Application of GIS Interpolation in assessment of a gold tailings dam

O., Abegunde; C., Wu; C.D., Okujeni; and A., Siad

Department of Earth Science, University of the Western Cape., Bellville, Cape Town. South Africa

Correspondence to: cokujeni@uwc.ac.za

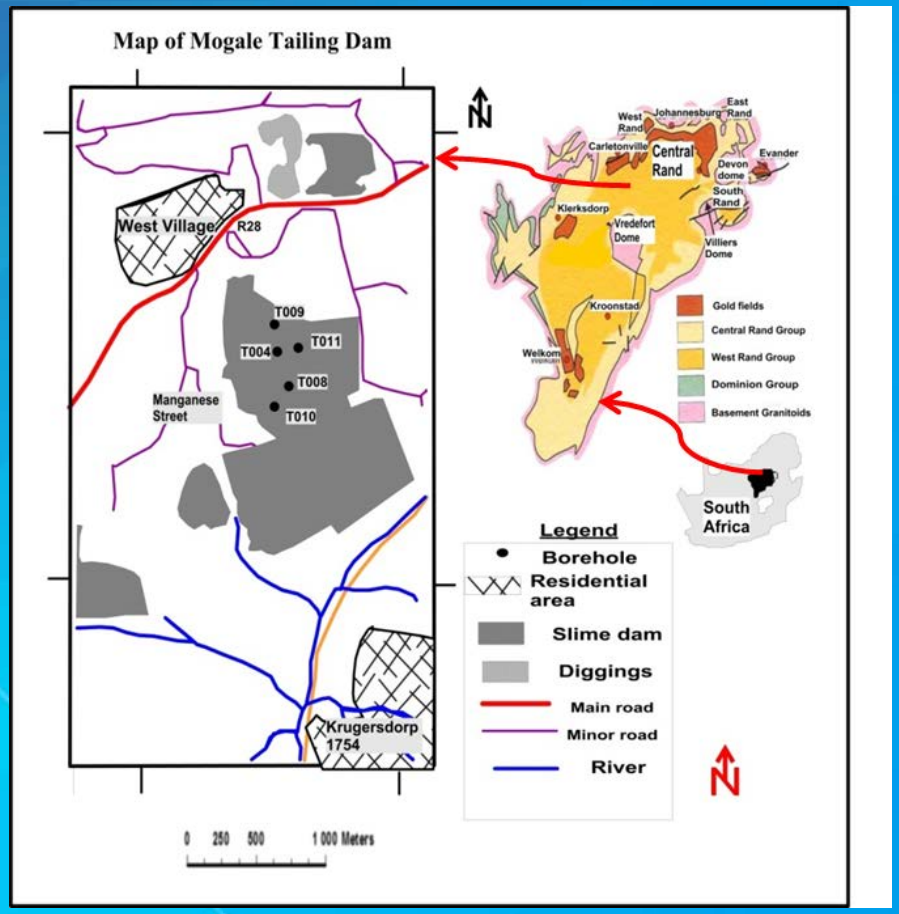
OUTLINE

- Study aim
- Map of Study Area and AMD transport
- Methodology
- Results
- Interpretation
- Conclusion

STUDY AIM

- Distribution patterns of trace elements of potential threat to the environment and assessed the oxidation trend within the tailing dam using IDW Interpolation

DIGITALIZED MAP OF THE STUDY AREA



Using Arc GIS, the map of the study area showing the sampling points was done

MODE OF AMD TRANSPORT

WHY IDW INTERPOLATION

- IDW gives a bull’s eye view
- It gives a general insight on what to expect spatial distribution of elements
- Individual elements can be analyzed for

METHODOLOGY

Methodology

Sample Collection(using auger)/ logging of drilled holes

(Five holes were drilled through the tailing dam to a depth of 10 meters and sampled at one meter interval.)

Sample preparation and Analysis

Drying and milling

Major and ultra trace element analysis (XRF/ICP MS

Paste pH and EC

Determination of Mineral composition (XRD)

Data compilation and analysis

Petrography result

Evaluation of Geochemical results

Description of drilled hole

Mineralogy

Data summary

Multivariate Statistics

GIS interpolation

Mass balance analysis

(Zhang & Selinus, 1998; Alkarkhi, et al., 2009)

(Mukherjee & Gupta, 2008; Lopez-Moro, 2012).

