

Abstract n° 2150

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In Sombetini and Unga Limited, two townships in Arusha, households use water mainly from groundwater. The objective of our research was to carry out a groundwater flow systems analysis (GFSA) in order to prepare a groundwater management plan with a focus on groundwater quality development.

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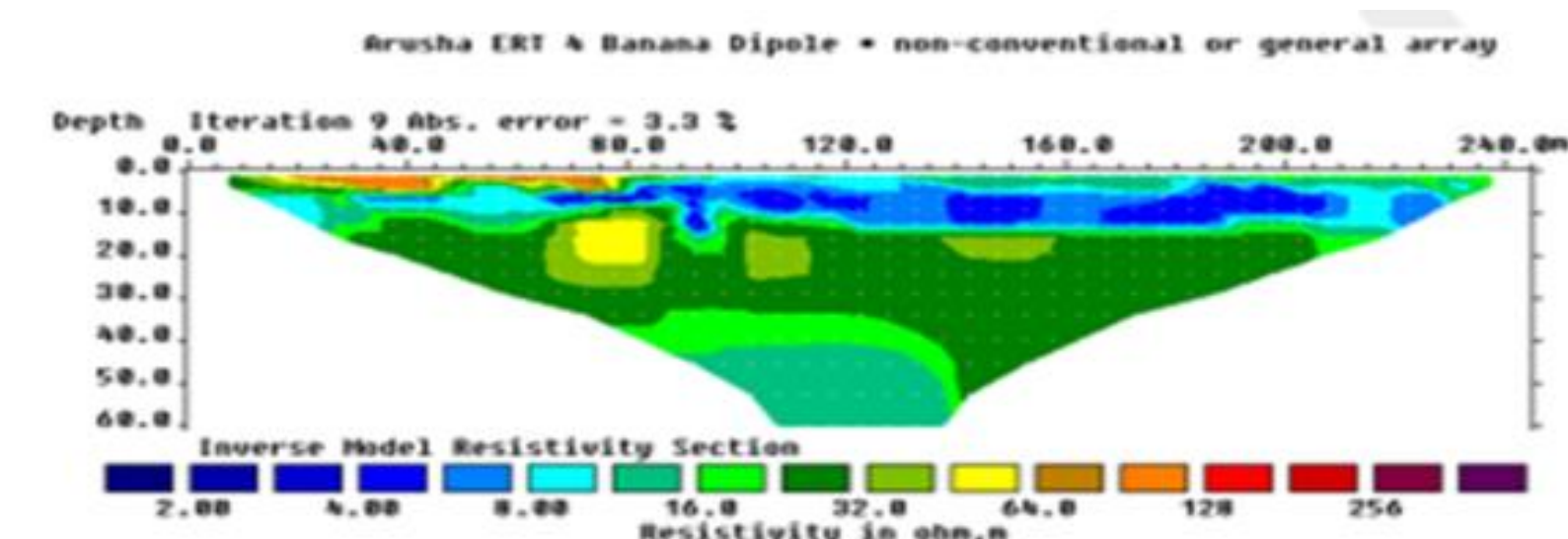
Methods

- Arusha is a major town in the north east of Tanzania. Sombetini and Unga Limited are located towards the



southwest of Arusha.

- We carried out an Electrical Resistivity Tomography study of the area with 8 transects of 200-500 m each.
- We drilled 23 boreholes at 15 locations with depths ranging from 5-30 m.
- In addition, we carried out slug tests using automated pressure transducers in order to obtain aquifer characteristics.
- We carried out an inventory of all wells in the area, whereby groundwater levels and water use was recorded.
- We took some 65 groundwater samples and analysed them for all major cations, anions, selected trace metals, and TOC at the UNESCO-IHE laboratories in Delft.



