

Geochemical and isotopic tracing of salinity loads into the Ramsar listed Verlorenvlei freshwater coastal estuarine lake, Western Cape, South Africa.

Nthabeliseni T. Sigidi.^{(1)*}, J.A. Miller⁽¹⁾, A. Watson⁽¹⁾, C. Clarke⁽²⁾ & W. de Clercq⁽²⁾



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Introduction
 The Verlorenvlei region is subject to high salinity levels of EC > 300mS/m whether as a result of natural or anthropogenic induced processes, with high evaporation rates of about 1800 to 2400 mm/annum, low mean annual rainfall of 275mm makes the area vulnerable to drought and salinisation, (CSIR, 2009) a problem in semi-arid regions. Problems such as: a) deterioration of water quality used for domestic and agricultural purposes, b) strain on ecological systems c) decline in socio-economic activities.

The approach used is a multi-tracer study employing stable isotopes of O and H, major ions and ⁸⁷Sr/⁸⁶Sr ratios to assess the relative contributions of the different tributaries feeding into the Verlorenvlei river and lake system.

Results
 Kruismans River is considerably higher at 500 mS/m < EC < 2000 mS/m. The Hol River has 400 mS/m < EC < 1500 mS/m; the Bergvallei River has 500mS/m < EC < 800 mS/m; and the Verlorenvlei River showing lower salt loads reflected by values 80 ms/m < EC < 300 mS/m. EC decreases during the rainy season and increases during the dry season for both surface and shallow groundwater. Absolute ionic dominance pattern is in the order of Na+ > Cl- > Mg2+ > Ca2+ > SO42- > HCO3- > K+ > Br-. Shallow groundwater defined as: Hol: δ²H=3.97 δ¹⁸O -0.99, Kruismans: δ²H=3.97 δ¹⁸O -0.166, Verlorenvlei: δ²H=4.93 δ¹⁸O+1.77, Krom Antonies: δ²H=2.815 δ¹⁸O+2.97, Bergvallei: δ²H=1.23δ¹⁸O-15.35.

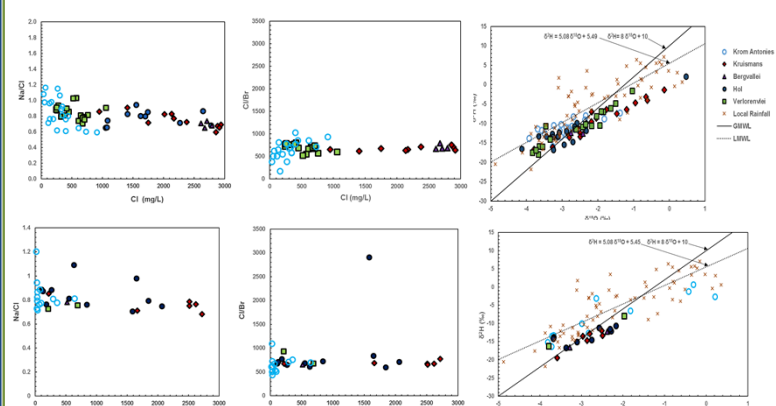


Figure 3: a) Na/Cl vs Cl and Cl/Br vs Cl for both surface (bottom) and (top), b) O and H stable isotopes graphs surface (bottom) shallow (top).

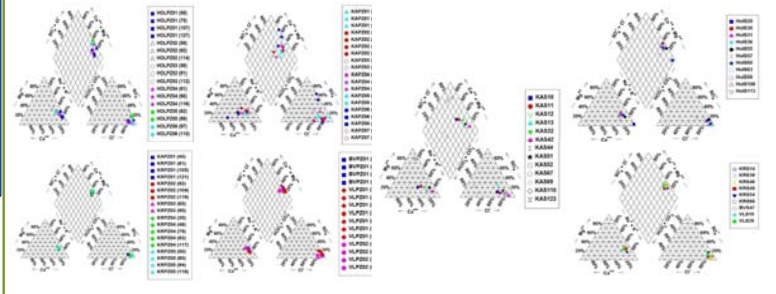


Figure 4: Piper diagram plots from absolute major ion concentrations from each tributary, surface (right), shallow (right).

