Simulation of groundwater recharge in a volcanic aquifer system using a probabilistic method

Tadjourah region, Republic of Djibouti

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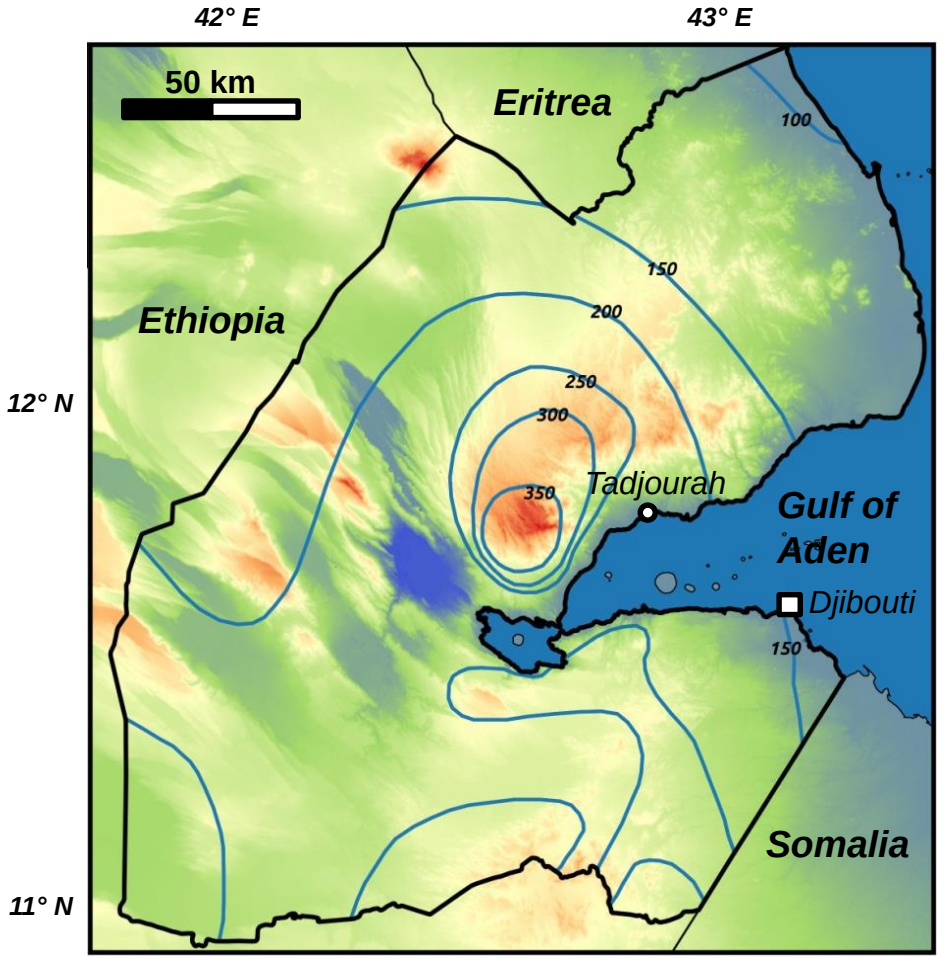
25-29th September 2016
Montpellier, France
CORUM CONFERENCE CENTER
43rd IAH congress

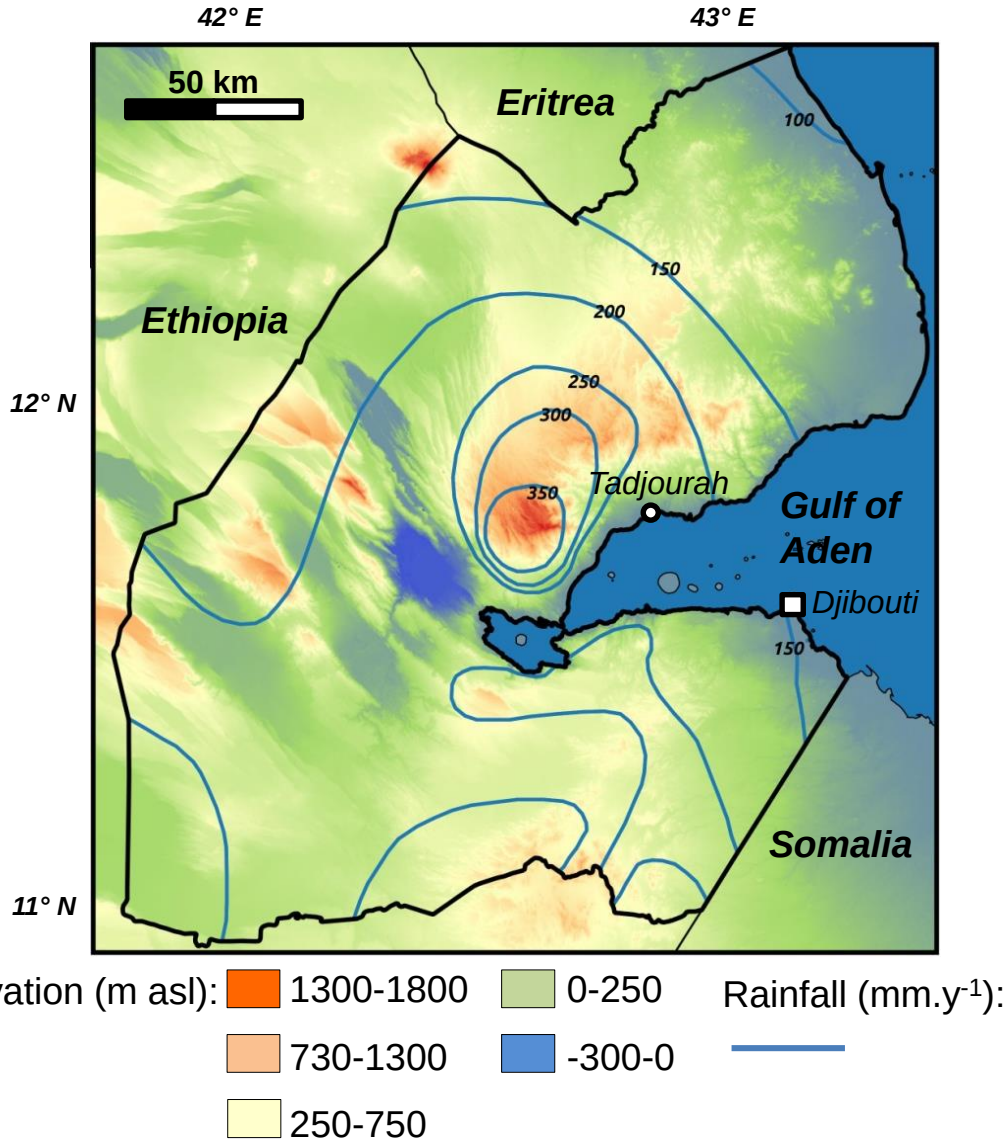
The Republic of Djibouti



23,000 km^2
900,000 inh.

150 mm.yr^{-1} / 38°C

The Republic of Djibouti

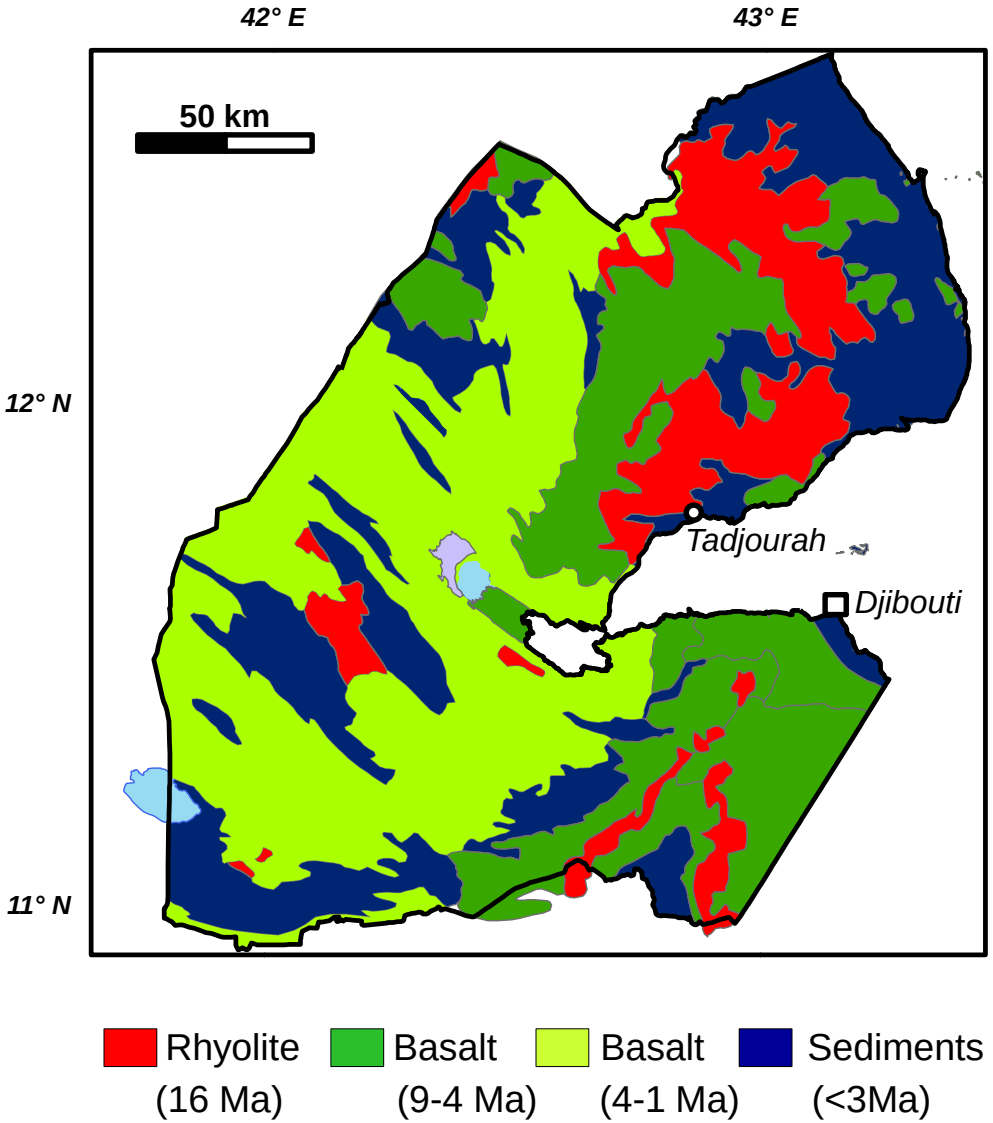


23,000 km^2
900,000 inh.

