABSTRACT

The investigation of the origin, distribution and possible impacts of Pb, Zn, Cu, As and Cr was done within and around Polokwane city and Ebenezer dam and its environment. For this purpose, the study incorporated fieldwork that involved random soil sampling to ascertain anomalous targets, systematic soil sampling over anomalous targets, sediment sampling along streams that run through or near the anomalous targets, rock specimens collection within anomalous targets and water sampling along the shore-line of the Ebenezer dam. The work was done in two phases; Phase 1 and Phase 2. The Atomic absorption spectrometer was used to analyse the concentrations of Pb, Zn, Cu, As and Cr in soils, sediments and water and X-Ray fluorescence spectrometer was used to analyse soils and rock samples.

The concentrations of Pb, Zn, Cu, As and Cr from soil samples revealed 5 and 7 anomalous sites in Polokwane and Ebenezer areas respectively. For example, anomaly 3 in Polokwane indicated maximum concentrations of Pb, Zn, Cu, As and Cr in soils of 1082, 61, 58, 39, and 765 ppm respectively. Similarly, anomaly 1 at Ebenezer area showed concentrations of Pb, Zn, Cu, As and Cr in soils to be 57, 157, 313, 73, and 888 ppm respectively.

The concentrations of sediments along the streams appeared to be high near the anomalies, but decreased downstream. For example, the stream passing near anomaly 1 in Ebenezer had Pb values of 7, 12, 14, 12, 8 and 5 ppm downstream. The concentration levels of heavy metals in water was found to be below the detection limit of AAS which was less than 0.01 ppm for Pb, Zn, Cu and Cr and less than 1.0 ppm for As. Thus, it was concluded that the distribution of heavy metals in this area was localized within and around the source rock or anomalies.

The Petrological studies and whole rock geochemical analysis revealed the nature and characteristics of rocks that were collected over the anomalies in Polokwane and Ebenezer areas. The rocks in Polokwane were felsic and mafic, namely; porphyritic

granite and amphibolite. In Ebenezer, they were felsic, comprising granite, pegmatite and quartzite. A comparison of the abundance of trace elements in rocks of the area with mean trace elements abundance in major rock types confirmed that the rocks forming the anomalies were either mafic or felsic. The study concluded that these rocks were responsible for the high concentrations of Pb, Zn, Cu, As and Cr in Polokwane and Ebenezer areas.

The determination of the soil pollution index registered Pi values of 1.3 and 1.5 for Cr in soils from Polokwane (anomaly 3) and from Ebenezer (anomaly 4) respectively. This indicated that the soils at these localities were lightly polluted, thus not suitable for agriculture which is the main activity in the area, and can be of risk to human health. The study recommends phyto-remediation measures to extract Cr from soils of the identified target areas.

Determination of heavy metals, pH values and electrical conductivity of water samples from Ebenezer dam indicated that the water was suitable for domestic and agricultural use, livestock watering, aquatic ecosystem and recreational use.