Integration of results

ASSESSMENT

PREDICTION

INTERPOLATION METHOD

- The spatial analysis of the data in which was done using Arc Map 10 software.
- The data was subjected to the Inverse Distance Weighted Analysis for the distribution of individual elements in layers of 1m down depth.
- An excel sheet containing the coordinates of each drill hole was converted into a shapefile (saved as drillhole) and geo-referenced into the coordinate system of the base map (map of the study area) used.
- Using the data management tool in the arc tool box, IDW interpolation method (Setianto & Triandini, 2013) was used.
- The input point feature was the drillhole, the Z-value field is the element analysed for. This was done for each meter (1-9).
- The layer properties of the IDW interpolation is displayed with classified symbology with polychromatic colour.
- The distribution of value of element was based on quantile range and four classes with none normalisation.
- The layer display is exported as a jpeg and all display for each element is displayed from 1-9m.

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

Editor | Geostatistical Analyst

1:2,466 | Drawing | Arial | 10

Georeferencing | Layer: phunox2

ArcToolbox

- Parcel Fabric Tools
- Schematics Tools
- Server Tools
- Spatial Analyst Too
  - Conditional
  - Density
  - Distance
  - Extraction
  - Generalization
  - Groundwater
  - Hydrology
  - Interpolation
    - IDW
    - Kriging
    - Natural Ne
    - Spline
    - Spline with
    - Topo to Ra
    - Topo to Ra
    - Trend
  - Local
  - Map Algebra
  - Math
  - Multivariate
  - Neighborhood
  - Overlay
  - Raster Creatio
  - Reclass
  - Solar Radiation
  - Surface
  - Zonal
- Spatial Statistics To
- Tracking Analyst To

Table Of Contents

- Layers
  - Sample_point
  - phunox2
    - 3.55
    - 3.55 - 3.93
    - 3.93 - 5.29
    - 5.29 - 8.69
  - phred
    - 2.86 - 3.45
    - 3.45 - 3.93
    - 3.93 - 5.29
    - 5.29 - 8.69
  - phunox1
    - 2.61 - 3.45
    - 3.45 - 3.93
    - 3.93 - 5.29
    - 5.29 - 8.69
  - phtrans
    - <VALUE>
    - 3.45
    - 3.45 - 3.93
    - 3.93 - 5.22
    - 5.22 - 8.69
  - ph2
    - <VALUE>
    - 3.12 - 3.45
    - 3.45 - 3.93
    - 3.93 - 5.29

IDW

Input point features: Sample point

Z value field: SiO2

Output raster: C:\Users\Abegunde Oluseyi\Documents\ArcGIS\Default.gdb\Idw_shp13

Output cell size (optional): 6.66800000000478E-06

Power (optional): 2

Search radius (optional): Variable

Search Radius Settings

Number of points: 12

Maximum distance:

OK | Cancel | Environments... | Show Help >>

0 50 100 200 Meters

27.764 -26.129 Decimal Degrees | 6.43 2.34 Inches

Load of sand suspected to be gypsum leached downward and gullies from the top of the tailings dam surface from the base of the dam

RESULTS (PETROGRAPHY)

