Towards the use of multiple state variables in hydrogeological modelling supporting site characterisation

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Introduction

Aquifers surrounding potential host rocks for geological radwaste disposal

- are **not part of the disposal system** itself,
- **do not fulfill any** containment, retardation or isolation **function**, but
- **form the connection** between disposal system and **biosphere**, and hence
- are an **essential element in site characterisation** studies.

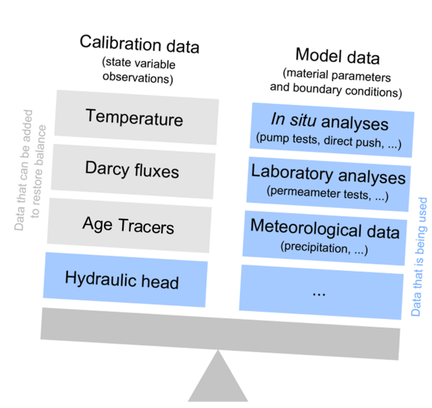
Advection-dispersion of radionuclides potentially released from the disposal system

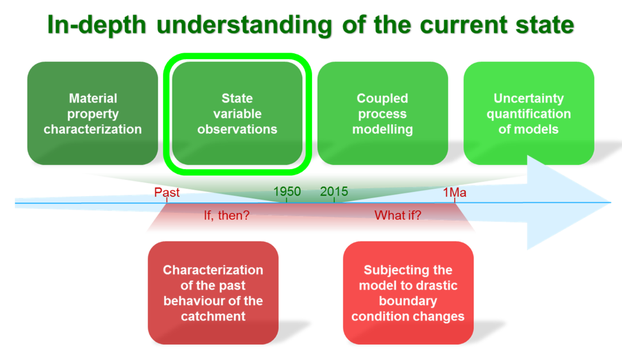
- should be **quantified** as **accurately** as possible, but
- can often be estimated based on **very limited information** only, on deep confined or deeper parts of unconfined aquifers, and hence
- comes with **large amounts of uncertainty**.

We will present an **overview of approaches** that have been tested and are being refined to address this issue. By integrating all existing knowledge and available data, we should be able to **reduce the uncertainties** considerably. We work with the Neogene aquifer (which overlies the Boom Clay), within the Nete catchment, NE Belgium, as a case study, to demonstrate the methodology.

Available data and modelling framework

Even when lots of material parameter and model forcing data are available, large uncertainties may still persist. Looking at subsurface **temperature**, **Darcy fluxes** and river discharges, hydrochemistry and **age tracers**, may drastically constrain the range of possible outcomes in terms of advection-dispersion. Furthermore, **in-depth process understanding** provides a decent basis for subjecting the models **to drastic boundary condition changes**, which is required for looking at **large time scales** relevant for geological disposal.