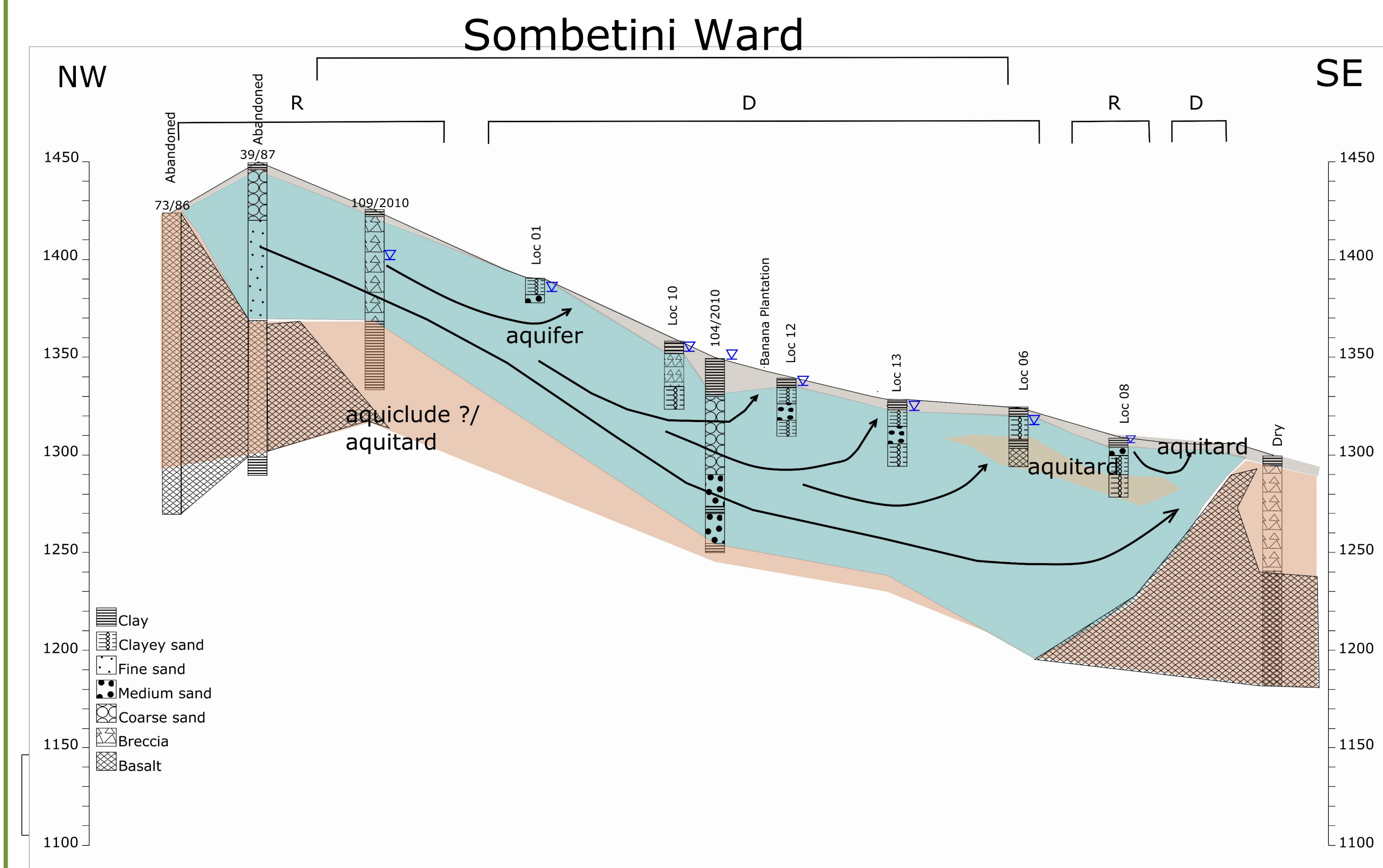
Example of ERT section (upper left); PAT-301 drilling rig used (right); At this location, we drilled 3 separate wells of various depths (5, 15, and 25m; lower left)

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Results – Hydrogeological map