150 mm.yr^{-1} / 30°C

No perennial surface water

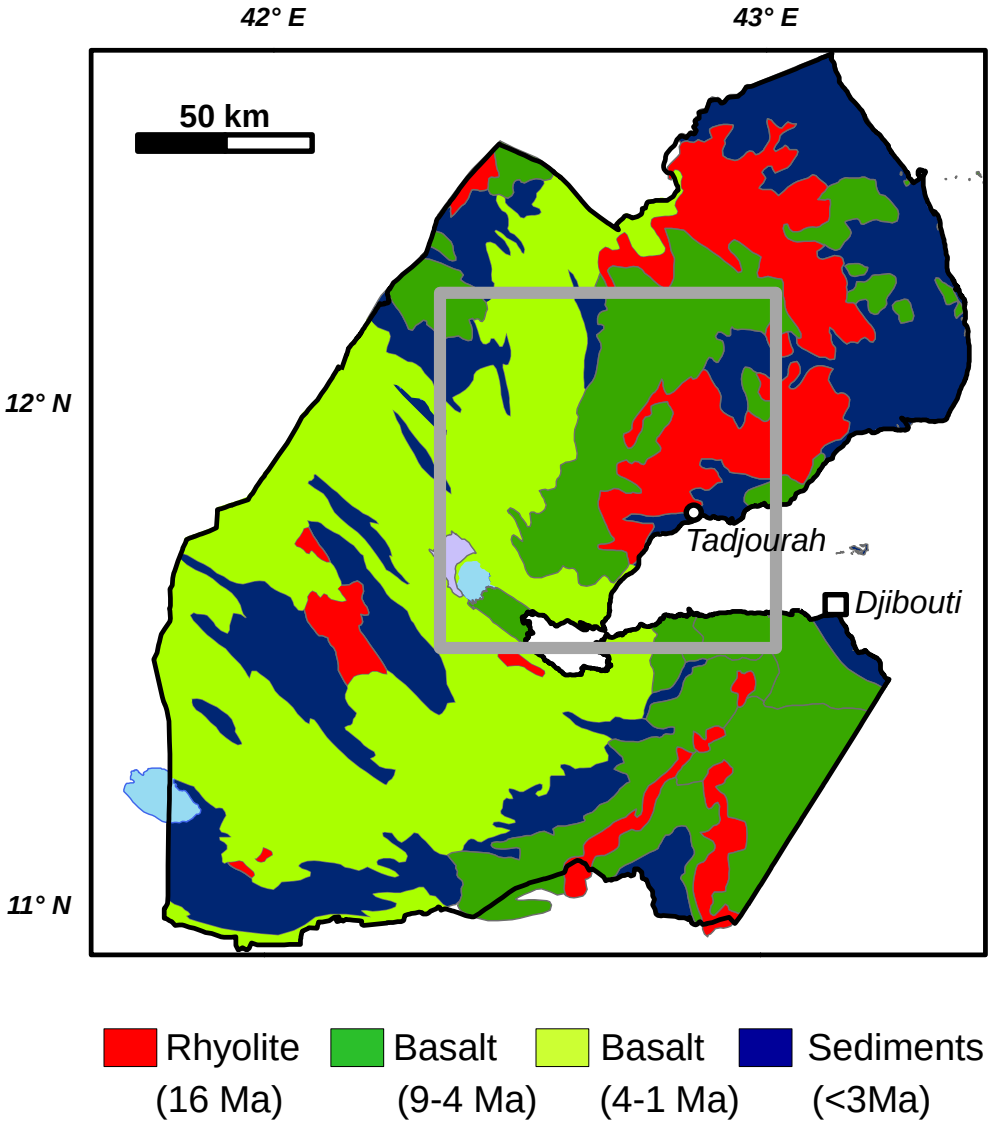
Groundwater potentialities



Evaluation of potentialities for the hard rock aquifer system

Dominant recharge processes ?
Recharge rates ?

Groundwater potentialities

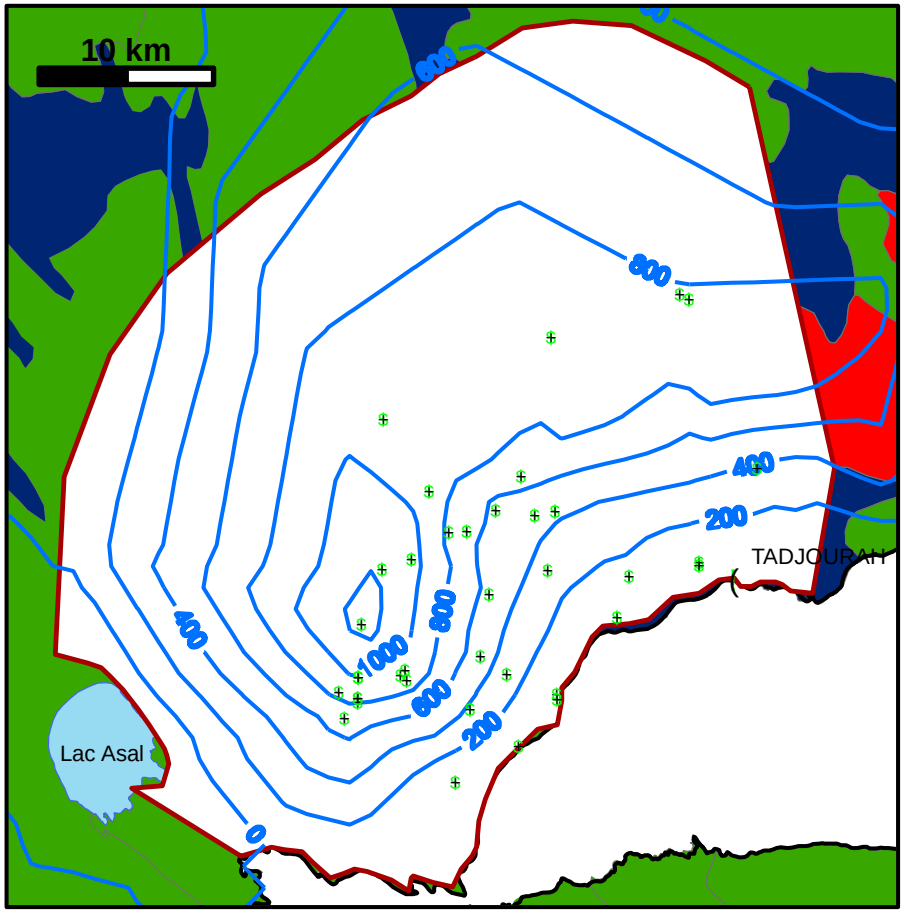


Evaluation of potentialities for the hard rock aquifer system

Dominant recharge processes ?
Recharge rates ?