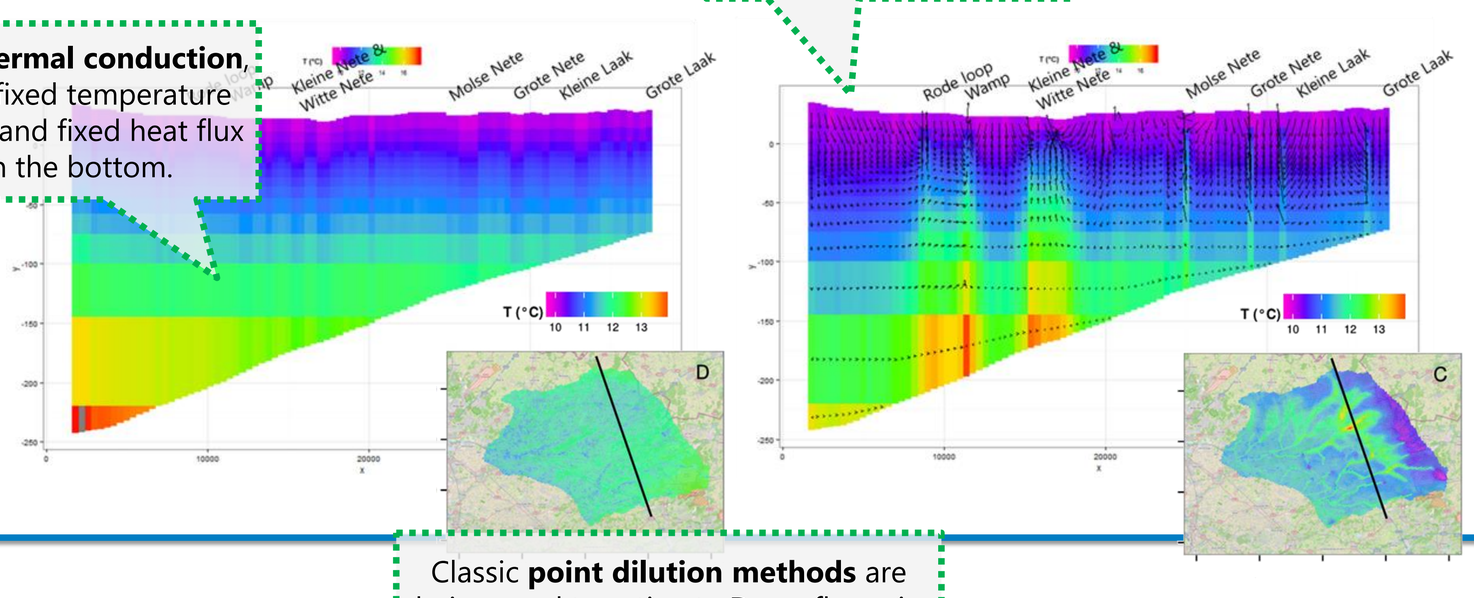


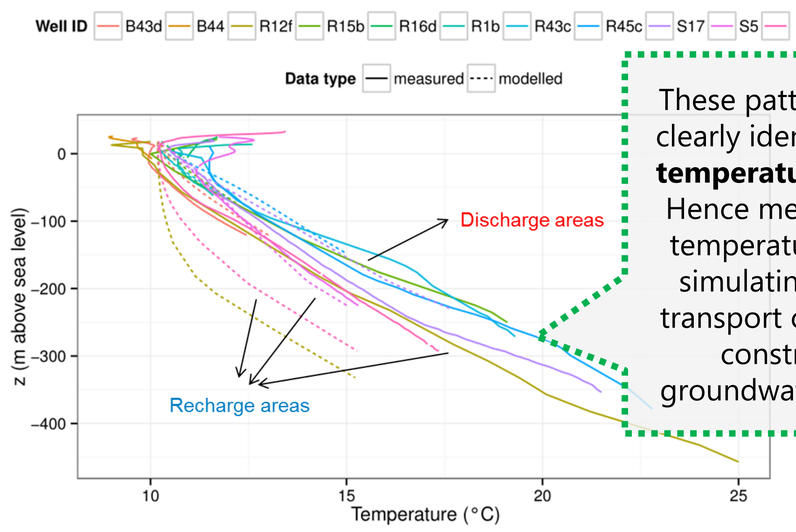


Temperature

Including the **advection of heat** in a preliminary model, reveals clear patterns below the rivers.

Pure **thermal conduction**, using fixed temperature on top and fixed heat flux on the bottom.