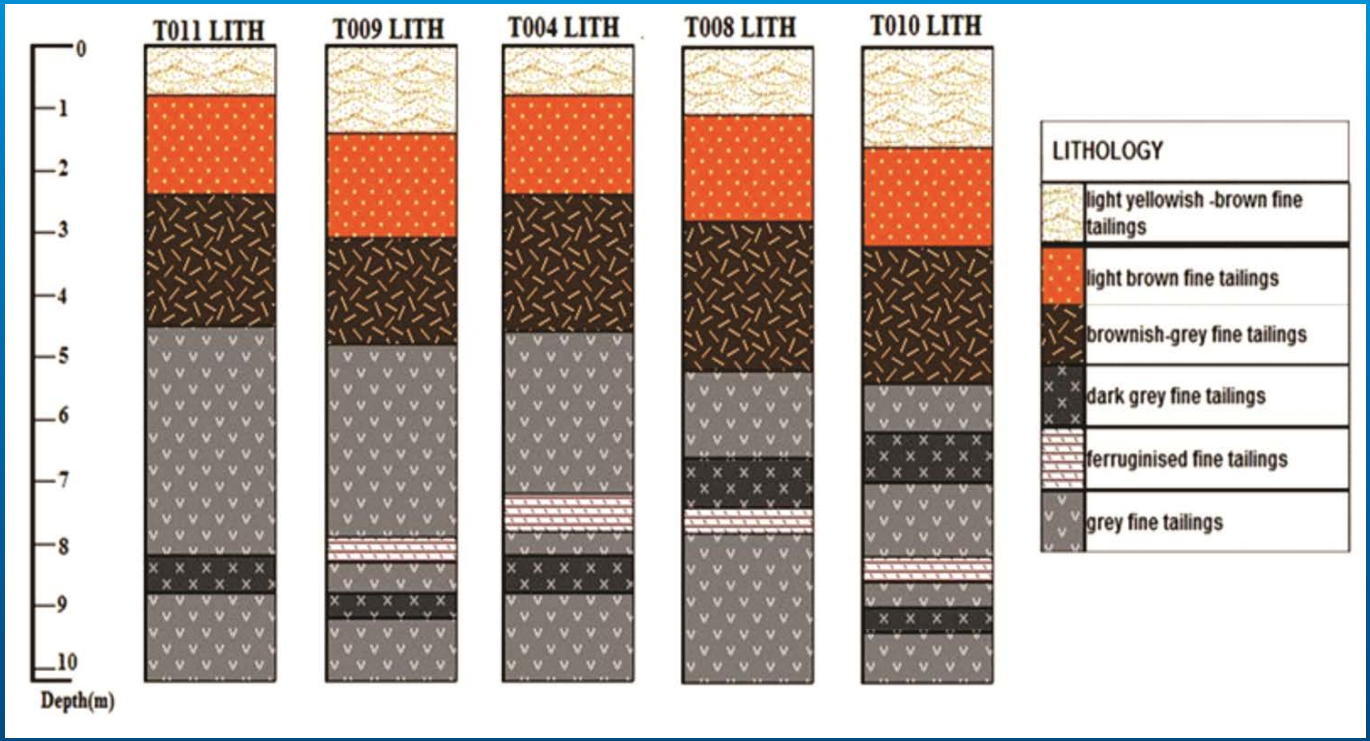
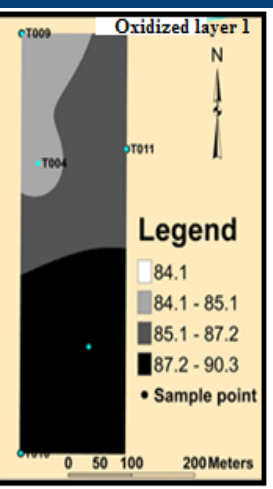


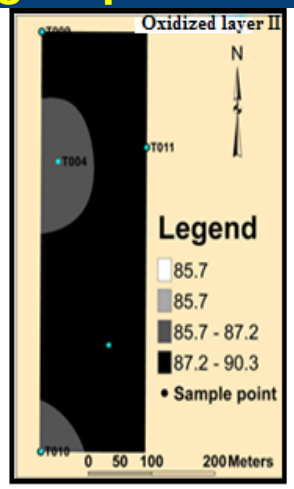
Figure 5: Lithology of the five drilled holes sampled

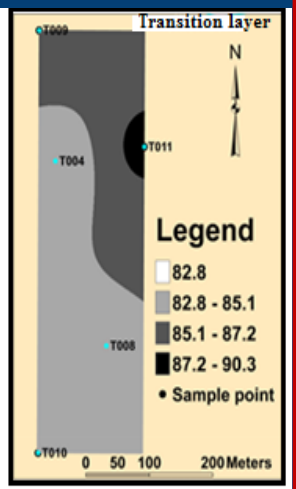
- Quartz, Muscovite, pyropyllite, gypsum, jarosite, delhayelite, hematite, pyrite and clinochore were identified qualitatively by XRD (which defines the mineralogy).
- Quartz, jarosite and gypsum contents are higher in the upper two horizons while pyrophilite, pyrite, hematite and muscovite contents dominate in the lower horizons.

