4th SADC GROUNDWATER CONFERENCE
10th -12th of November 2021
VIRTUAL CONFERENCE

GROUNDWATER MANAGEMENT INSTITUTE

Characterization of Hydro-Geochemical Processes influencing groundwater quality of the Soutpansberg area, Limpopo, South Africa

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Outline of the Presentation

1. Background
2. Study Aim
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4. Methodology
5. Results and Discussions
6. Conclusion

Background

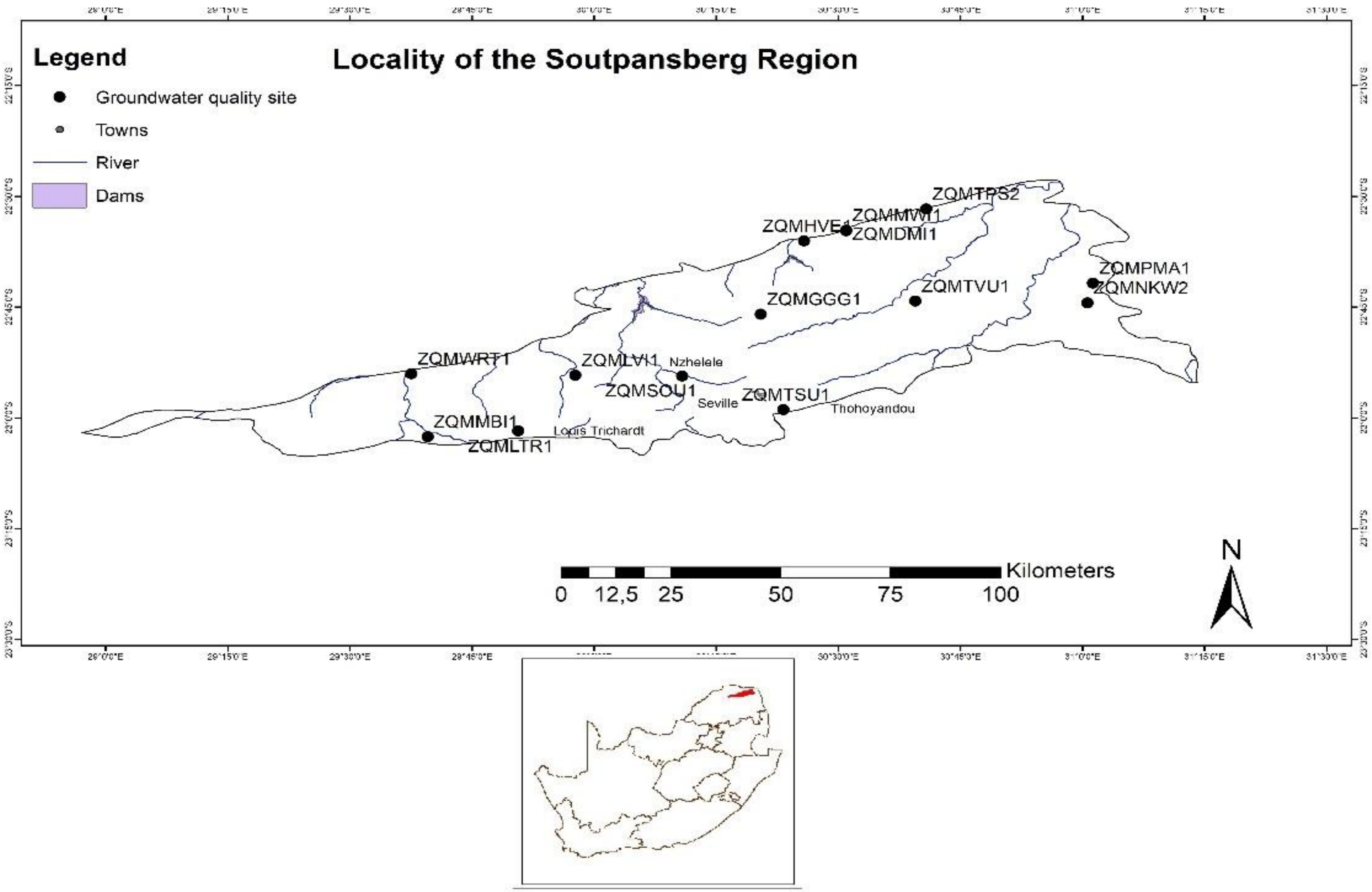
- Studies on groundwater quality and processes controlling the quality are becoming important in arid and semi-arid regions. This is associated with increasing pressure on water resources due to climatic variations, droughts, socio-economic developments and pollution.
- More people in Southern Africa are relying on groundwater for domestic use and irrigation due to climatic variation and socio-economic factors.
- Current practices on hydro-geochemical processes influencing groundwater quality focuses on determination of suitability for use and models without influencing policy changes that will improve rural livelihood and improve food security and health (Tiwari and Singh, 2014; Mangoua et al., 2015).
- Improved understanding of hydro-geochemical processes is important in achieving UN SDG 2 (zero hunger), 3 (good health and well being), 6 (clean water and sanitation).

