Dust Deposition Footprint & Impact on Saldanha Bay Soils

Background

- Mining and associated activity has a proven detrimental effect on the environment. Studies have shown that there is causal link between mining activity and contamination of the environment [1]
- Metal contaminants can move from the emission source into the environment by wind [2]
- One method to assess the level of contamination is by testing the concentration of metals in the soils and comparing them to natural occurring levels [3]

Saldanha Bay District

- Saldanha Bay on the West Coast has experienced an increase in the metal ore transportation through the area
- This activity has the potential to cause elevated levels of metals in the soils

Fig 1: Saldanha Bay Port Terminal

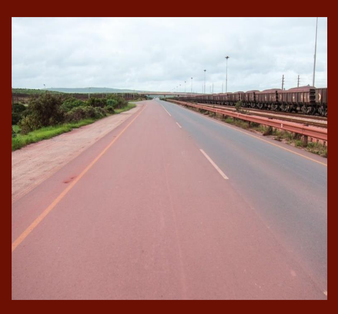


Fig 2: Red Iron Ore stained Road & House

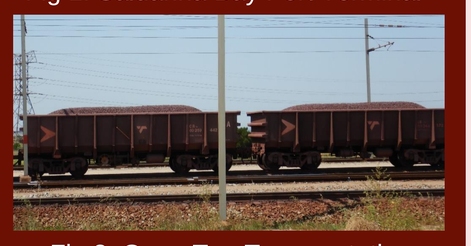


Fig 3: Open Top Transportation

Hypothesis

The presence of multiple mining related activities & the exportation terminal in Saldanha Bay District has contributed to metal contamination of soils.

Key Questions

1. What are key emission sources and are metals potentially dispersed by wind from these sources?
2. Does LOI (organic matter), pH and PSD affect metal retention of soils?
3. Are soils in this area contaminated?

Fieldwork Sampling

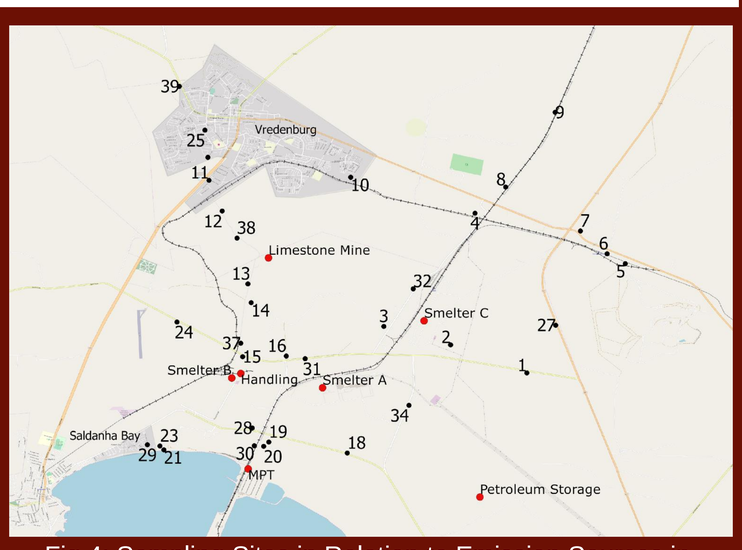
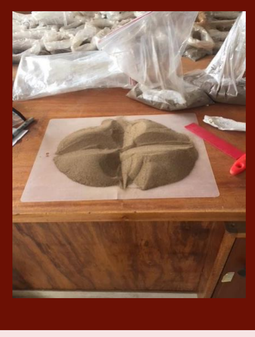


Fig 4: Sampling Sites in Relation to Emission Sources in Saldanha Bay District

Two samples were taken at each sample sites, at two different depths of 0-5 cm and 5-20 cm

Analysis Procedure

1. Sample preparation
   - Sieving over 1 and 2 mm
   - Splitting: Cone & Quartering
2. Loss on ignition (LOI)
3. XRF Elemental Analysis
4. pH analysis
5. Particle Size Distribution
6. QGIS Interpolation
7. Statistical & Location Correlation



