Hydraulic Interconnection between the Volcanic Aquifer and Springs, Lake Tana Basin on the Upper Blue Nile

Fenta Nigate[a,b], Marc Van Camp[b], Seifu Kebede[c], Kristine Walraevens[b]

[a] Blue Nile Water Institute, Department of Earth Science, Bahir Dar University, Ethiopia

[b] Laboratory for Applied Geology and Hydrogeology, Department of Geology Ghent University,Gent, Belgium

[c] Department of Earth Sciences, Addis Ababa University, Ethiopia

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Wisdom at the Source of the Blue Nile

VLIR Vlaamse Interuniversitaire Raad
UOS University Development Co-operation

N°abstract

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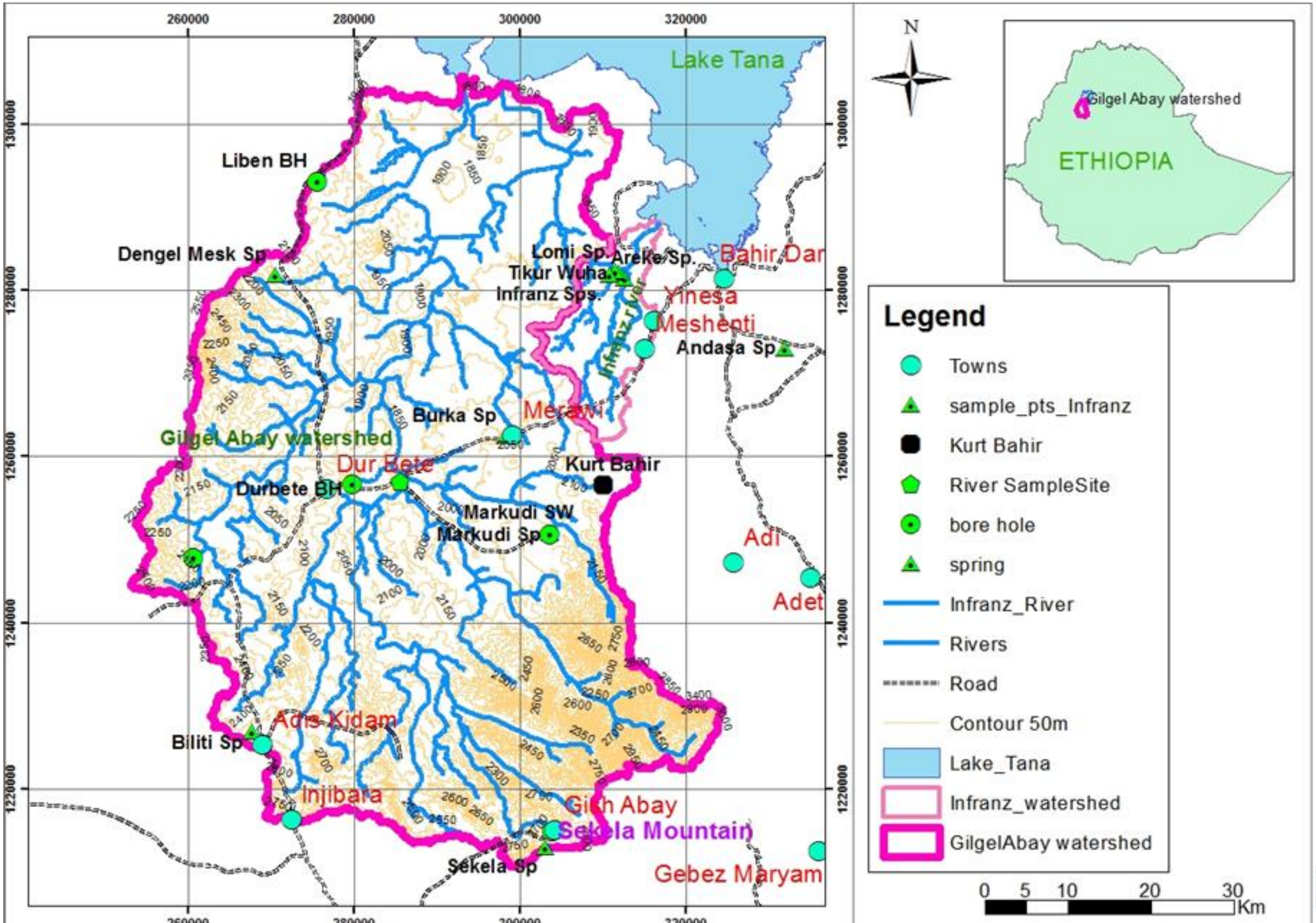
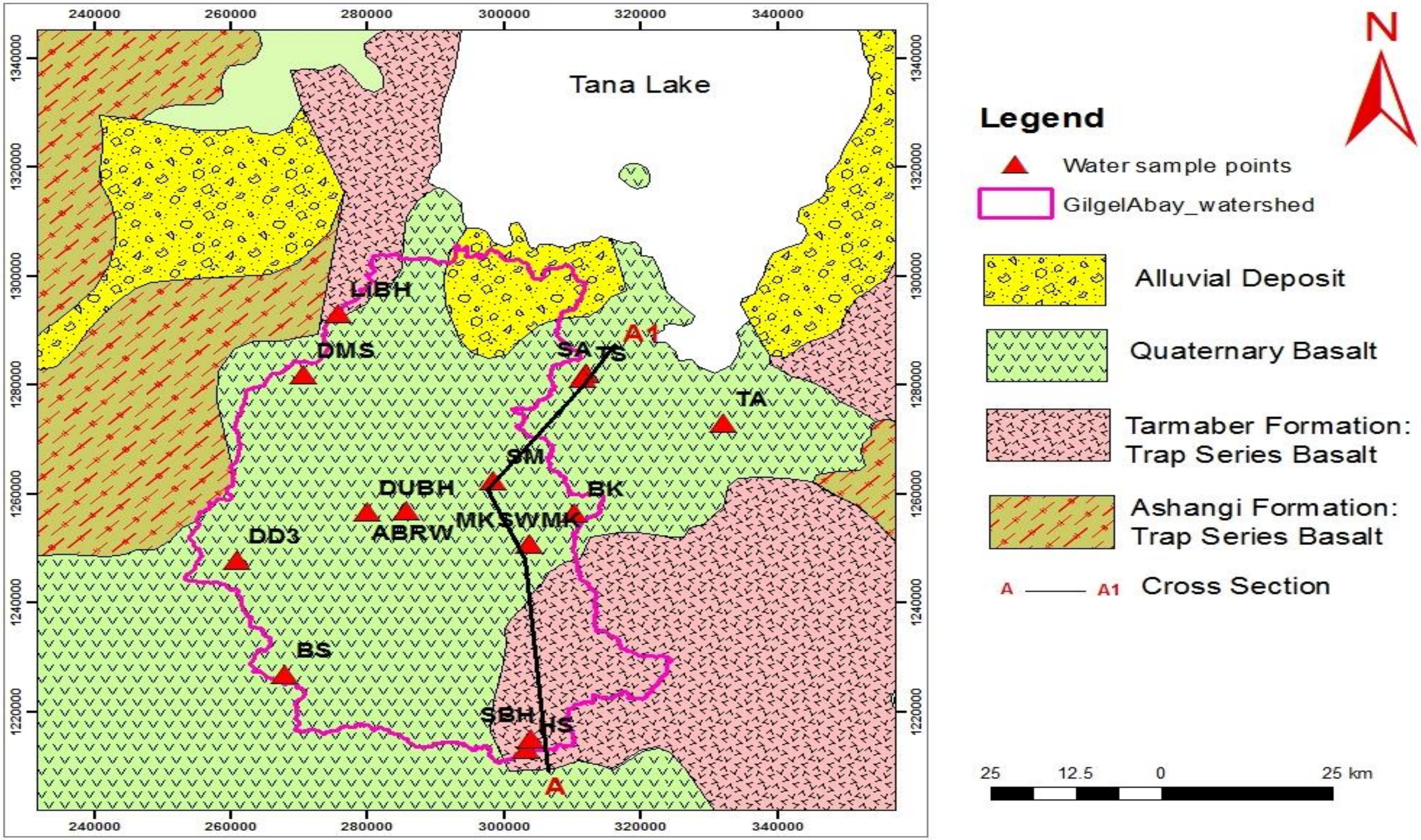
Introduction