Study Aim

- To identify the main hydro-geochemical processes influencing groundwater quality in the Soutpansberg region.
- ➢ Improved understanding of the aquifer.
- ➢ Improved groundwater quality management and protection.
- ➢ Feasible groundwater remediation technique

Description of the Study area

- 148 Mm3/a of groundwater allocated for domestic use, water supply and irrigation.
- Arid environment with decaying water storage and supply infrastructure.
- Small to large scale subsistence and commercial farming rely on groundwater



Methodology

Data collection methods: Mean of 124 samples (per site) of physio-chemical parameters were analysed. These parameters include (Mg^{2+}), (Ca^{2+}), (Na^{+}), (K^{+}), (HCO_3^{-}), (Cl^{-}), (NO_3^{-}), (F^{-}), SO4 and (TDS). 12 boreholes, 2 geothermal springs: 1995-2021

Data analysis methods:

- **Piper diagram-** To determine water type and hydro-geochemical facie.
- **Gibbs diagram-** To understand water-rock interaction
- **Chloro-alkaline Indices (CAI) and Bivariate plots-** To understand interaction between groundwater and host rocks.
- **PHREEQC**- Geochemical modelling for Saturation Index (SI).

Results & Discussions- Hydro-Geochemistry

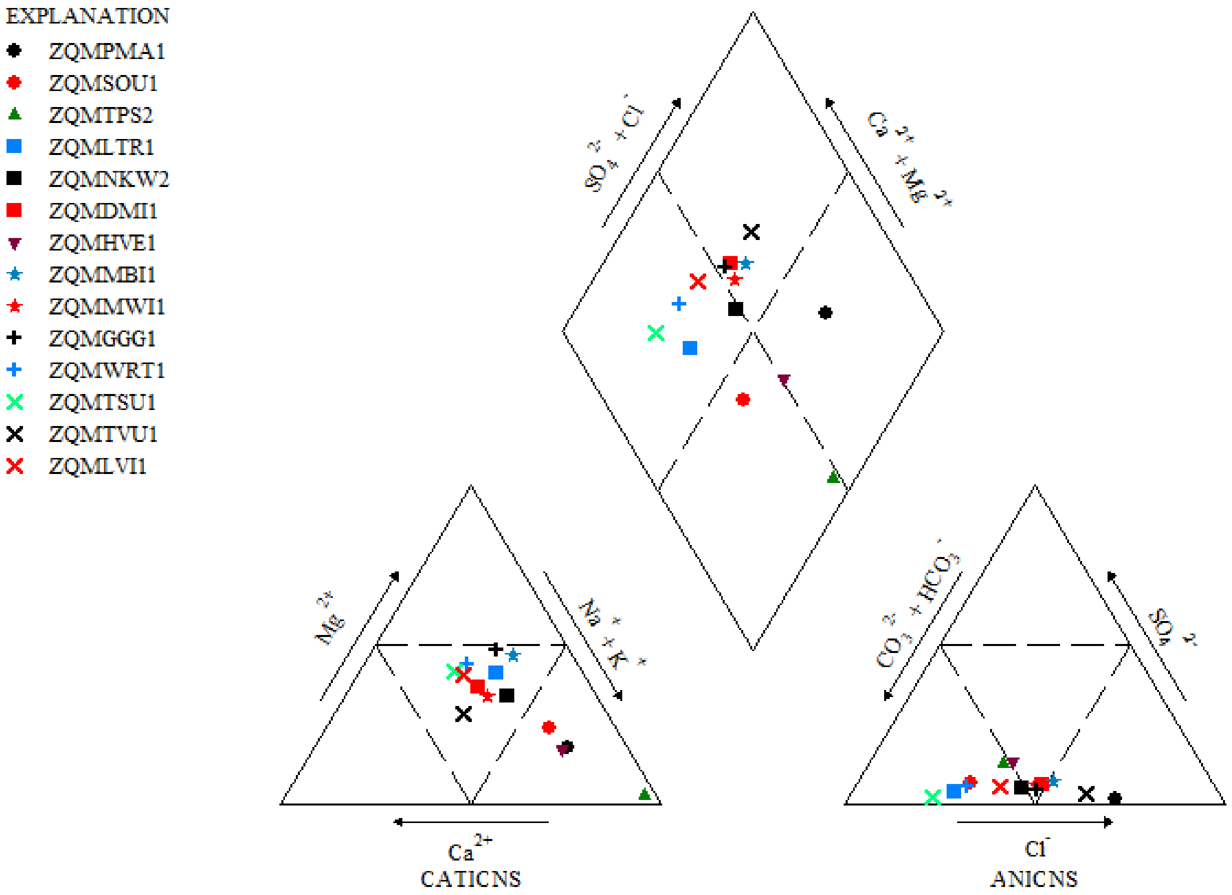