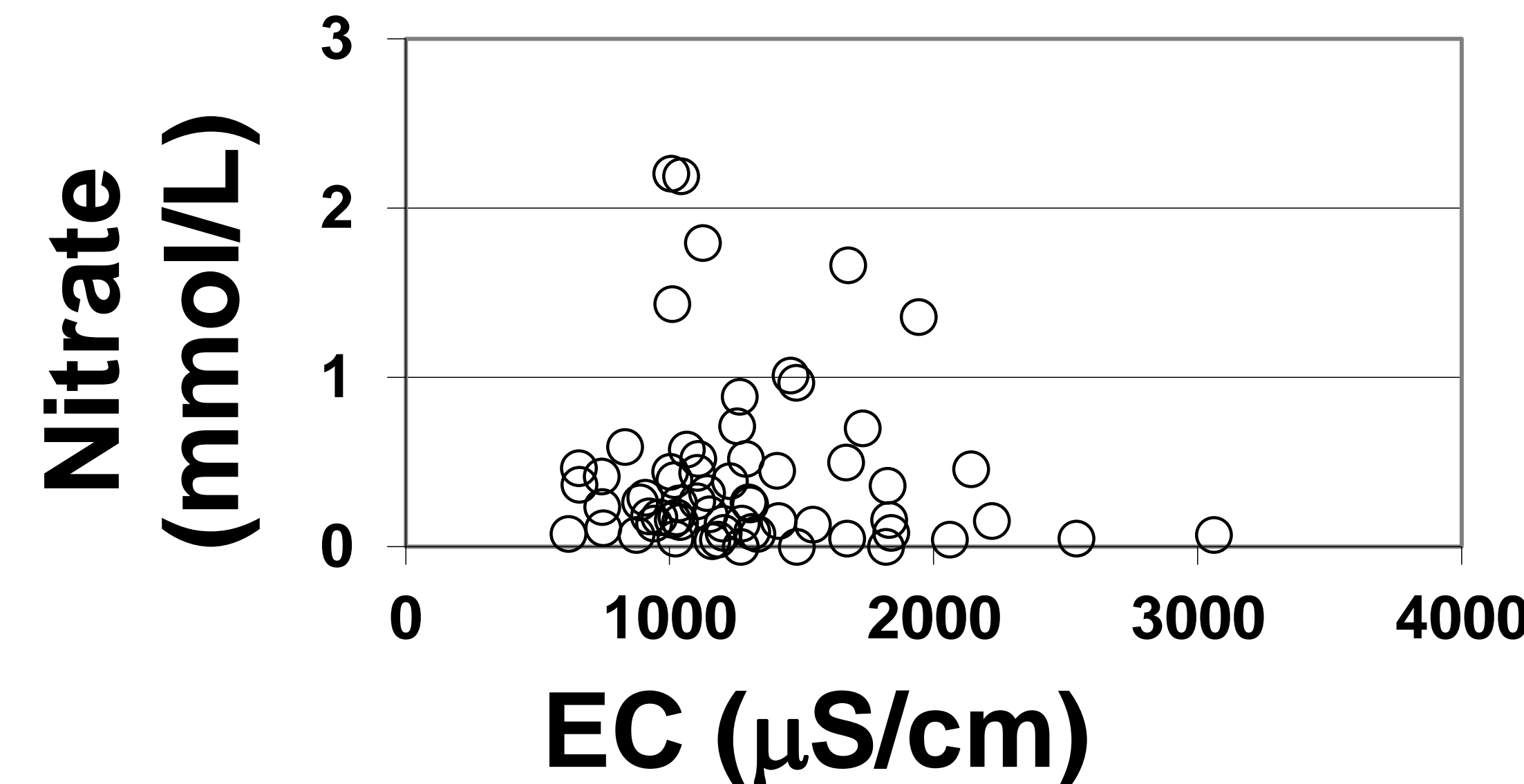
The area is mainly composed of a debris type of formation with basaltic pebbles, cobbles, and boulders of various size and shape. The thickness of this

formation ranges from a few meter in the northwestern part of the area to more than 200 m towards the south, and then thins out further southeast. The piezometer nests indicated upward groundwater flow along most part of the cross-section. Slug tests and pumping tests indicated that the permeabilities ranged from 1-20 m/d.