- Location of the study area



Geology and hydrogeology



Geological outcrops at the spring area

Recent Quaternary basalt:Highly vesicular, scoraceous and blocky nature and froms small hills here and there

Major springs in the study area

Name of Major springs	Estimated discharge	characteristics	Extraction to water supply
Areke Spring	estimated discharge > 165 l/s; some technical reports and thesis estimated differently, 210 l/s	They are highly diffused to estimate correctly	51 % of estimated discharge
Lomi spring	estimated discharge > 58 l/s, some technical reports estimated 90 l/s		41 % of estimated discharge
Infranz springs (two twin springs)	Estimated > 60 l/s		Not known
Tikur Wuha spring	estimated discharge> 30 l/s		
Merawi spring	Not estimated		Not known
Andasa spring	Not estimated		Not used

Problem statement

- The high discharge springs, namely: Areke, Lomi, Infranz, Tikur Wuha and others around Bahir Dar; Andasa (Tikurit) spring, and Merawi (Burka) springs are not well studied, and
  - it remains unclear whether they are regionally or locally sourced, because of the limited set of physical, chemical isotopic characteristics.

Objectives of the Study

- The study was conducted:
  - ❖ to identify the hydrological interconnection between these springs with the surrounding regional and local volcanic aquifer systems

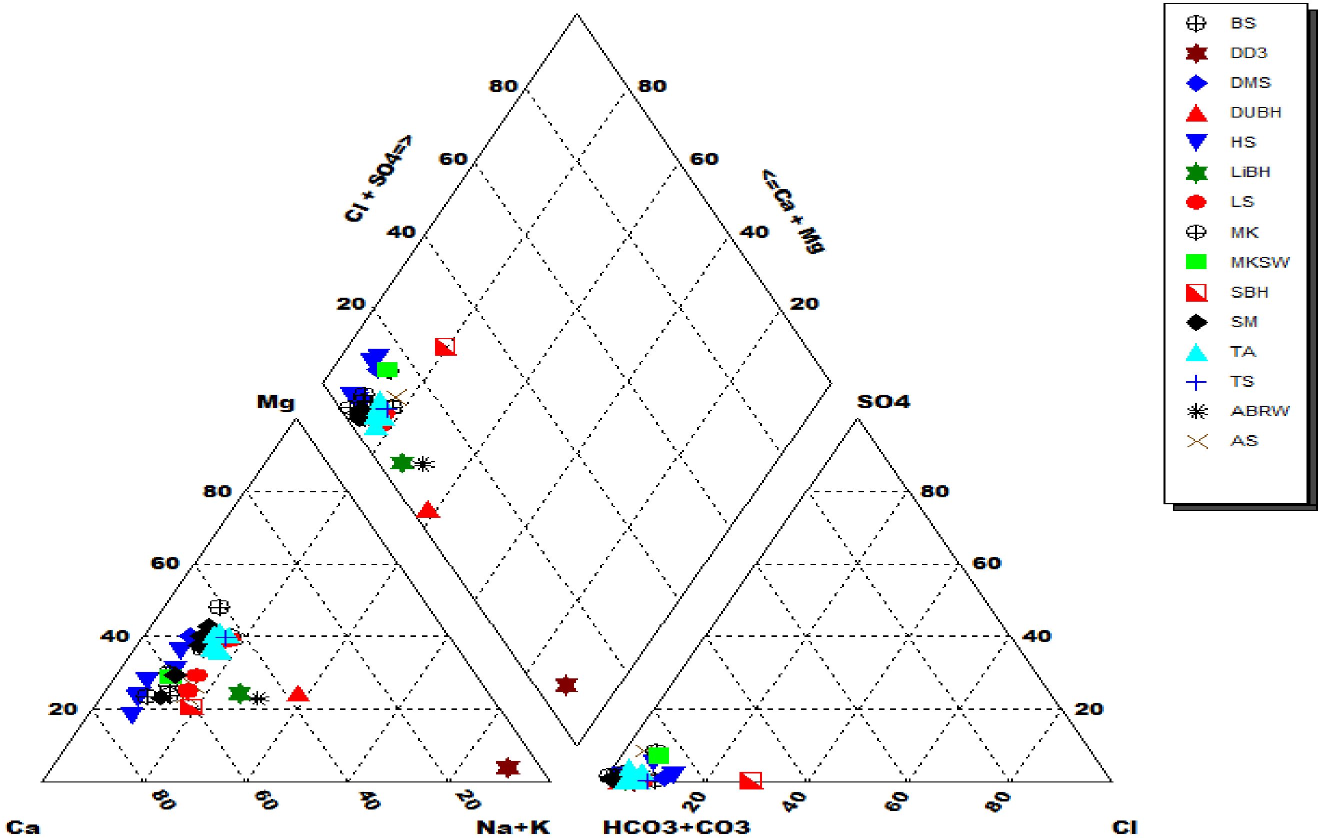
Methodology and Approach

Water sampling for chemistry and isotope analysis

- 1 spring at highlands of the area,
- 1 spring in transition zone and
- 3 springs in the lowlands of the study area were selected for continuous physico-chemical and isotope data collection and analysis for one year, June 2012-June 2013.
- 1 time snapshot samples were collected from boreholes, surface water and other available springs.

- The sampling sites were selected based on
  - ❖ the accessibility,
  - ❖ groundwater flow direction and
  - ❖ physiographic distribution in the catchment
- The collected water samples were analyzed for cations and anions; and stable isotopes