Site	Ca^{2+}	Na^{+}	Mg^{2+}	K^{+}	Cl^{-}	NO_3^{-}	F^{-}	HCO_3^{-}	SO_4^{2-}	SiO_2	pH	TDS	EC
ZQMDMI1	53	69	40	3	146	5	0,4	227	25	11	8,4	633	89
ZQMGGG1	50	97	77	4	192	15	0,4	322	24	26	8,1	905	123
ZQMHVE1	15	64	9	2	55	2	0,8	122	26	19	8,2	328	48
ZQMLTR1	43	76	47	4	76	7	0,4	335	14	22	8,3	697	88
ZQMLVI1	30	32	25	1	62	2	0,3	156	12	18	8,3	360	50
ZQMMBI1	64	175	118	9	334	22	0,3	455	65	30	8,3	1418	202
ZQMMWI1	41	59	29	3	109	2	0,7	183	20	10	8,5	494	70
ZQMNKW2	8	16	7	1	25	1	0,1	50	4	17	7,7	125	20
ZQMPMA1	86	424	61	2	664	0	0,5	451	22	30	7,9	1810	279
ZQMSOU1	12	45	10	2	33	1	2,5	119	10	22	8,2	262	36
ZQMTPS2	2	66	1	2	39	0	0,8	84	19	34	9,3	321	34
ZQMTSU1	16	13	13	1	15	3	0,3	87	2	25	8,2	180	25
ZQMTVU1	13	22	10	1	29	15	0,2	28	2	7	7,8	179	28
ZQMWRT1	12	12	11	1	20	1	0,1	74	5	11	8,4	155	22

**EC in mS/m, all in mg/l*

- pH ranged from 7.7 to 9.3 – Groundwater is alkaline- high concentrations of Na^{+}, Mg^{2+}, Ca^{2+} and HCO_3^{-} from lithological settings - mafic-ultramafic igneous rocks
- TDS: 85.7% -Fresh, 14.3%- Brackish
- Major cation dominance order :$Na^{+} > Mg^{2+} > Ca^{2+} > K^{+}$ and major anion: $HCO_3^{-} > Cl^{-} > SO_4^{2-}$.
- F mean concentration of 2.5 mg/l in geothermal spring (ZQMSOU1)
- High concentration of NO3 at ZQMGG1,MBI1 and TVU1.
- Salinity in groundwater is an issue in certain areas.