Results - Chemistry

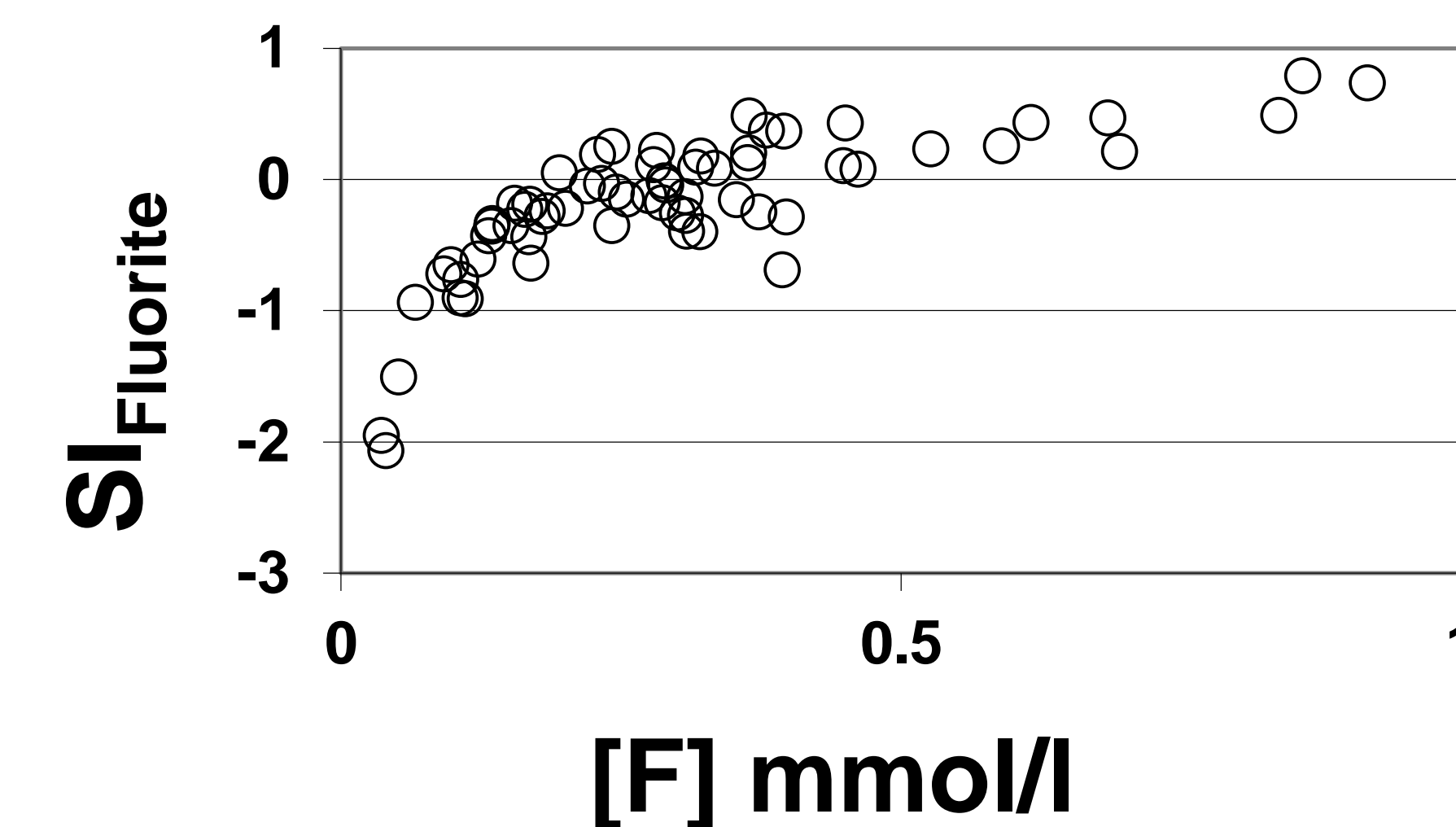
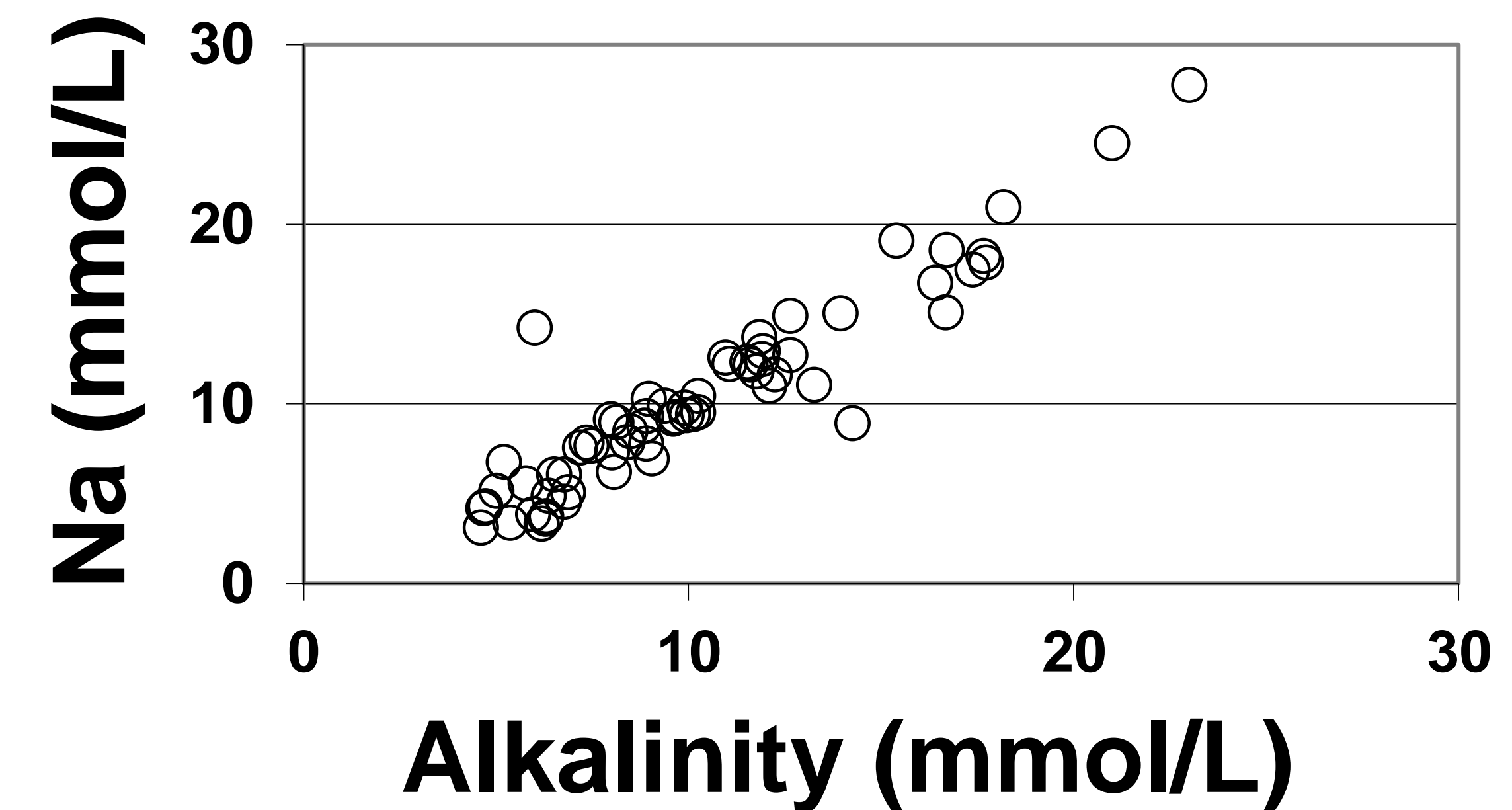
Electrical conductivity values ranged from 500-3000 $\mu\text{S}/\text{cm}$, while nitrate concentrations ranged from 0-2 mmol/L (0-120 mg/L), which indicated that infiltration and nitrification of on-site disposed waste water occurred. Generally, TOC values were low (1-6 mg/L).