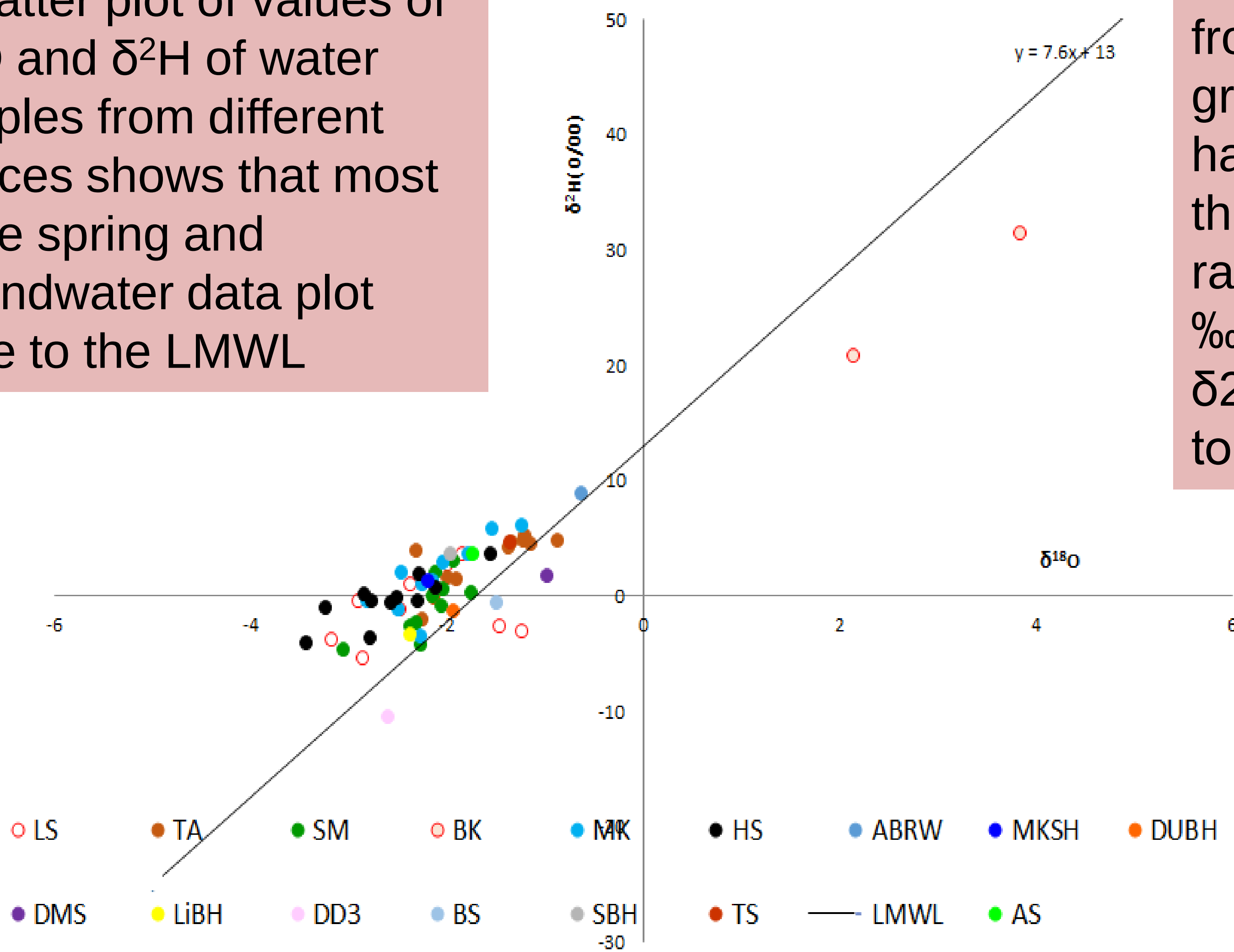
Result and Discussion



- Samples from the springs and wells have low TDS (less than 400 mg/l) and low EC (less than 400 µS/cm).
- Major ions collected from springs, wells and surface water are plotted in