Numerical modelling in the Tadjourah area

Data scarcity

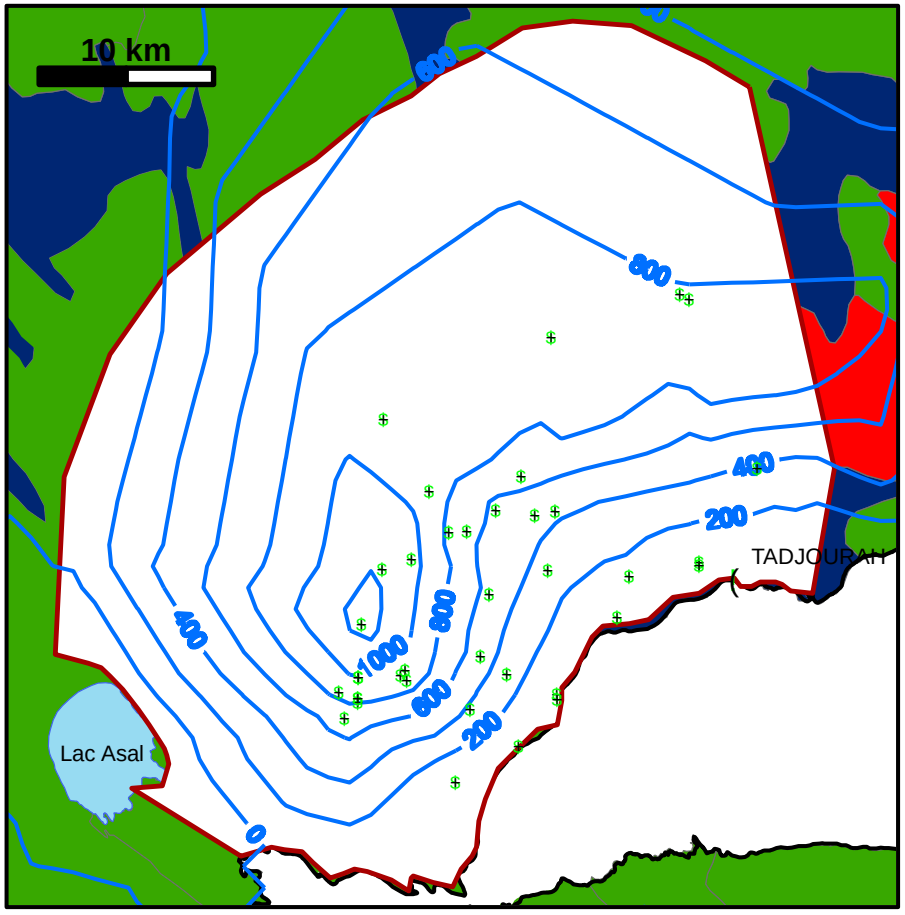


3,000 km^2
38 head control points with a high uncertainty level

Rhyolite (16Ma) Basalt (9Ma) Sediments (<3Ma)

Head control point Piezometric head

Data scarcity



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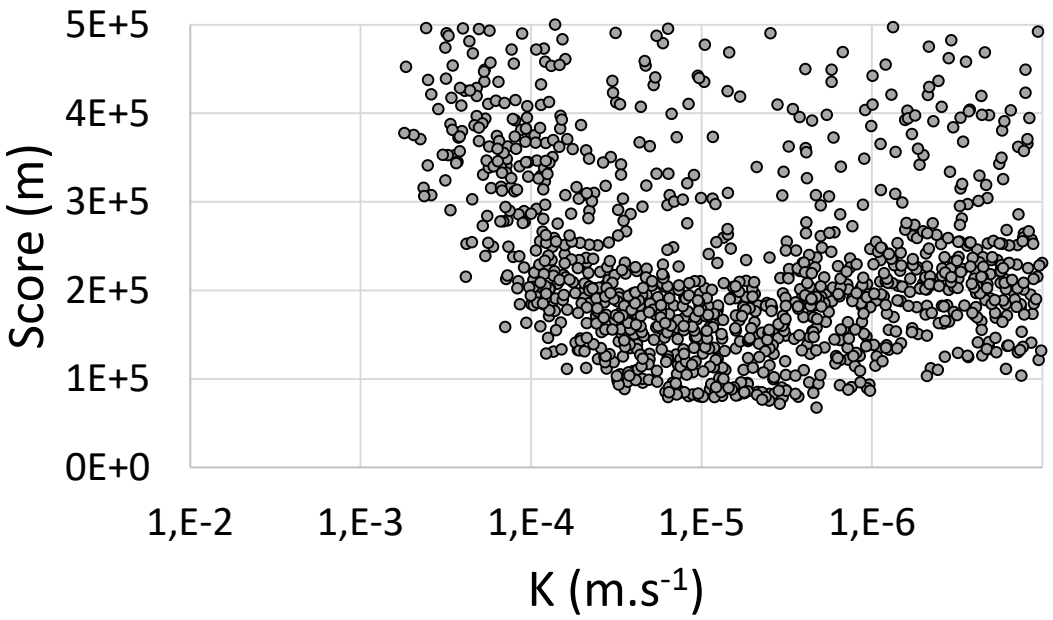
Head control point Piezometric head

3,000 km^2
38 head control points with a high uncertainty level

A method dealing with uncertainties

A Monte-Carlo approach

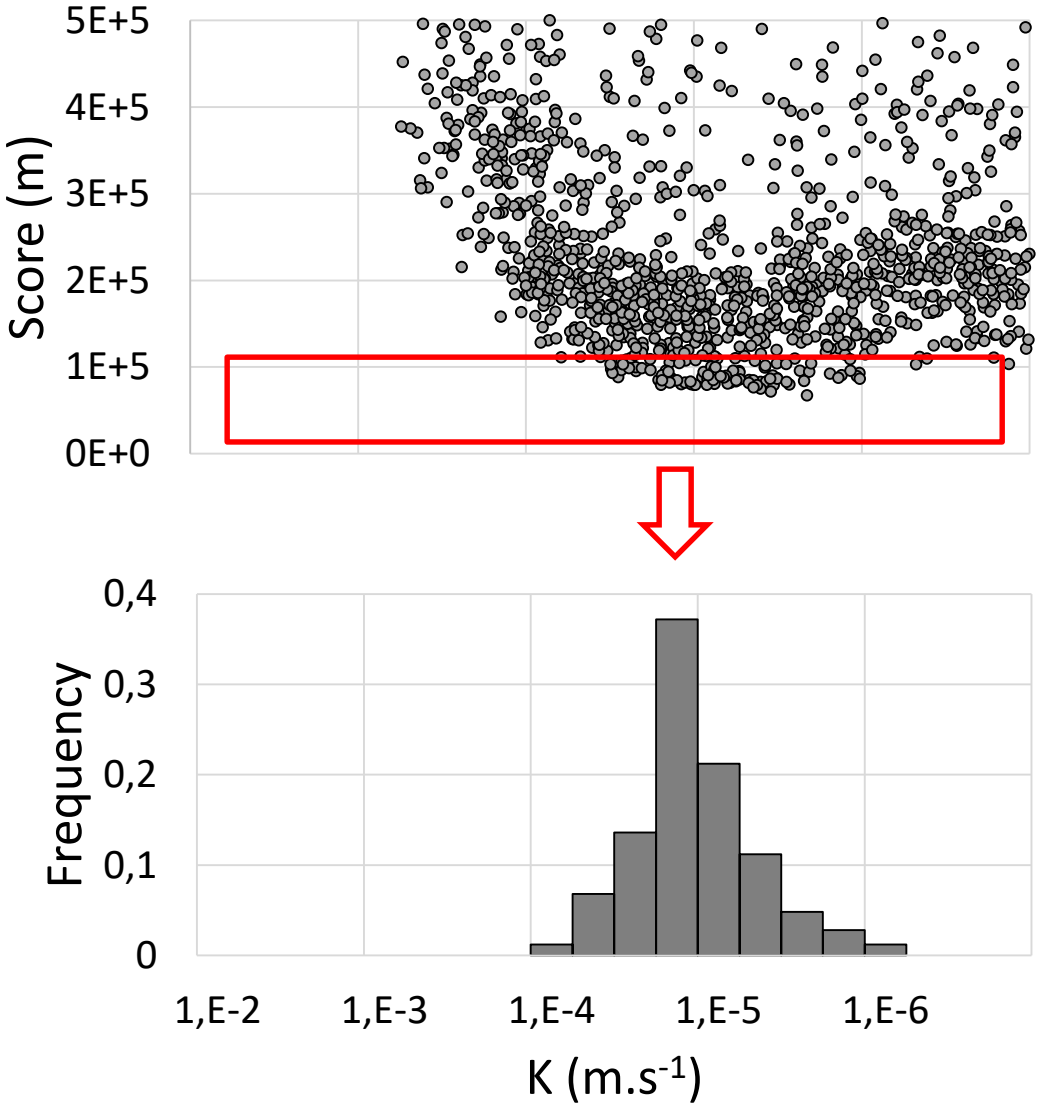


(i) 10,000 random parameters sets

(ii) 10,000 simulations

(iii) sorting regarding [simulated head – observed head]

A Monte-Carlo approach



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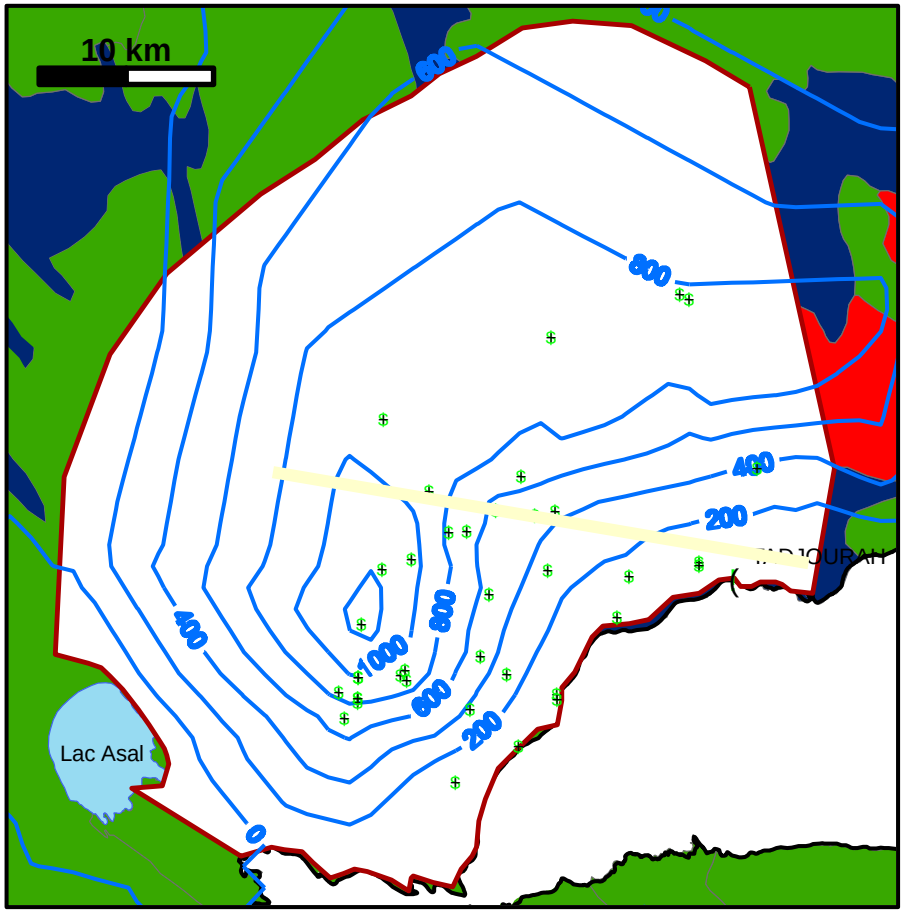
Results in probability density functions