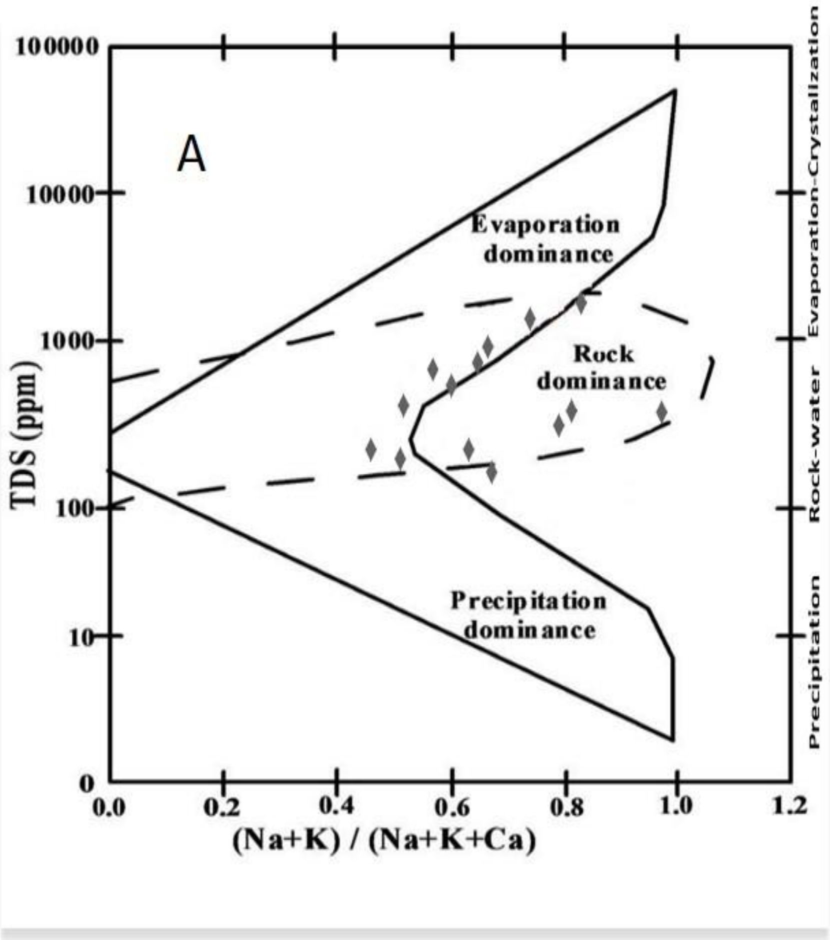
Piper diagram

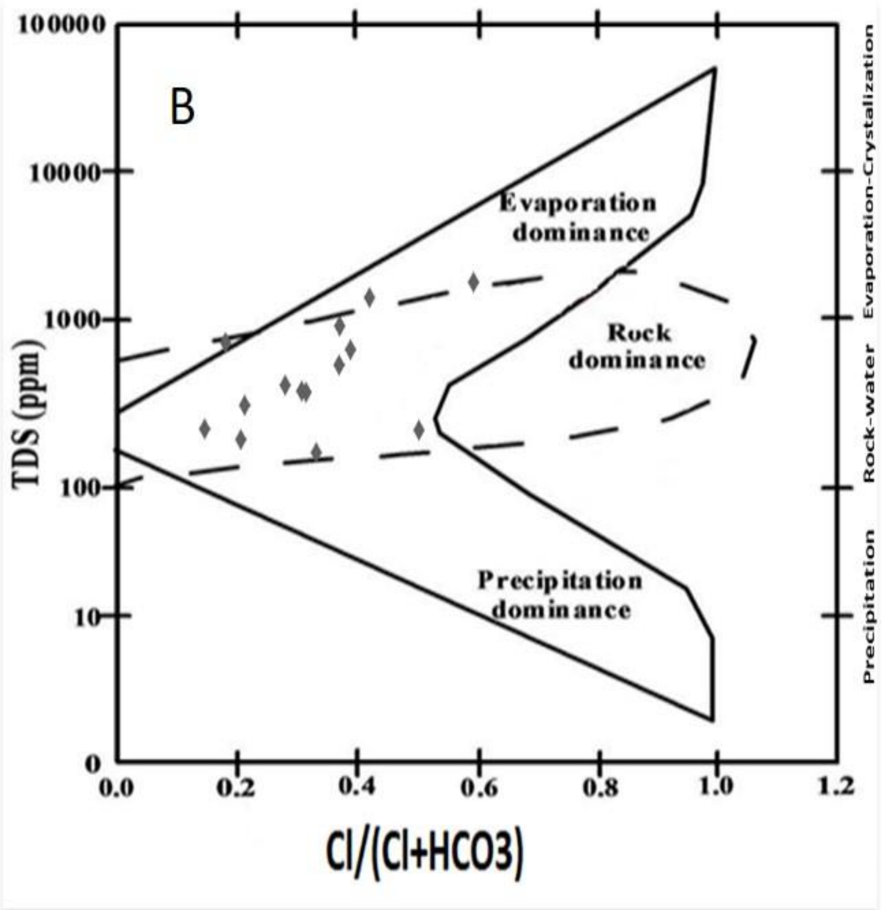
Hydro-geochemical facies of groundwater



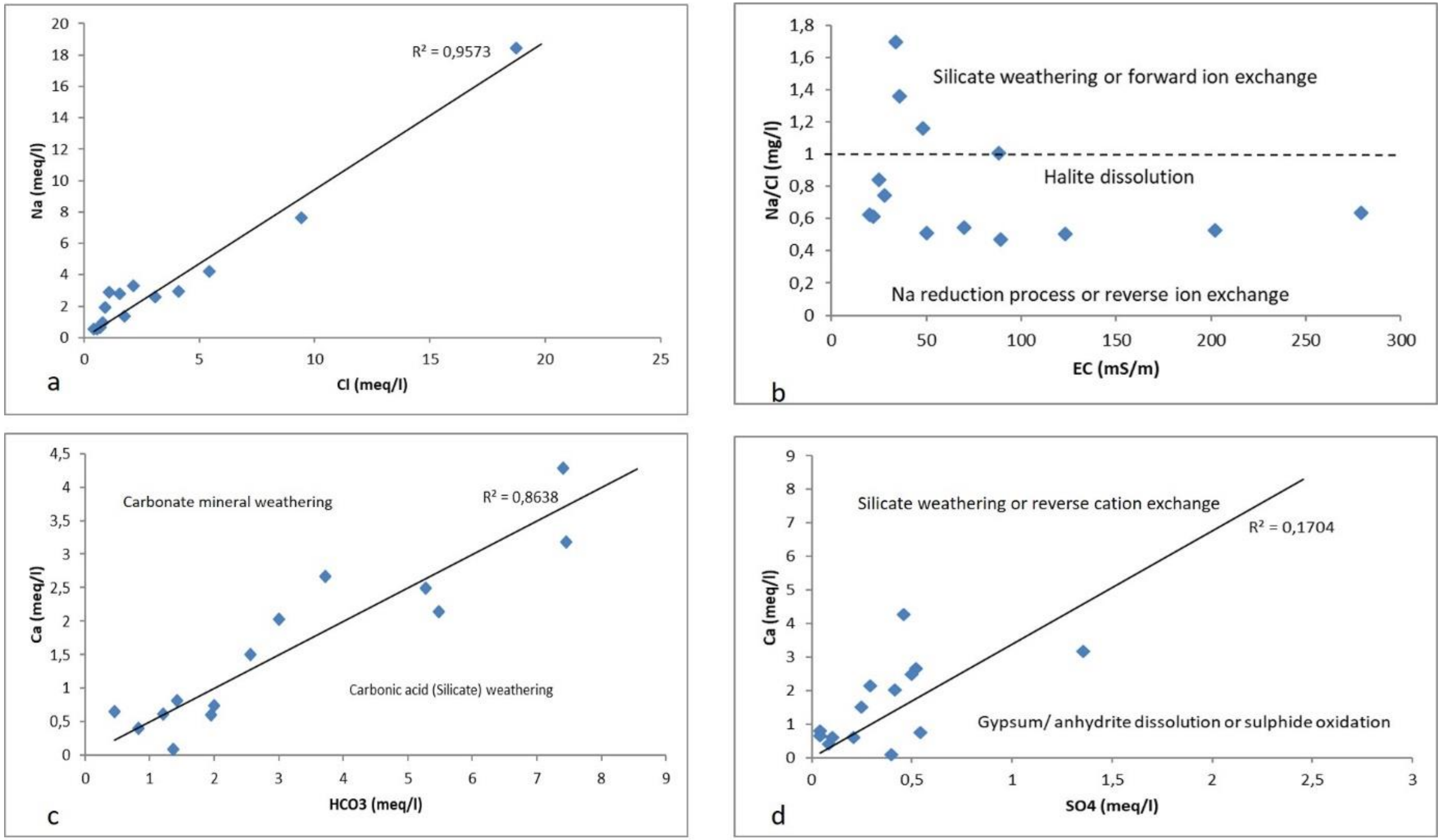
- Dominant water types were Ca-HCO_3 (35,7%)-<15mbgl and mixed Ca-Mg-Cl (35,7%)- 16-37mbgl.
- Least dominant water types were Na-Cl (14.3%) and mixed Ca-Na-HCO_3 (14.3%)- Geothermal springs
- Mixing of deep ancient groundwater with fresh water.