Results & Discussion

- Metals of concern: Fe, Mn, Zn, Pb & Ti
- Concentration maps show three main elevated concentration sites: port terminal, Handling/Smelter B and in Vredenburg
- The dispersion of metals as result of predominant southerly wind direction (Fig 9)
- Topography (Fig 8) influence particles settling at elevated site in Vredenburg
- Zn shows 4 sites of high enrichment which are close to the MPT (Fig 10)
- Fe also shows the same 4 sites away from the MPT (Fig 11)

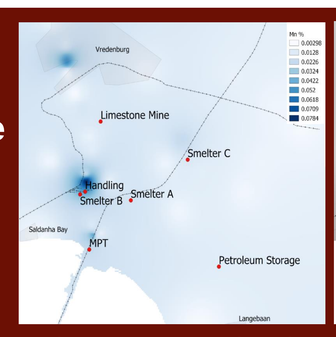


Fig 5: Mn Interpolated Concentration Map

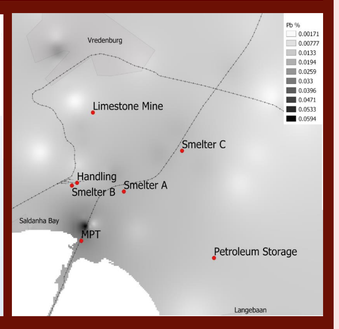


Fig 6: Pb Interpolated Concentration Map

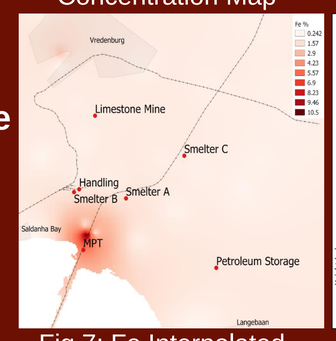


Fig 7: Fe Interpolated Concentration Map

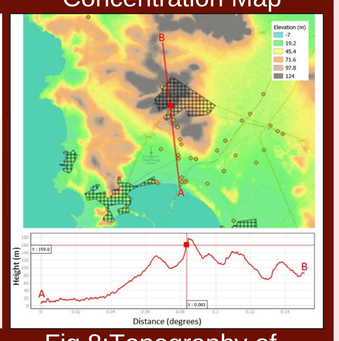


Fig 8:Topography of Vredenburg Site

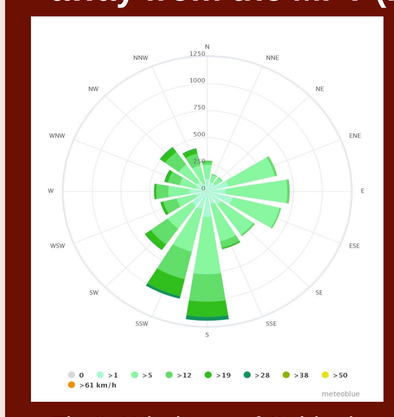


Fig 9: Windrose of Saldanha

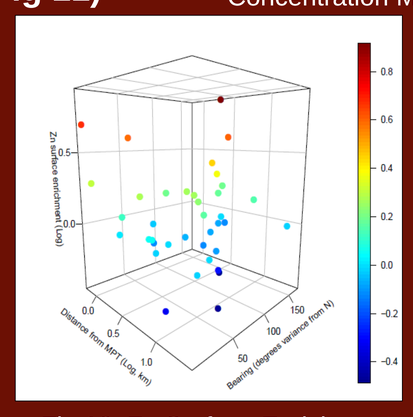


Fig 10: Zn Surface Enrichment

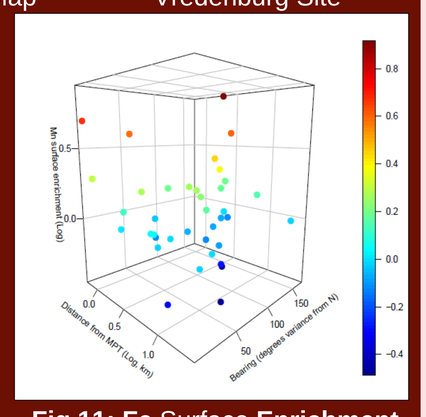


Fig 11: Fe Surface **Enrichment**

Fig 12 & 13 show that there is a potential correlation between the LOI % and clay % and increase in concentration for Zn %. Similar trends were shown for metals of concern.