The conceptual model



3 hydrogeological units
2 layers

Recharge (diffuse or indirect) related to 3 rainfall zones

Rhyolite (16Ma) Basalt (9Ma) Sediments (<3Ma)

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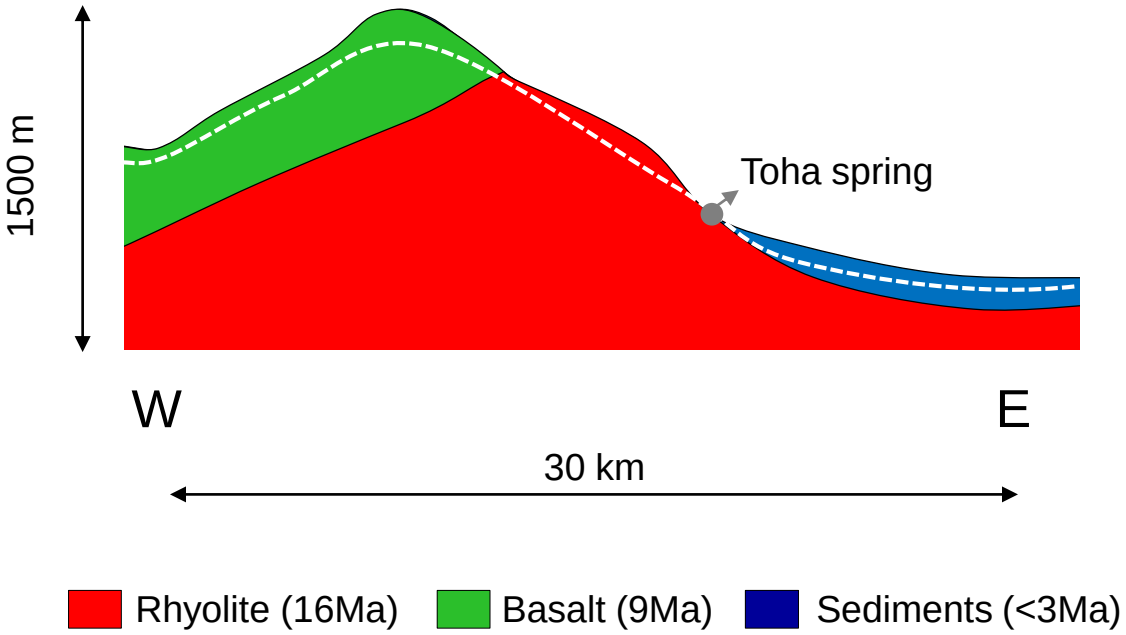

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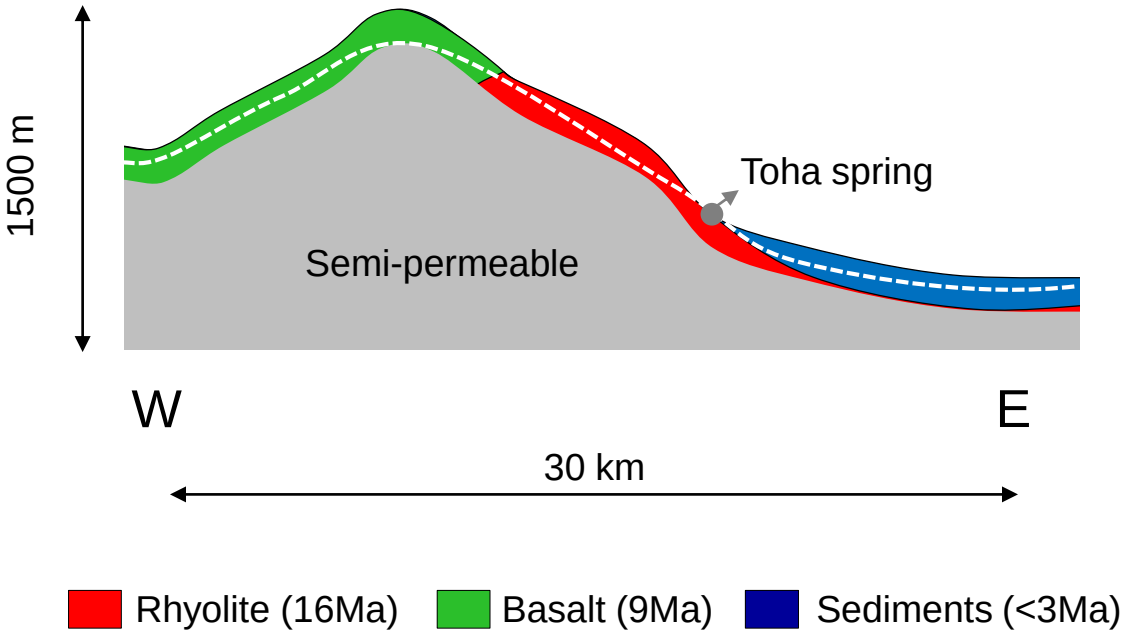

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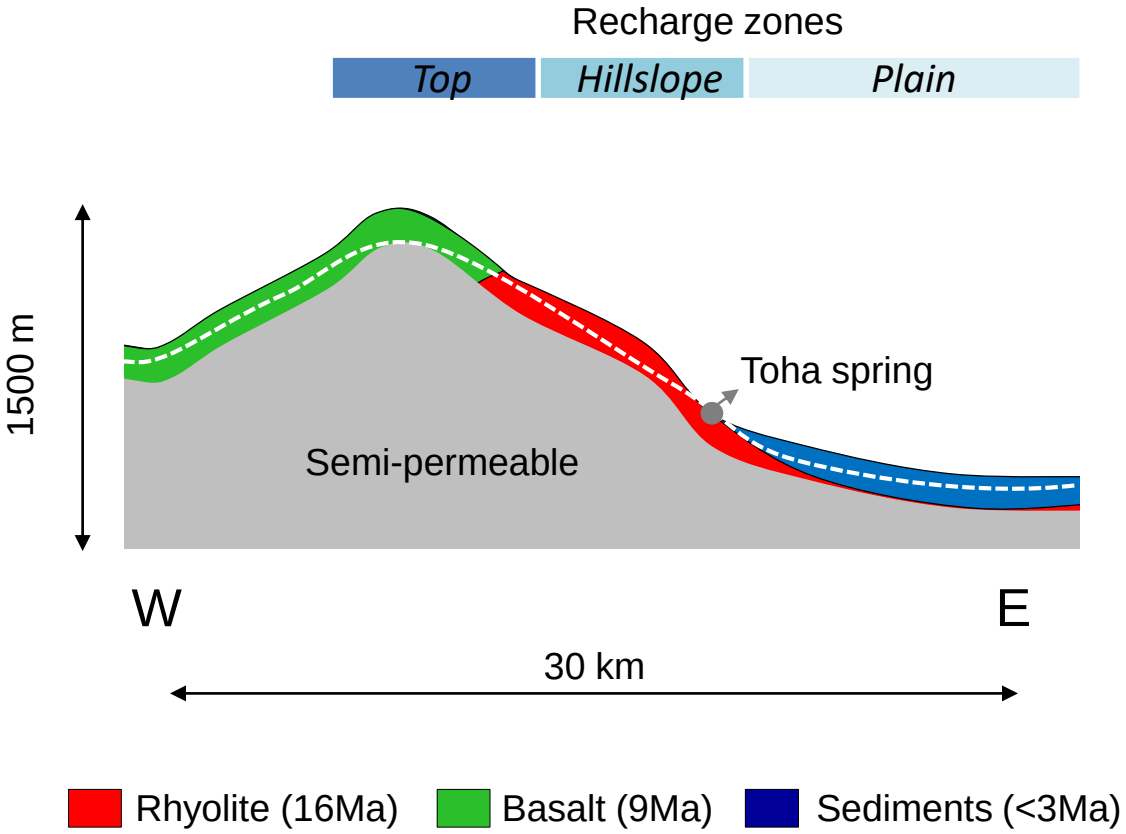