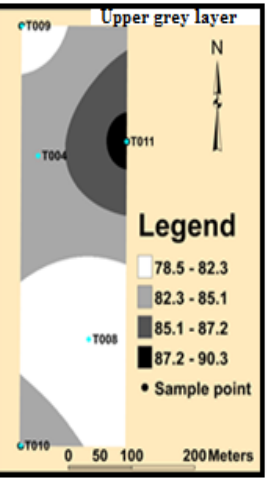
DISTRIBUTION OF CLAYS AND SILICA

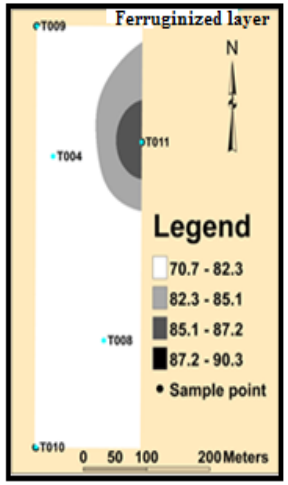
Silicates group

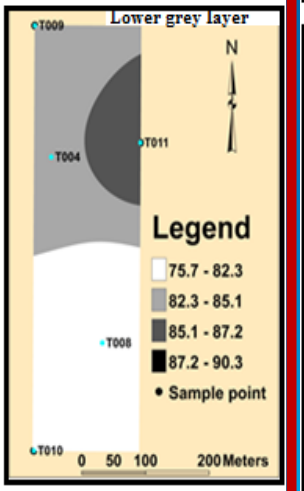




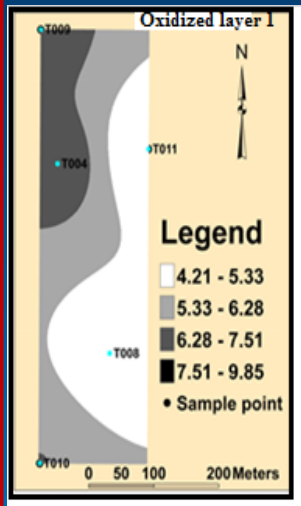


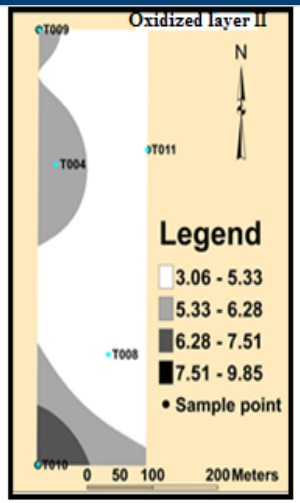


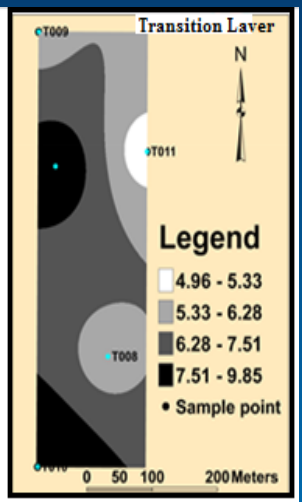


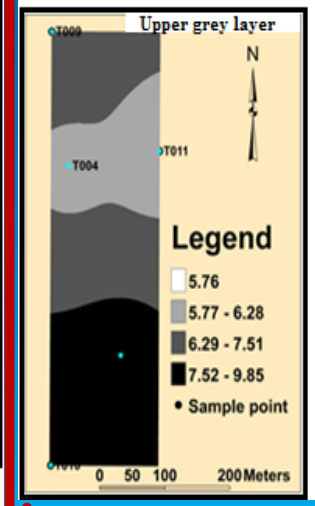


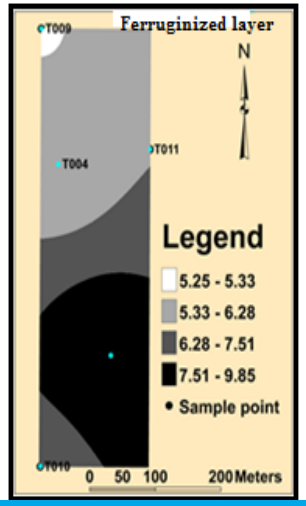
Clay group

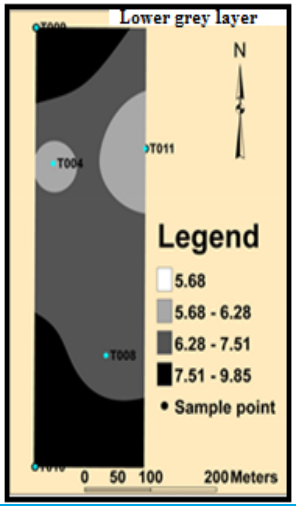






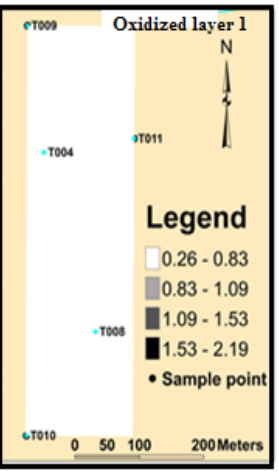


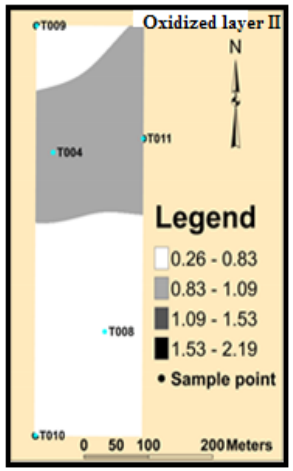


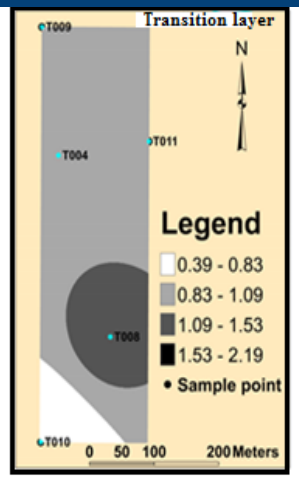


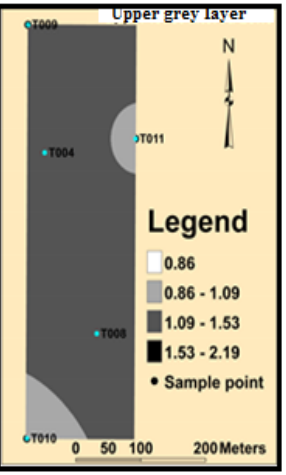
Distribution of Sulphides and ADDITIVES

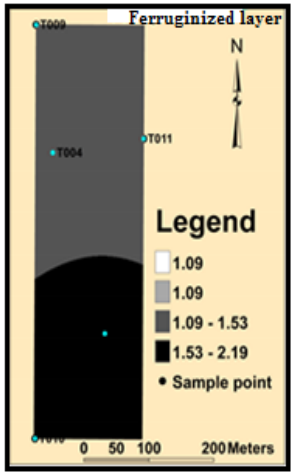
Tot S