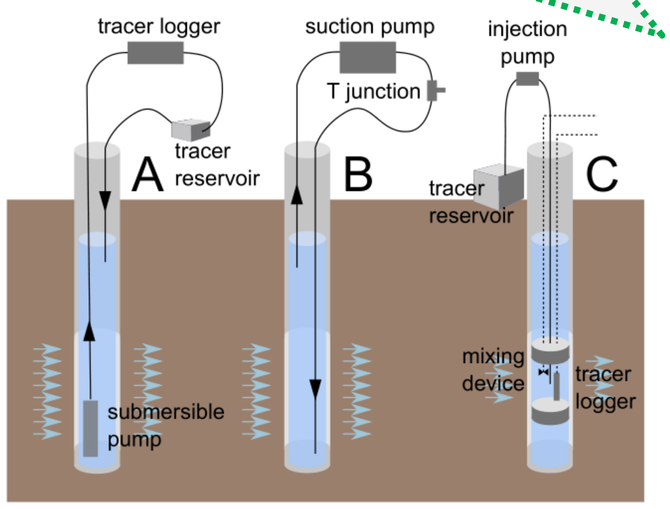




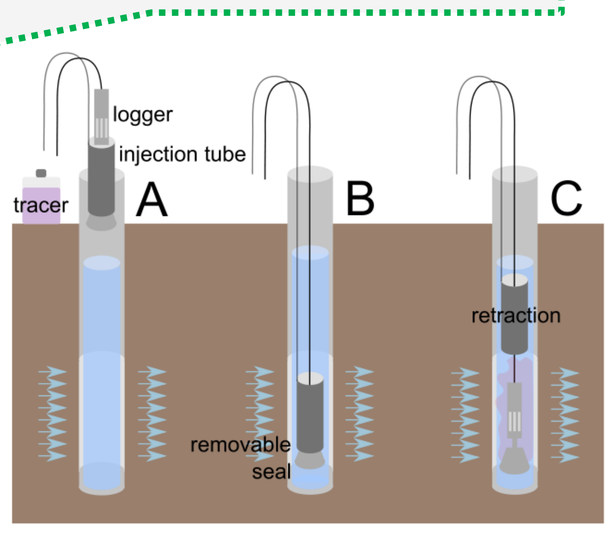
These patterns are clearly identified in **temperature logs**. Hence measuring temperature and simulating heat transport can help constrain groundwater flow.

Classic **point dilution methods** are being used to estimate Darcy fluxes in the shallow part of the aquifer.

Darcy fluxes

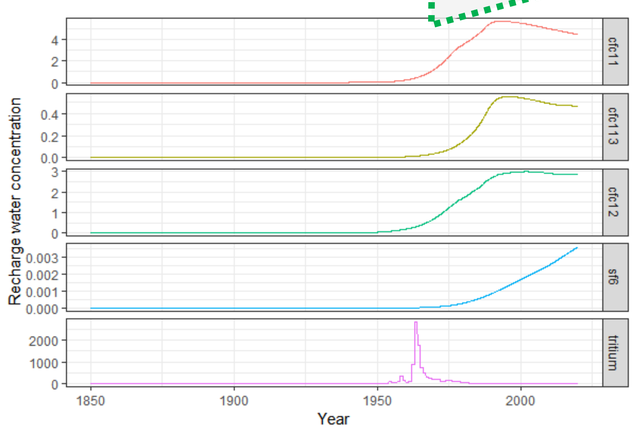


Different approaches are being investigated for performing **similar measurements in deep wells**, more relevant for geological disposal.



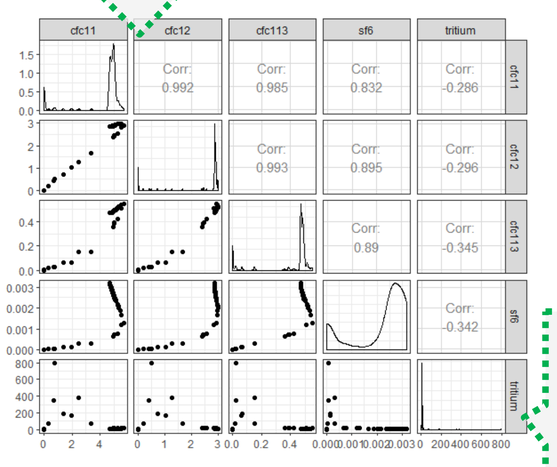
Age tracers

An exploratory study looking at **atmospheric young groundwater age tracers** was performed. The recharge water concentrations were transformed into tracer concentrations by convolution with **age distributions** obtained from **random walk particle tracking**.



Noble gas analyses for correction of Tritium concentrations indicated **large amounts of ^{4}He**. This will be further investigated in a recently initiated PhD project.

Preliminary results indicate some issues with certain tracers while others seem to be promising.



Original amount, without decay!

More info?

Rogiers B, Labat S, Gedeon M. 2015. An assessment of dilution tests and ambient temperature logging for quantifying groundwater flow in the Neogene aquifer. External Report, SCK•CEN-ER-276.

Rogiers B. 2014. Exploratory temperature logging in the upper part of the Neogene aquifer at Mol-Dessel-Retie. External Report, SCK•CEN-ER-258.

Gedeon M. 2008. Neogene Aquifer Model. External Report, SCK•CEN-ER-48.