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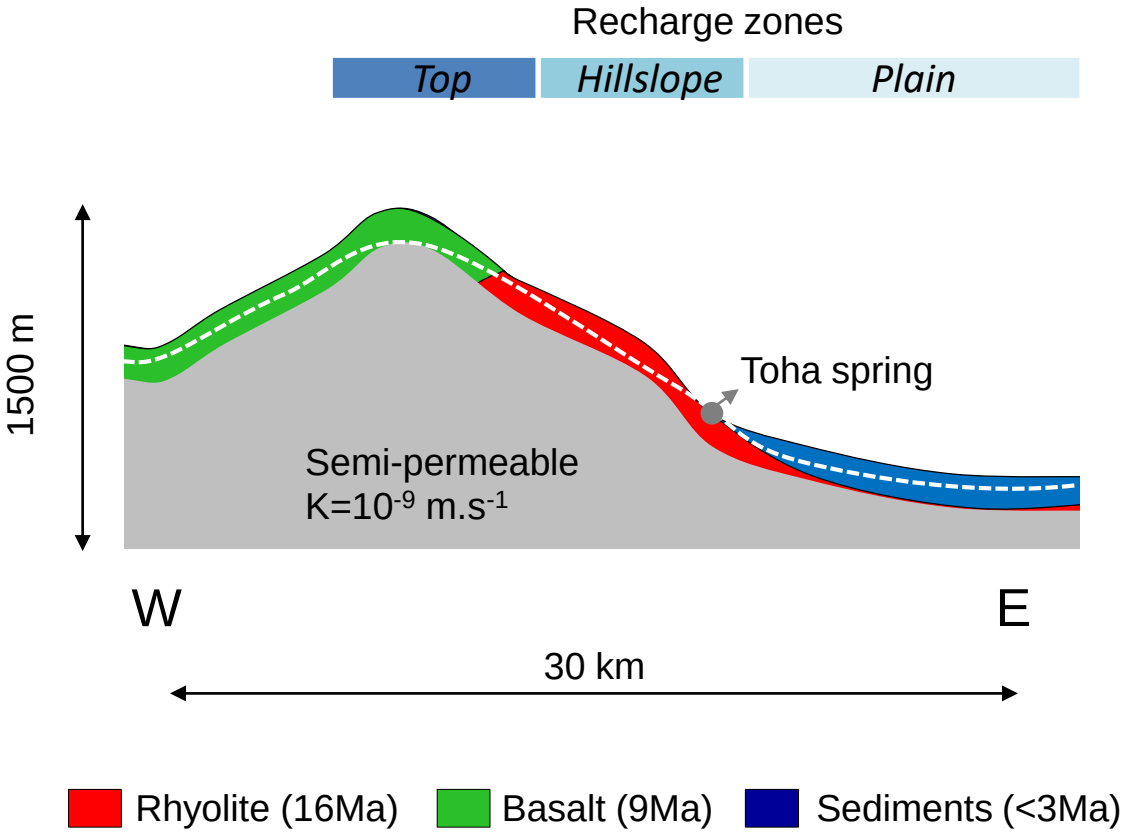


3 hydrogeological units
2 layers

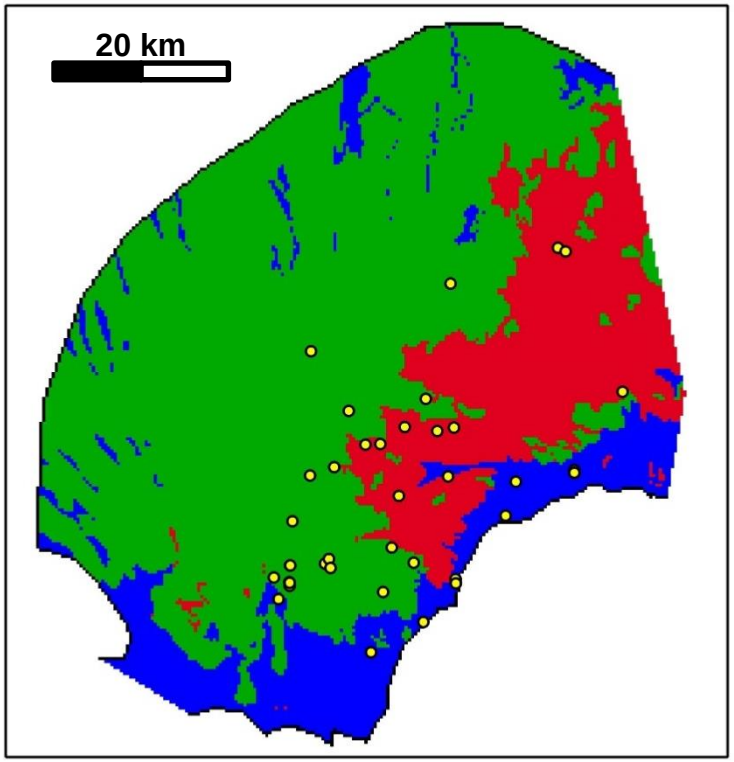
Recharge (diffuse or indirect) related to 3 rainfall zones