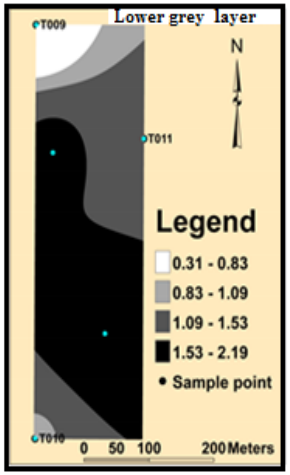




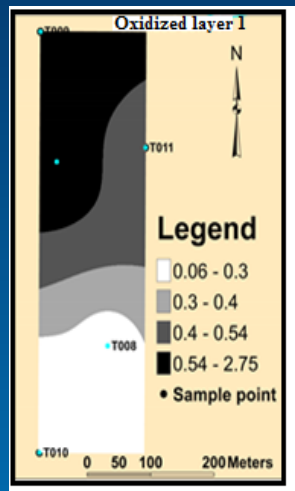


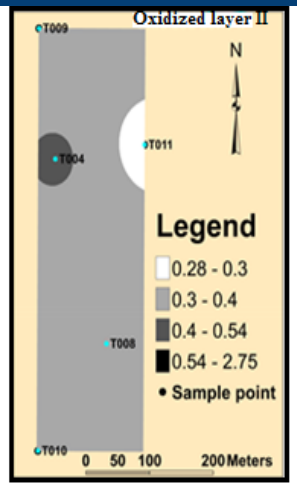


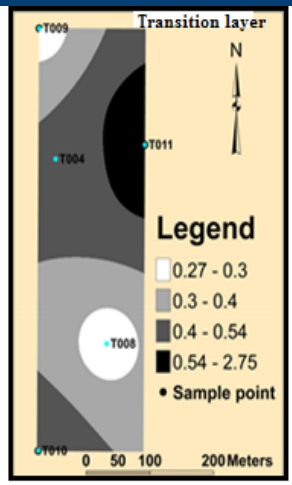


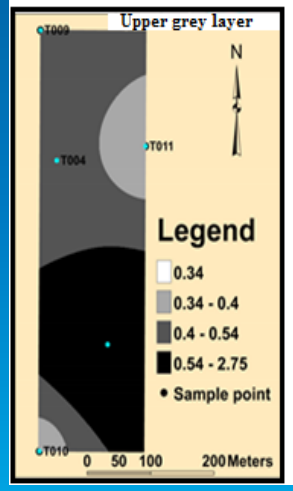


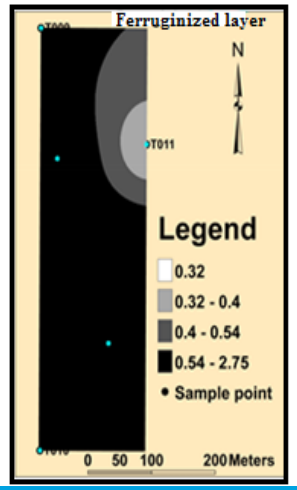
CaO

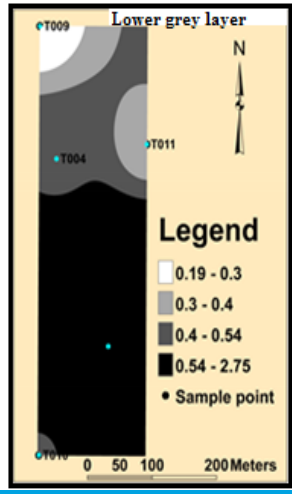








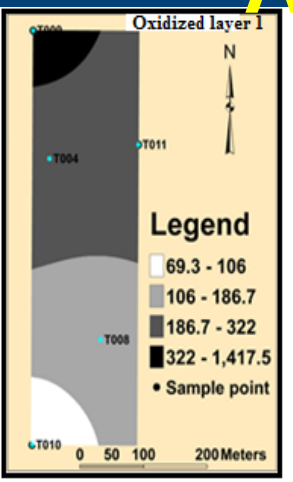


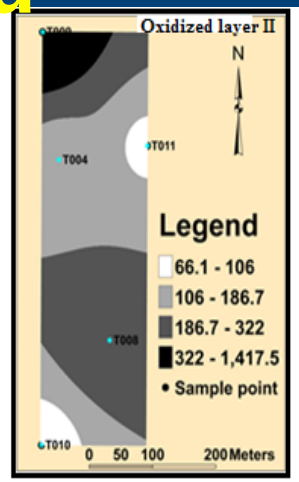


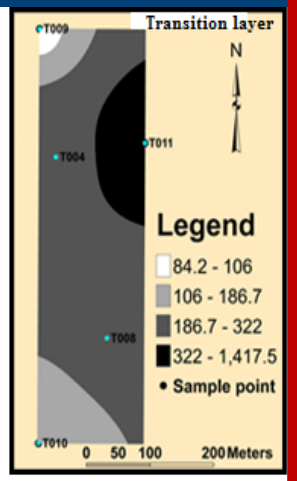
DISTRIBUTION OF AU AND U

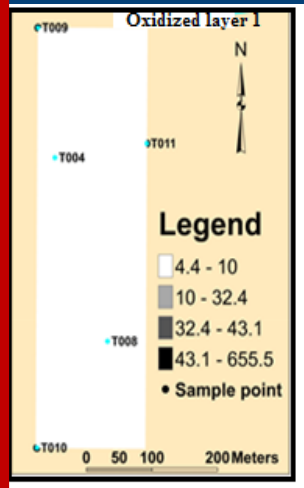
Au

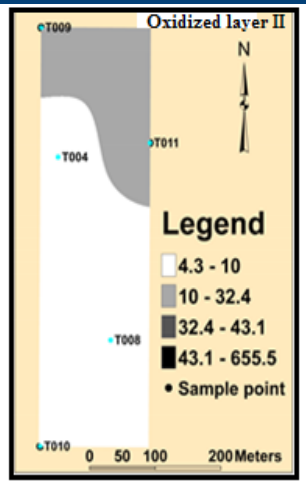
U

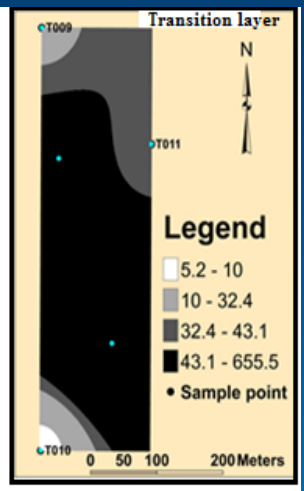


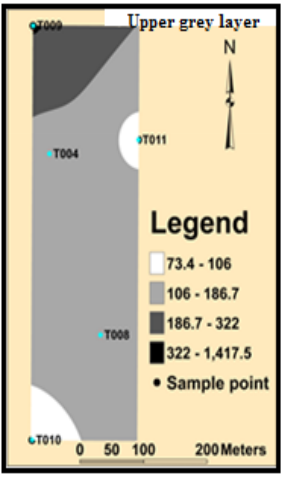


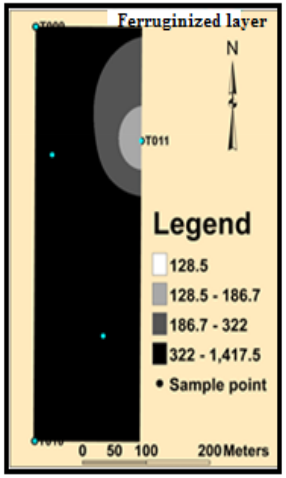


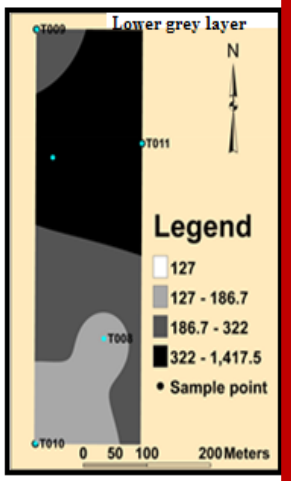