Gibbs diagram

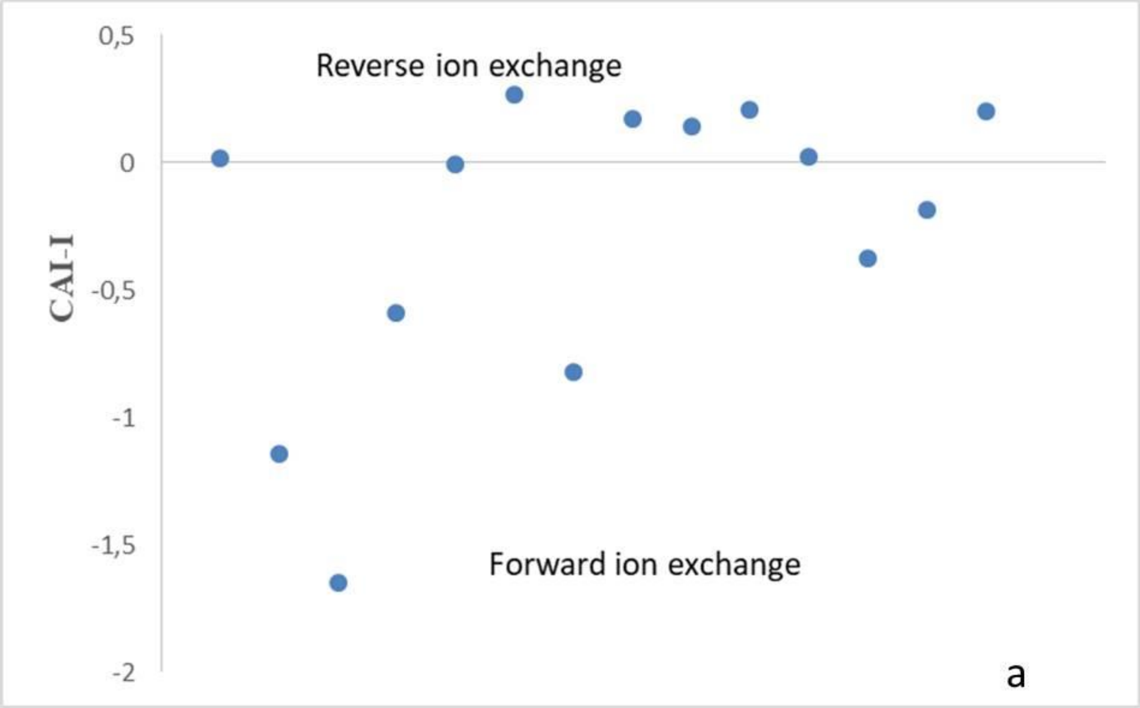


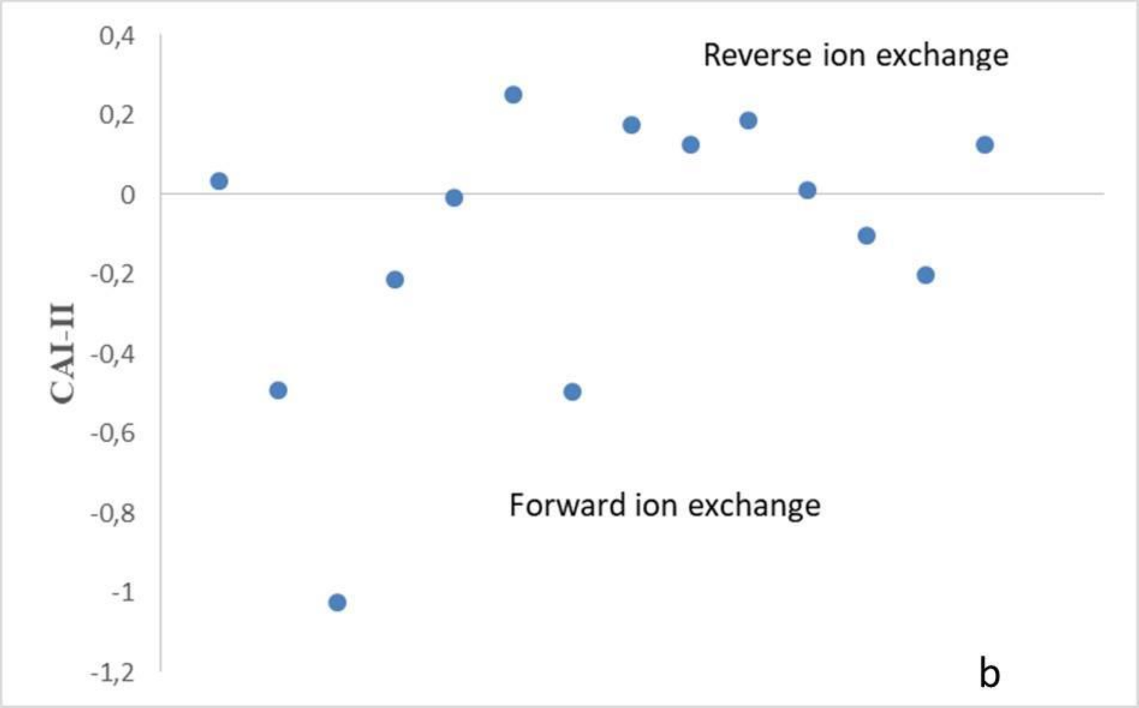


Correlation analysis

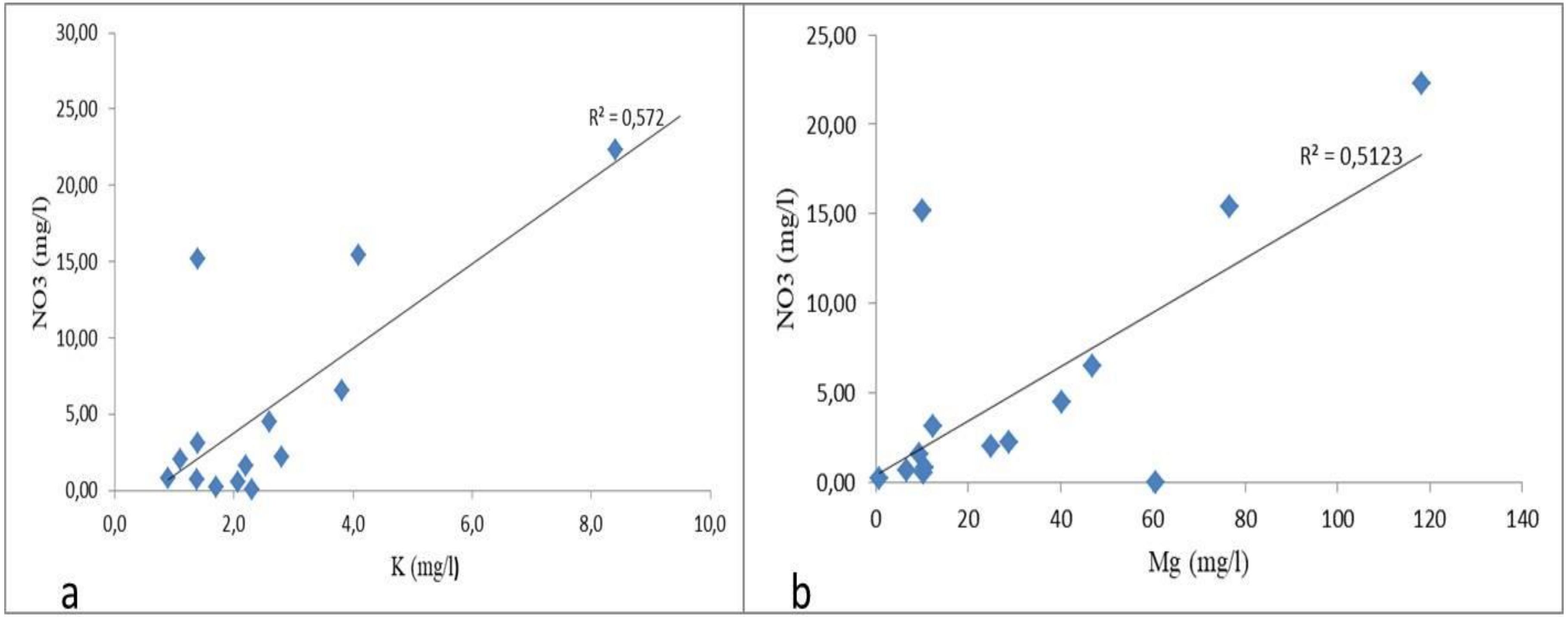


Correlation analysis





Correlation analysis- Source of Nitrates



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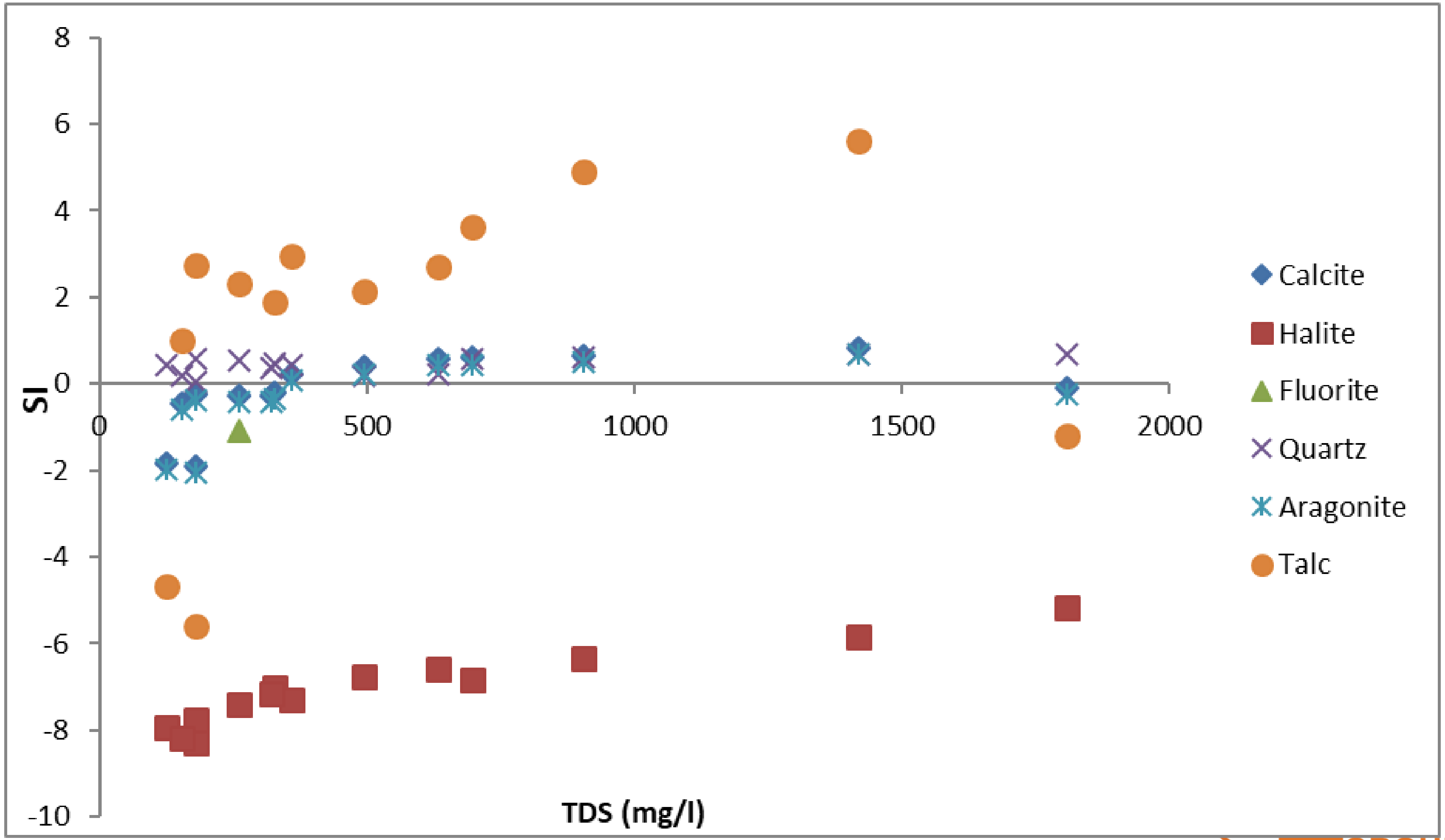
Saturation Index



Discussions

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At Siloam hot water is cheap, but remember to brush your teeth

News - **Date:** 31 October 2021

Written by: Maanda Bele / **Viewed:** 966

For the past few decades, about 400 households of Siloam village in the Nzhelele valley have been enjoying free hot water from a natural hot spring. But where, many have wondered, does it come from?

Conclusion

- Various methods applied concluded that weathering of minerals (silicates and carbonates), dissolution of halite, ion exchange (reverse and forward) and anthropogenic inputs (usage of K-Mg Nitrate fertilizers) influences groundwater quality.
- Dissolution of fluorite (CaF_2) is the source of high concentration of Fluoride (ZQMSOU1).
- Rock dominance processes are the main processes controlling hydro-geochemistry.
- Main Discussions suggested that;

➢ Research outputs on groundwater quality are not being used to improve health and livelihood (Parachute research), improve groundwater quality related policies and water allocation.

➢ It will be impossible to achieve SDG 2, 3 & 6 without sharing research outputs on groundwater quality with communities and groundwater users in general.

- An appropriate groundwater remediation technique for rural area such as the Soutpansberg should be developed.

Thank You