the piper diagram . The result shows that most of the waters are very similar and fall in the same cluster of Ca-HCO_3 type, except some

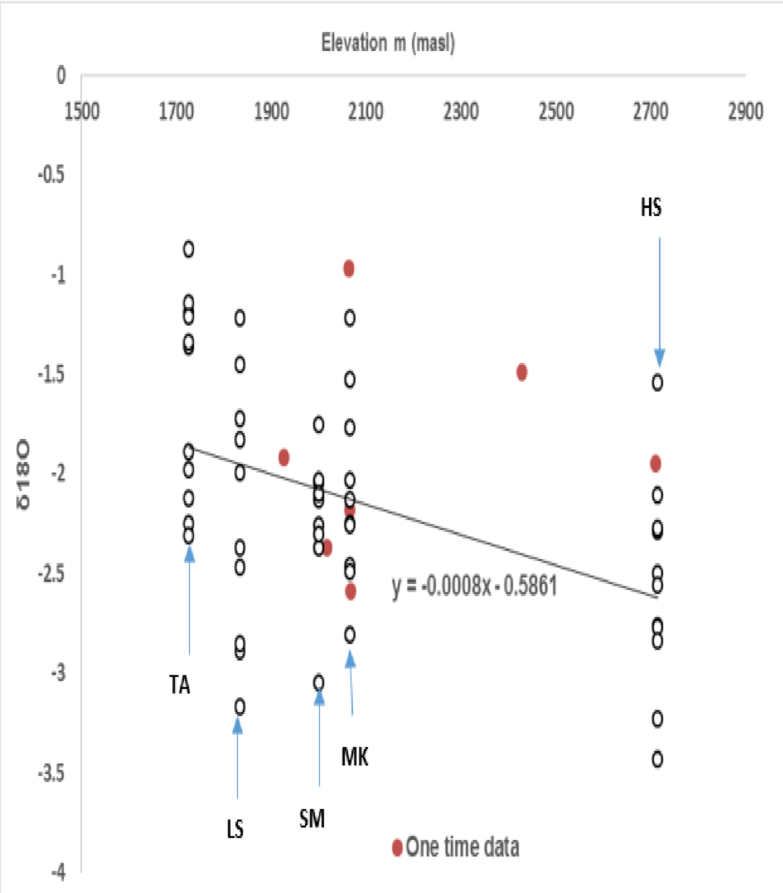
Isotopic composition of the waters of spring and adjacent boreholes