Inference of 6 (+1) parameters

Model design

3 hydraulic conductivities

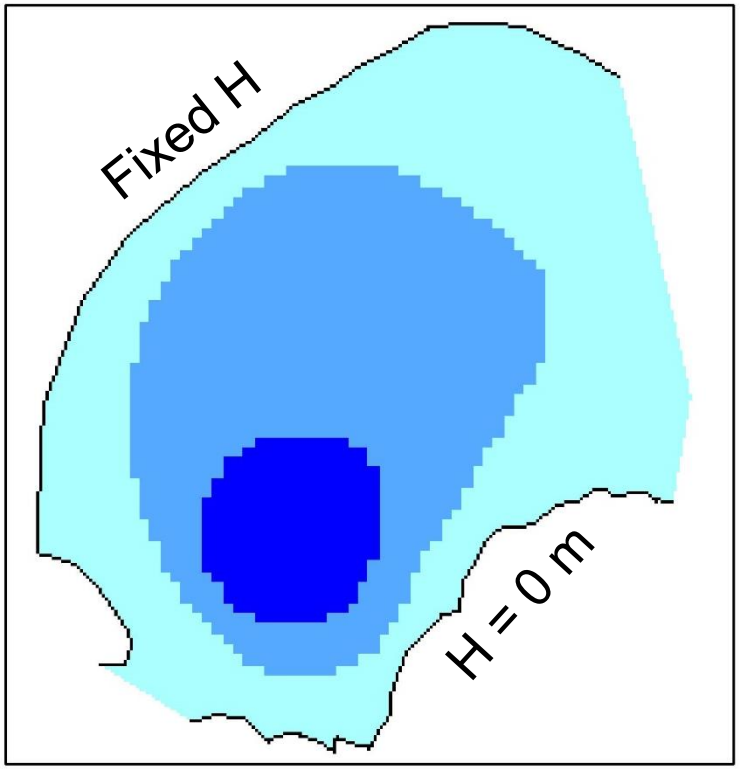
Rhyolite Basalt Sediments



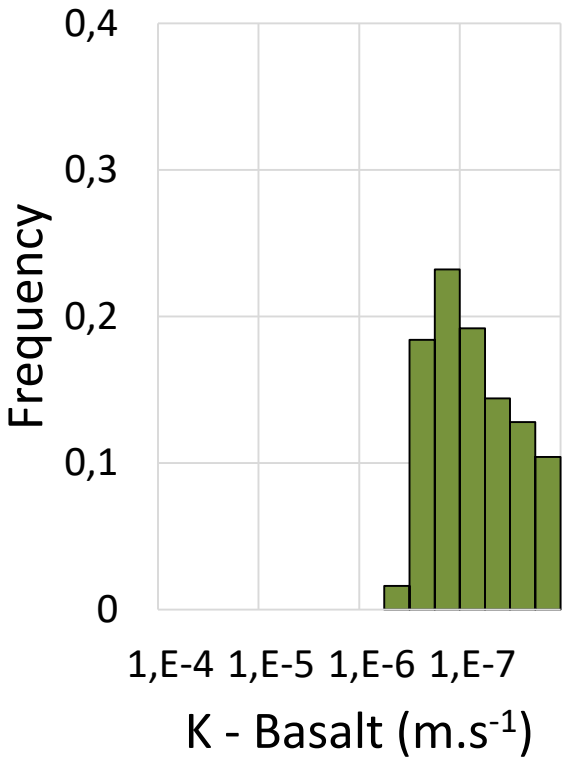
Head control point

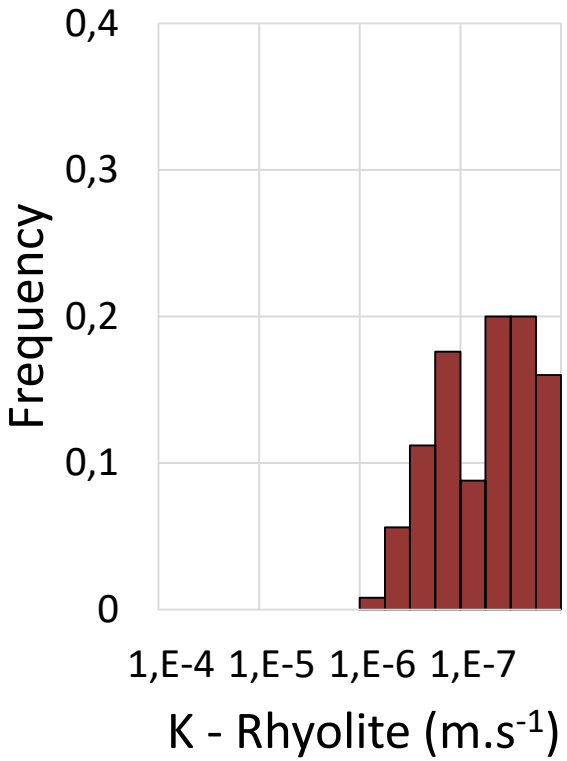
3 recharge zones

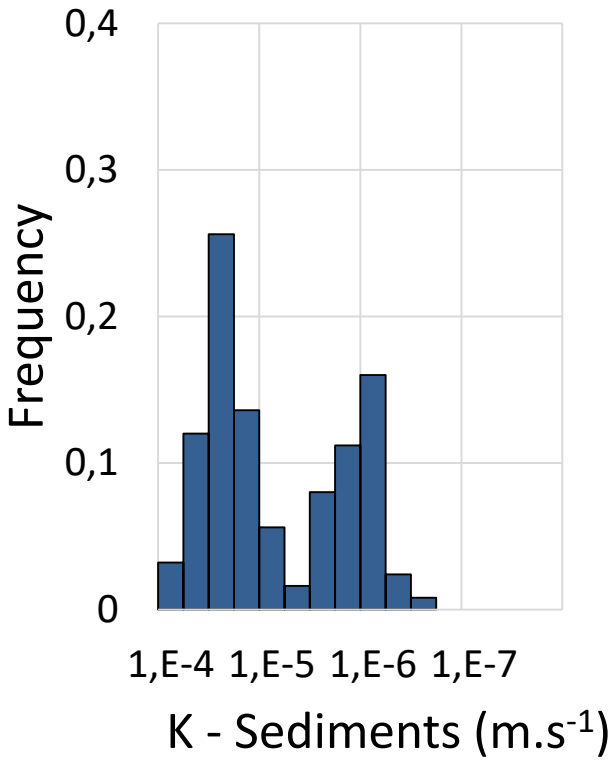
Top | Hillslope | Plain



Hydraulic conductivities (250 best simulations)

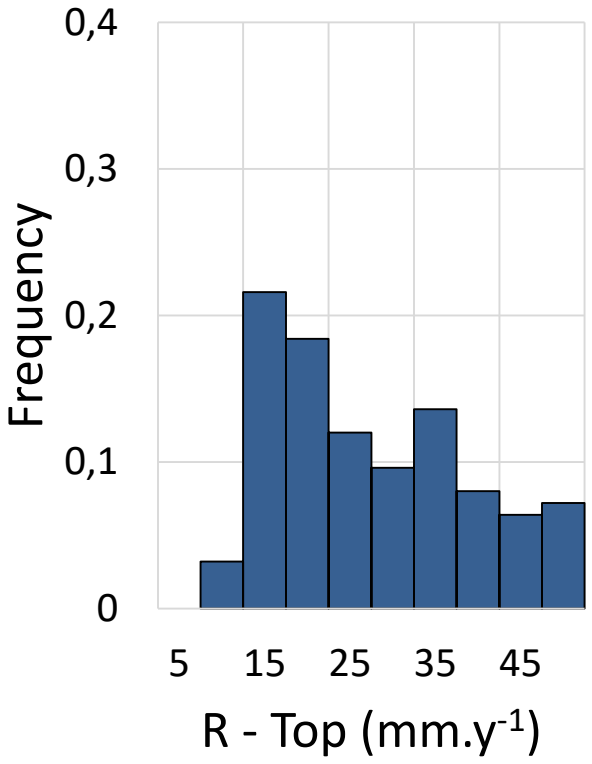


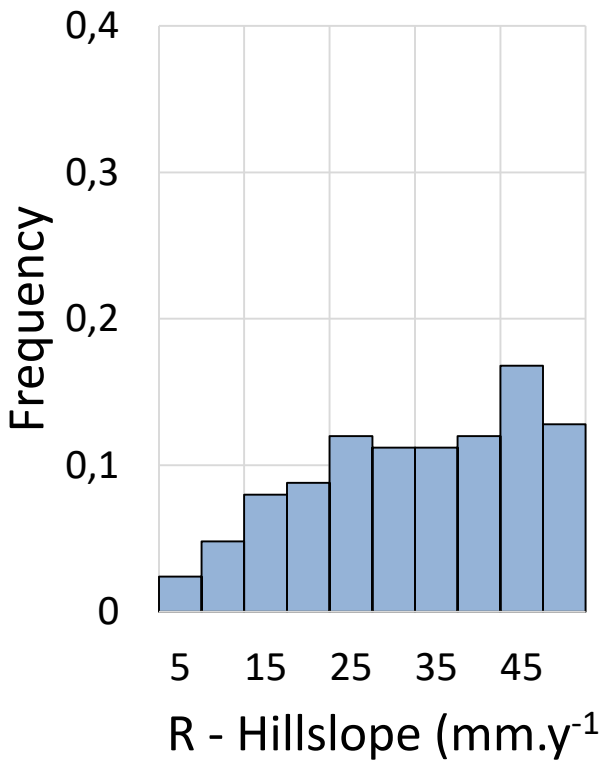


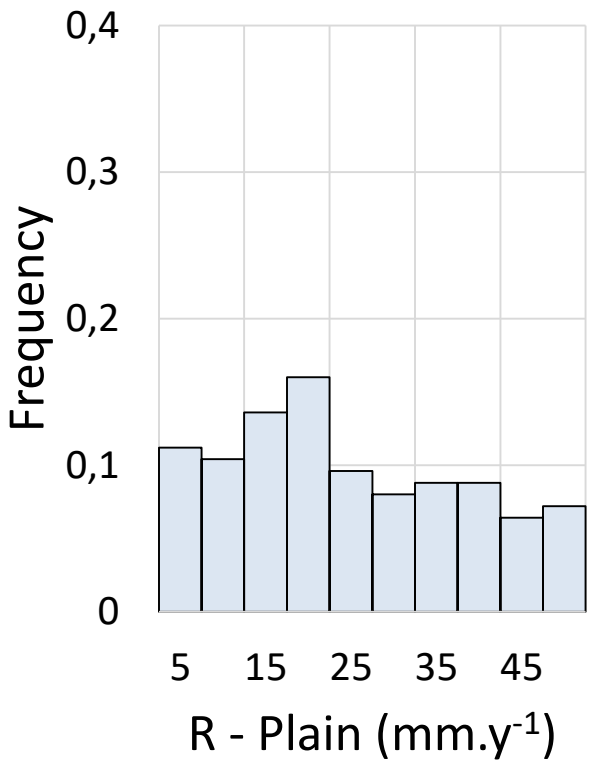


K / 10 regarding available field data

Diffuse recharge (250 best simulations)