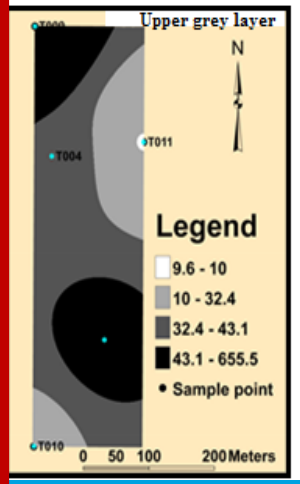


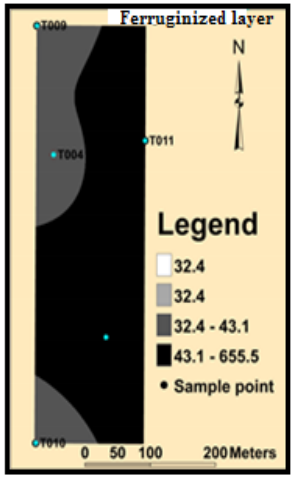


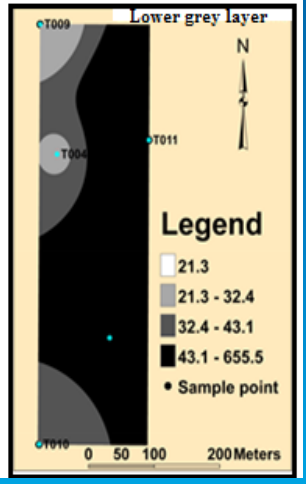








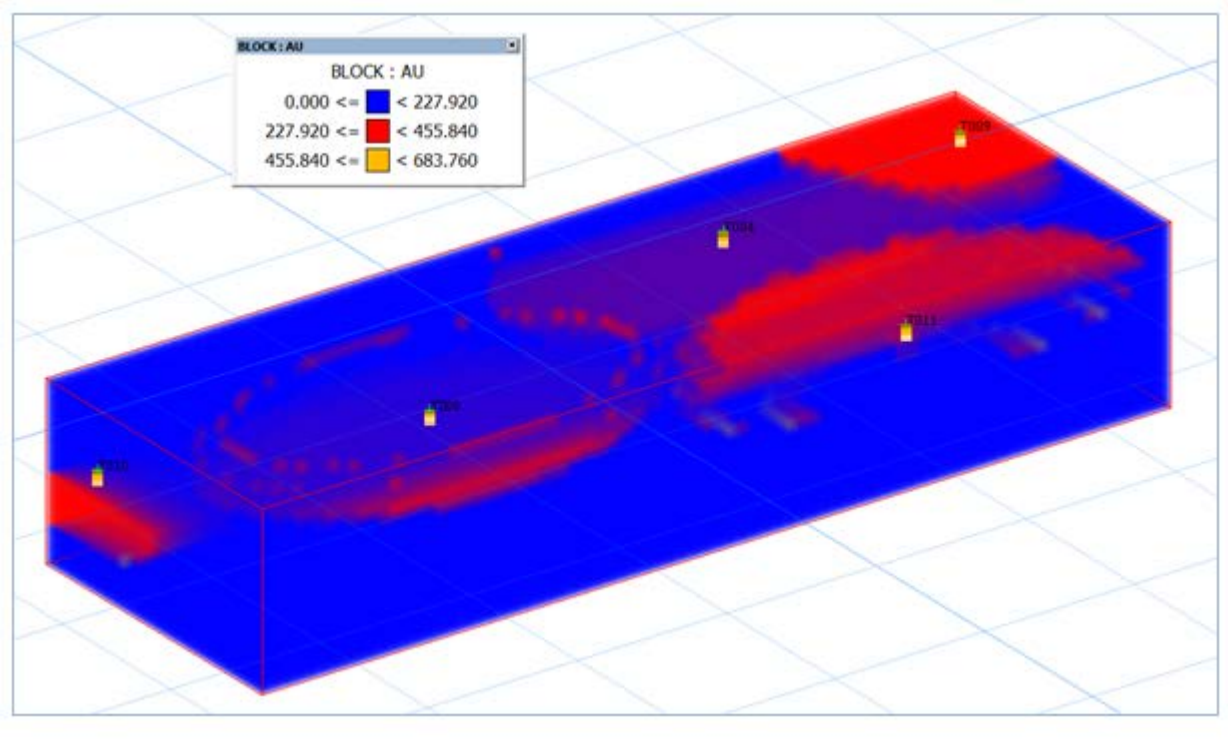




INTERPRETATION

- The significance of the knowledge of the elemental distribution pattern assisted in understanding general trend of mobile and non-mobile elements and species in tailing dam sampled.
- The high concentration of SiO_2 and low concentration of Al_2O_3 and tot/S in the first two meter depicts depletion and this fall within layer 1.
- Sulphides and uranium show a distinct depletion trend indicating that the surface has exposed to extensive leaching (Naicker, et al., 2003).