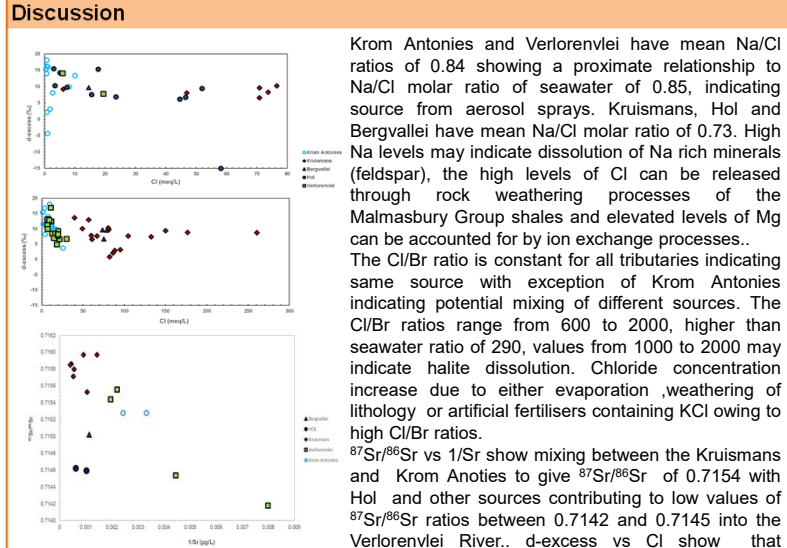


Figure 5: d-excess vs Cl (top). Figure 6: ⁸⁷Sr/⁸⁶Sr vs 1/Sr (bottom).

Krom Antonies and Verlorenvlei have mean Na/Cl ratios of 0.84 showing a proximate relationship to Na/Cl molar ratio of seawater of 0.85, indicating source from aerosol sprays. Kruismans, Hol and Bergvallei have mean Na/Cl molar ratio of 0.73. High Na levels may indicate dissolution of Na rich minerals (feldspar), the high levels of Cl can be released through rock weathering processes of the Malmesbury Group shales and elevated levels of Mg can be accounted for by ion exchange processes. The Cl/Br ratio is constant for all tributaries indicating same source with exception of Krom Antonies indicating potential mixing of different sources. The Cl/Br ratios range from 600 to 2000, higher than seawater ratio of 290, values from 1000 to 2000 may indicate halite dissolution. Chloride concentration increase due to either evaporation, weathering of lithology or artificial fertilisers containing KCl owing to high Cl/Br ratios. ⁸⁷Sr/⁸⁶Sr vs 1/Sr show mixing between the Kruismans and Krom Antonies to give ⁸⁷Sr/⁸⁶Sr of 0.7154 with Hol and other sources contributing to low values of ⁸⁷Sr/⁸⁶Sr ratios between 0.7142 and 0.7145 into the Verlorenvlei River. d-excess vs Cl show that evaporation shown by a decrease in d-excess with increasing Cl for Krom Antonies and Verlorenvlei is not the only source of Cl.

Conclusion

- Na-Cl water type for Kruismans, Bergvallei and Verlorenvlei. Krom Antonies Ca-Na-SO4-Cl and Hol Mg-Na-Cl water types. Krom. Kruismans, Hol and Bergvallei are brackish waters. Krom Antonies and Verlorenvlei being freshwater types.
- Potential sources include evaporation and other sources such as weathering of bedrock (shale) or anthropogenic input
- From Sr ratios mixing processes of 2 or 3 end members account for low ⁸⁷Sr/⁸⁶Sr ratio.

References

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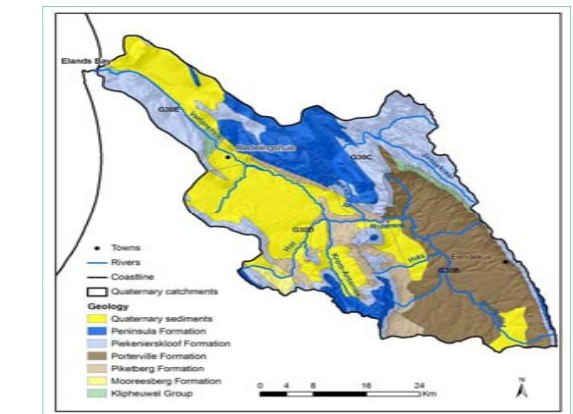


Figure 1: Verlorenvlei geological and catchment area map.



Figure 2: Twenty-one installed piezometers: 6 in Hol River, 7 in Krom Antonies River, 5 in Kruismans River, 2 Verlorenvlei River.

(1) Department of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland 7601, South Africa, ntsigidi@gmail.com
 (2) Department of Soil Sciences, Stellenbosch University, Private Bag X1, Matieland, 7601, South Africa.