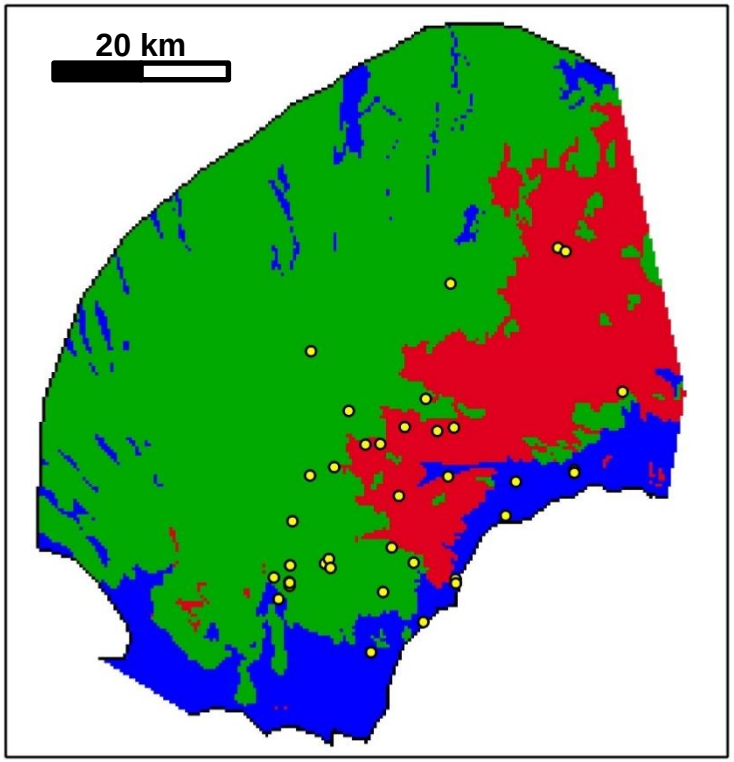


R - Top & Hillslope influence the model

Model design

3 hydraulic conductivities

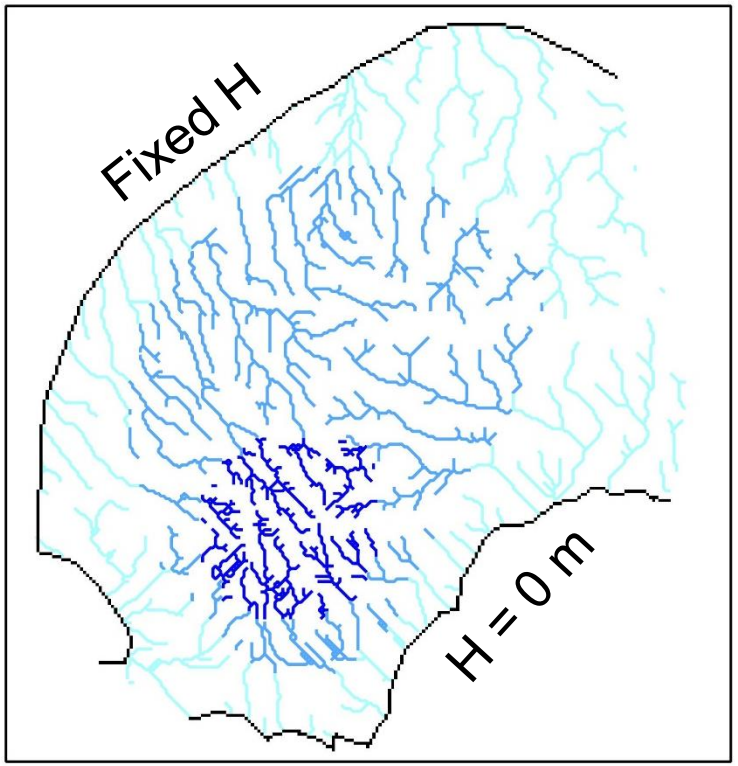
Rhyolite Basalt Sediments



Head control point

3 recharge zones

Top | Hillslope | Plain



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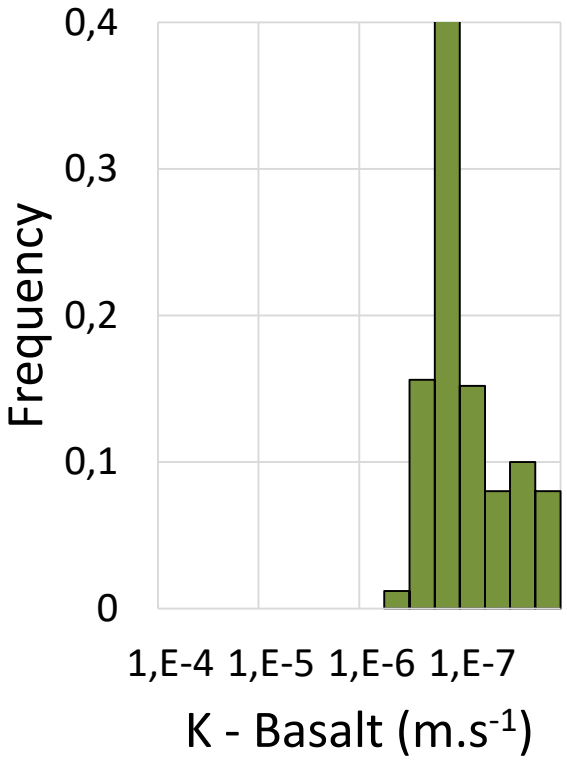
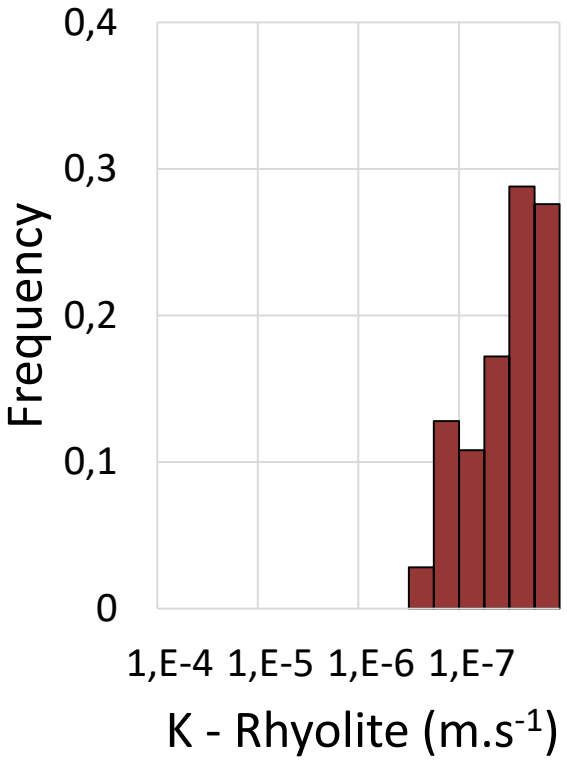
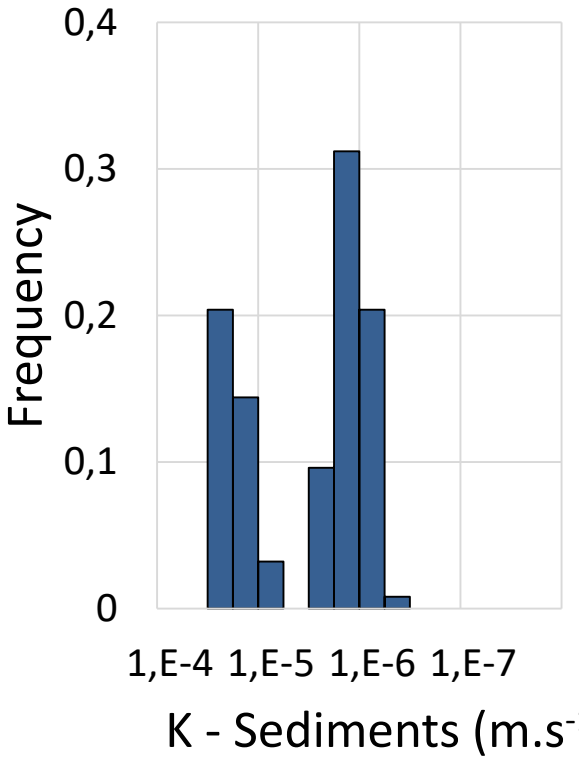
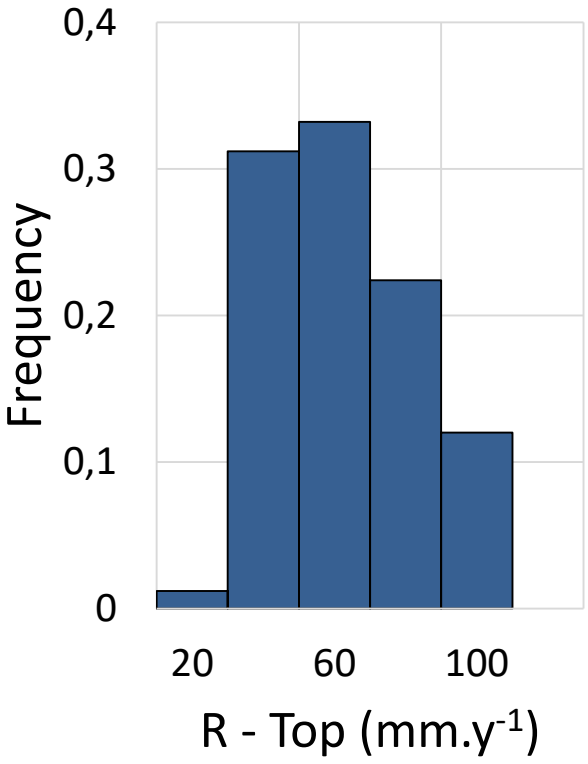


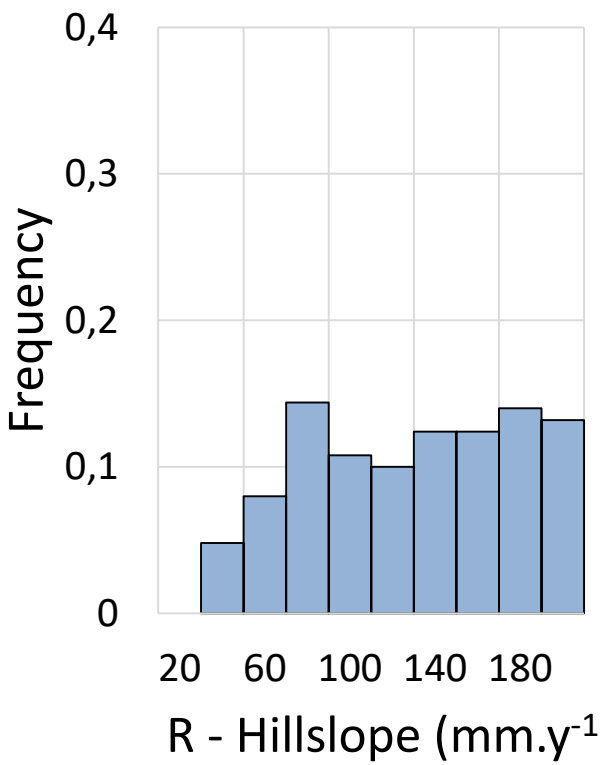


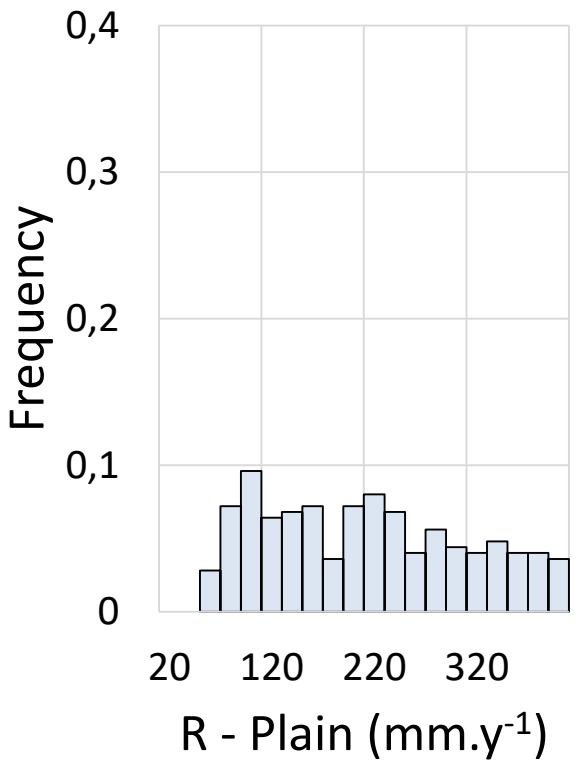


Similar trends regarding the diffuse case

Indirect recharge (250 best simulations)