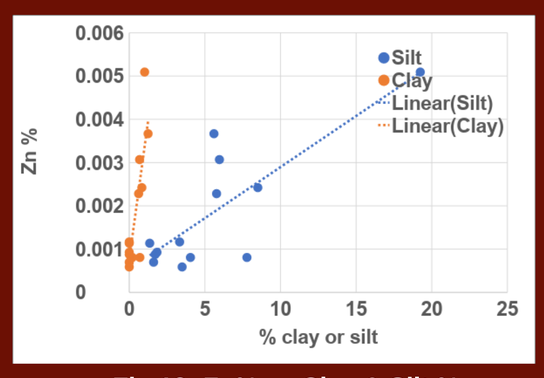


Fig 12: Zn% vs Clay & Silt %

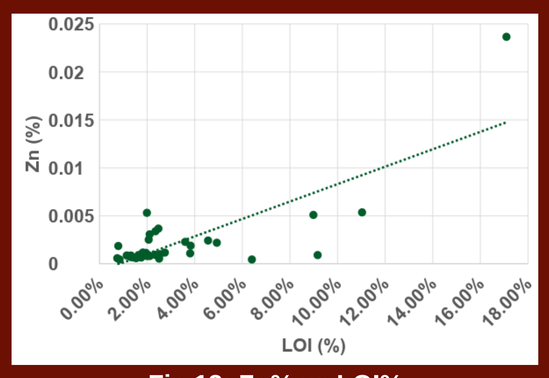


Fig 13: Zn% vs LOI%

The Pollution Index (PI) shows half the sites are moderately polluted and Mn has the highest % of highly polluted sites (Table 1)

Table 1: Percentage of Sites Considered Contaminated

	Ti (%)	Mn (%)	Fe (%)	Zn (%)	Pb (%)	Pollution level
PI < 1	36.8	42.1	44.7	13.2	52.6	Unpolluted
1 ≤ PI ≤ 3	63.2	47.4	47.4	78.9	42.1	Unpolluted to moderately polluted
3 ≤ PI	-	10.5	7.9	7.9	5.3	Highly polluted

Conclusions

- Two locations show an increased metal concentration in soils: the port terminal and Vredenburg sites. Smelter B and handling zone also show a moderately increased level.
- Organic matter content and % clay show a potential relationship with concentration of metals in soil.
- The presence of metals in soil suggest that they are possibly in the atmosphere too – creating concern for inhalation of toxic metals.

Recommendations

- Perform additional sampling to determine soils prone to metal retention for monitoring purposes
- Obtain airborne sample to determine concentrations and sources
- Complete seasonal sampling to account for variations in metal concentrations for various atmospheric conditions
- Refine dispersion models used and compare the effectiveness of those currently employed.

References

[1]Li, Z. et al., 2014. A review of soil heavy metal pollution from mines in China: Pollution and health risk assessment. *Science of the Total Environment,* Volume 468, pp. 843-853.

[2] Csavina, J. et al., 2012. A review on the importance of metals and metalloids in atmospheric dust and aerosol from mining operations. *Science of the Total Environment,* pp. 53-78.

[3] Kribek, B. et al., 2014. Contamination of soils with dust fallout from the tailings dam at the Rosh PInah area, Namibia: Regional assessment, dust dispersion modeling and environmental consequences. *Journal of Geochemical Exploration,* Volume 144, pp. 391-408.

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