3

Results - Chemistry

Our results indicated that alkalinity concentrations were high to very high (up to 25 mmol/L) and strongly positively correlated with sodium, suggesting the influence of magmatic carbon dioxide as a driver for the dissolution of sodium-rich silicates present in the aquifer (figure right). Chloride concentrations in the aquifer were around 0.5-1.5 mmol/L, which suggested that evapotranspiration was not likely to be a determining hydrochemical process.



We think that due to the dissolution of sodium-rich silicates, some fluoride, present in the silicates, also dissolved. The dissolution was governed by the saturation index of fluorite (CaF_2 ; figure left).

With PHREEQC determined fluorite saturation index as a function of the fluoride concentration

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Conclusions

- Permeabilities of the basaltic debris aquifer were in the range of 1-20 m/d, which is considered to be high.
- Many groundwater samples contained nitrate due to waste water infiltration combined with nitrification in the apparently aerobic aquifer.
- Groundwater use management strategies should discard the shallowest, most contaminated, groundwater and focus on defluoridation of groundwater from depths of 20 m and more below ground surface

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Reference

Morienyane, T., 2016. Groundwater Flow System Analysis Of A Slum Area in Sub Saharan Africa Case Study of Sombetini and Unga Limited in Arusha Tanzania. UNESCO-IHE MSc Thesis WSE-HWR-16.01.

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