- The high presence of CaO in the first meter could be because of carbonates formed from neutralization process and deposited as salts.
- There is enrichment of sulphides coupled with low SiO_2 at a ferruginized zone. This layer is probably a sink for elements emanating from the upper layers.
- Also, from the IDW interpolation, it could be inferred that tailings from the transition and unoxidised zone, it could be economically viable if assessed for U and Au and therefore the tailing should be reclaimed.
- Therefore, the tailing dam could be said to be uraniferous-gold tailing (Winde, et al., 2004). The concentration of Au indicates that tailings could still be reprocessed for gold.

The major elements contents occurred in the following decreasing order: SiO_2(84.24%)> Al_2O_3(6.25%)> LOI(3.28%)> Fe_2O_3(2.64%) >CaO(0.43%)> MgO(0.35%)> K_2O(0.32%)> TiO_2(0.24%)> Na_2O(0.07)> Cr_2O_3(0.04%)> MnO (0.02%) ≈ P_2O_5(0.02%).



Block model for Au

CONCLUSION

- **The IDW interpolation analysis reflects the distribution pattern of elements down depth, and their relative behaviour based on the factor analysis.**
- **Could be used to assess how economically viable the tailings dam is for U and Au and why the tailings dam be reclaimed**

THANK YOU

- **Special thanks to ESRI South Africa, InkabaYeAfrika, Division of Postgraduate studies University of the Western cape and office of the Dean of Science University of the Western cape**