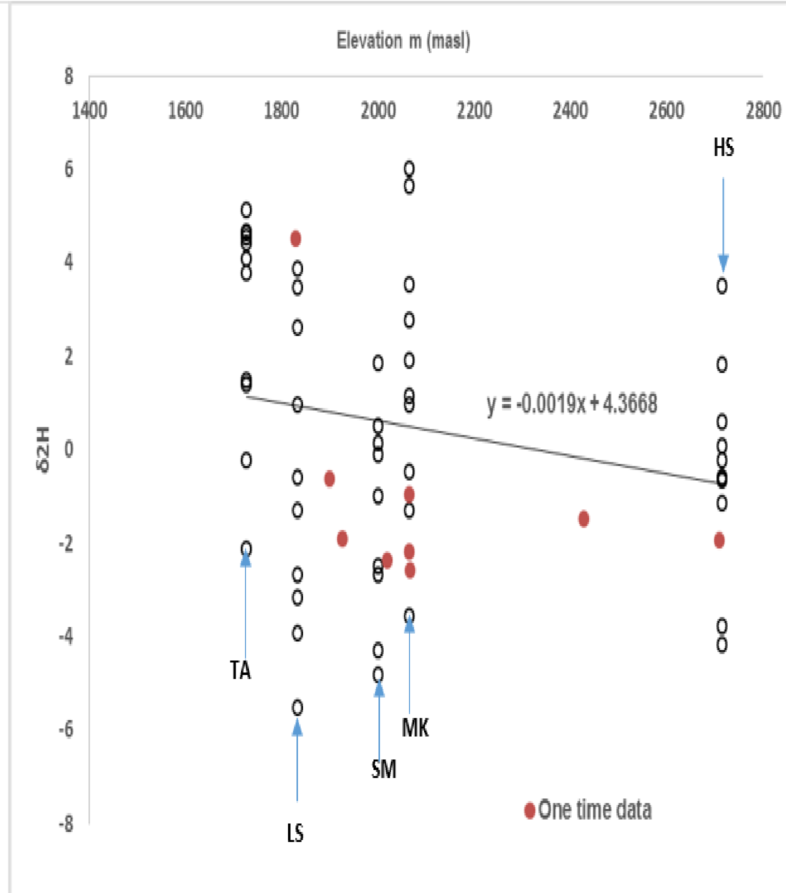
A scatter plot of values of $\delta^{18}O$ and $\delta^{2}H$ of water samples from different sources shows that most of the spring and groundwater data plot close to the LMWL



The data collected from springs and groundwaters have shown that the value of δ18O ranges from -3.43 ‰ to -0.87‰ and δ2H from -10.58‰ to +6.03‰.