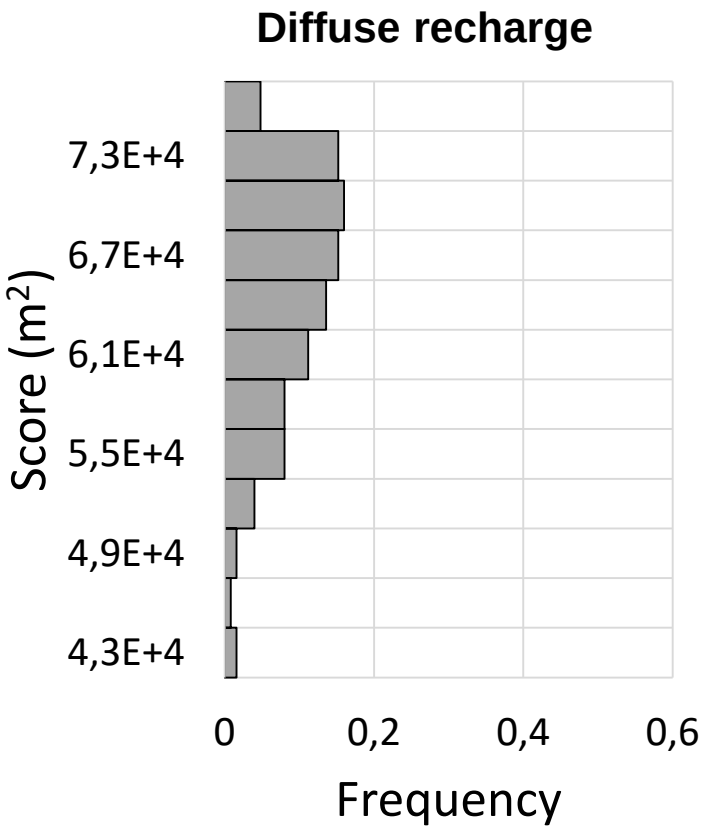


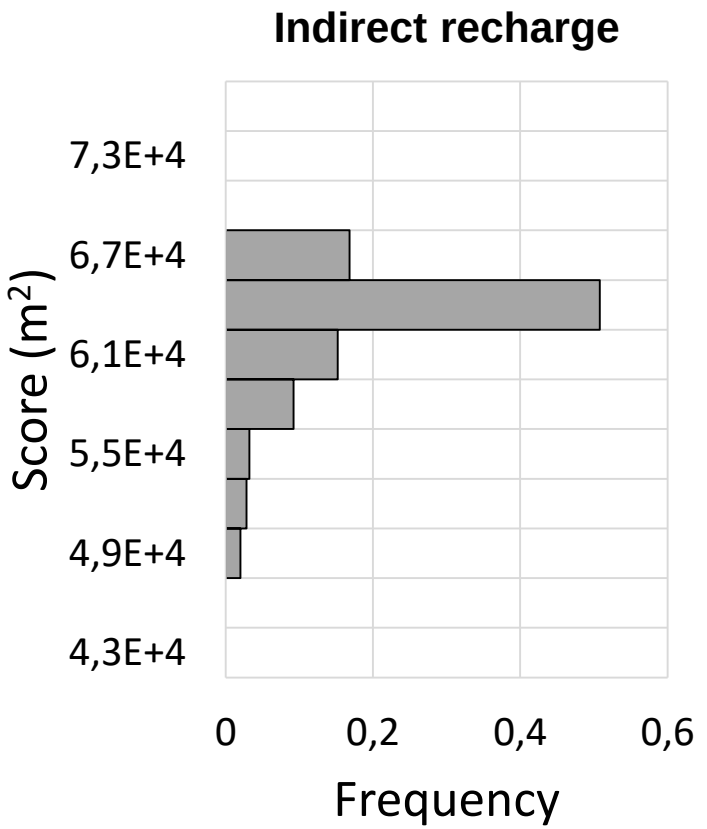




Similar trends regarding the diffuse case

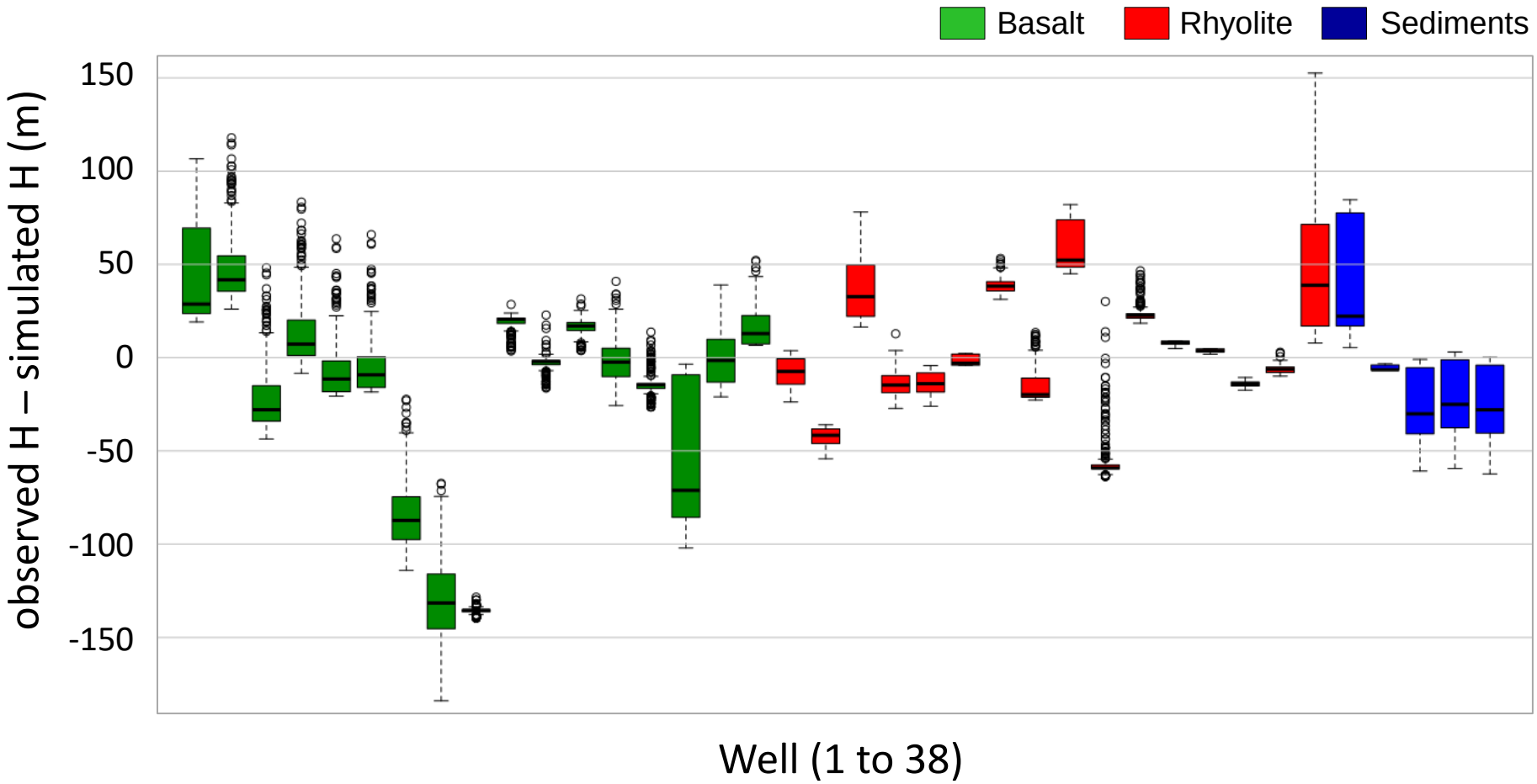
Simulation quality (250 best simulations)





The indirect configuration slightly enhances the scores

Simulation quality (250 best simulations)



Differences regarding observed head remains important (data quality problem?)

Monte-Carlo approach: dealing with uncertainty and exploring the equfinality issue

Two recharge configurations: similar trends and performance with diffuse and indirect recharge

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Two recharge configurations: similar trends and performance with diffuse and indirect recharge

Piezometric dome: well reproduced with a low recharge rate

Basalt hydraulic conductivity: well constrained / lower than expected

Rhyolite: poor aquifer properties

Monte-Carlo approach: dealing with uncertainty and exploring the equfinality issue

Two recharge configurations: similar trends and performance with diffuse and indirect recharge

Piezometric dome: well reproduced with a low recharge rate

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A mixed recharge diffuse/indirect configuration?

Test with selected head control points?

MERCI POUR VOTRE ATTENTION