Elevation versus stable isotopes



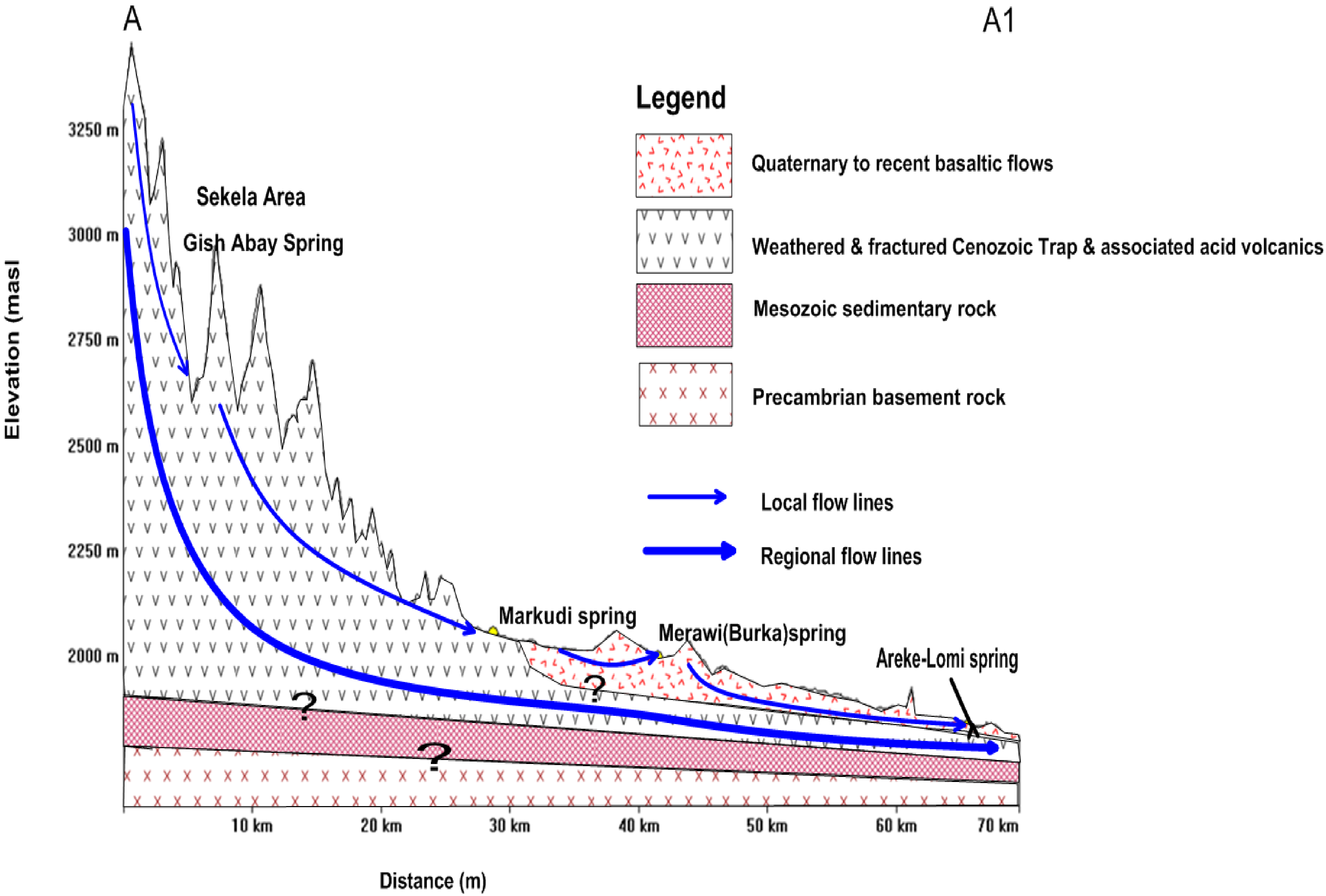


the best fit trend line was calculated
$\delta^{18}O = -0.0008 Z - 0.5861$

best fit trend line equation
$\delta^{2}H = -0.0019 Z + 4.3668$

Groundwater flow system and sources of recharge to the springs

- The hydrochemical composition of springs and some groundwater wells is Ca-HCO_3.
  - ❖ This indicates that recharge to springs and groundwater is from the shallow aquifer system with short residence times without further chemical evolution.
- The isotopic signature of most of the samples from boreholes and springs falls within the range of rainwater isotopic composition at Addis Ababa.
  - ❖ This indicates that the sources of recharge for the shallow wells and springs are from modern precipitation



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Conclusion

- The springs and most of the well waters sampled for chemical analysis show that the chemistry of the water is categorized into one type of water, Ca-HCO_3.
- The chemical and isotopic composition of spring and borehole water, except some, shows limited water-rock interaction, shallow groundwater circulation, superficial flow and low residence time.
- The isotopic signature of most of the samples from boreholes and springs falls within the range of rainwater isotopic composition.
  - ❖ This indicates that the sources of recharge for the shallow wells and springs are from modern precipitation. Their isotopic composition relates with elevation of the springs, and together with their limited chemical evolution,
    - ➢ this shows that they are locally recharged rather than regionally

Thank you