Transport of Corrosive Species through Highly Compacted Bentonite Clay: Model Development and Sensitivity Study

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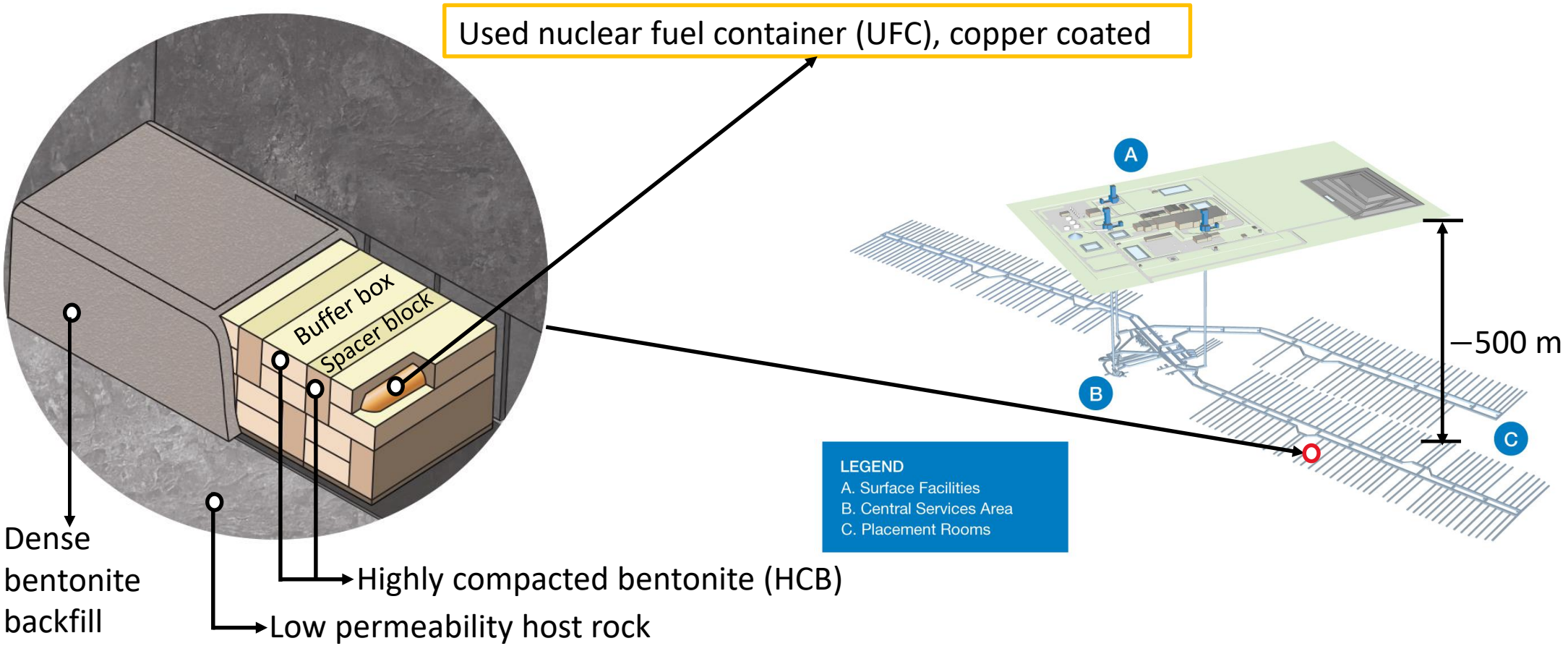
BENTONITE CLAY BUFFER IN SUBSURFACE



(NWMO 2020)

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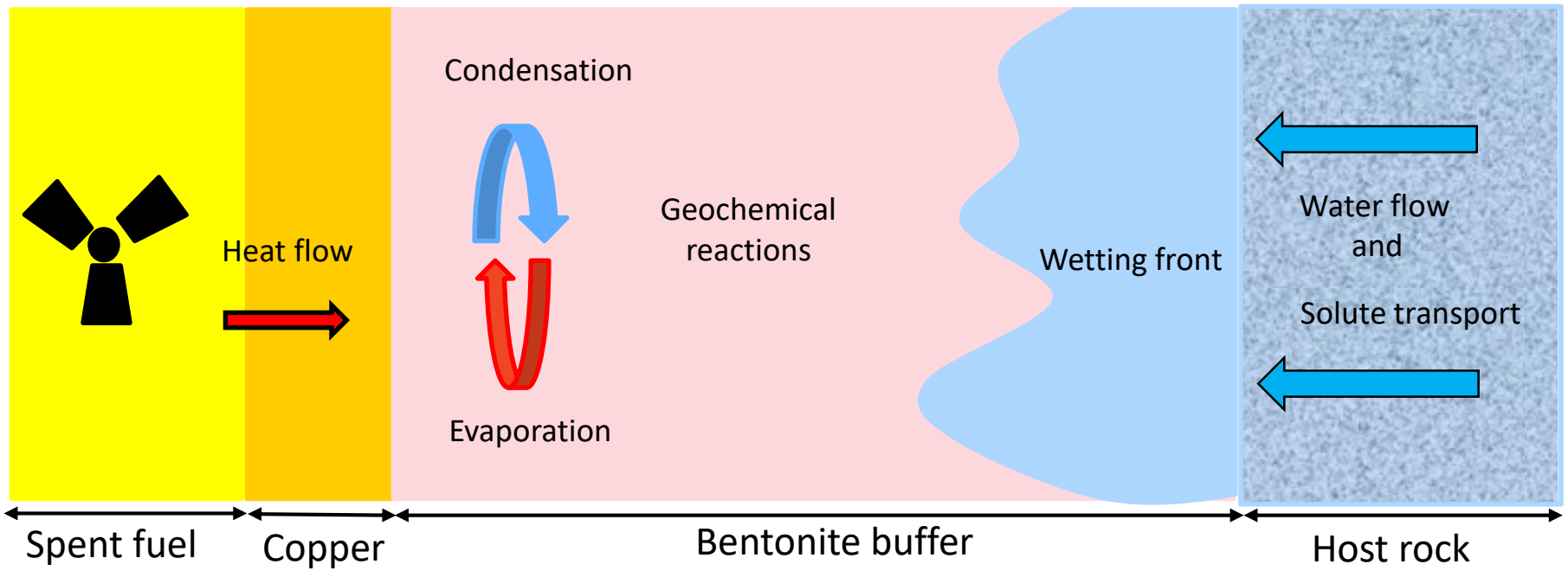
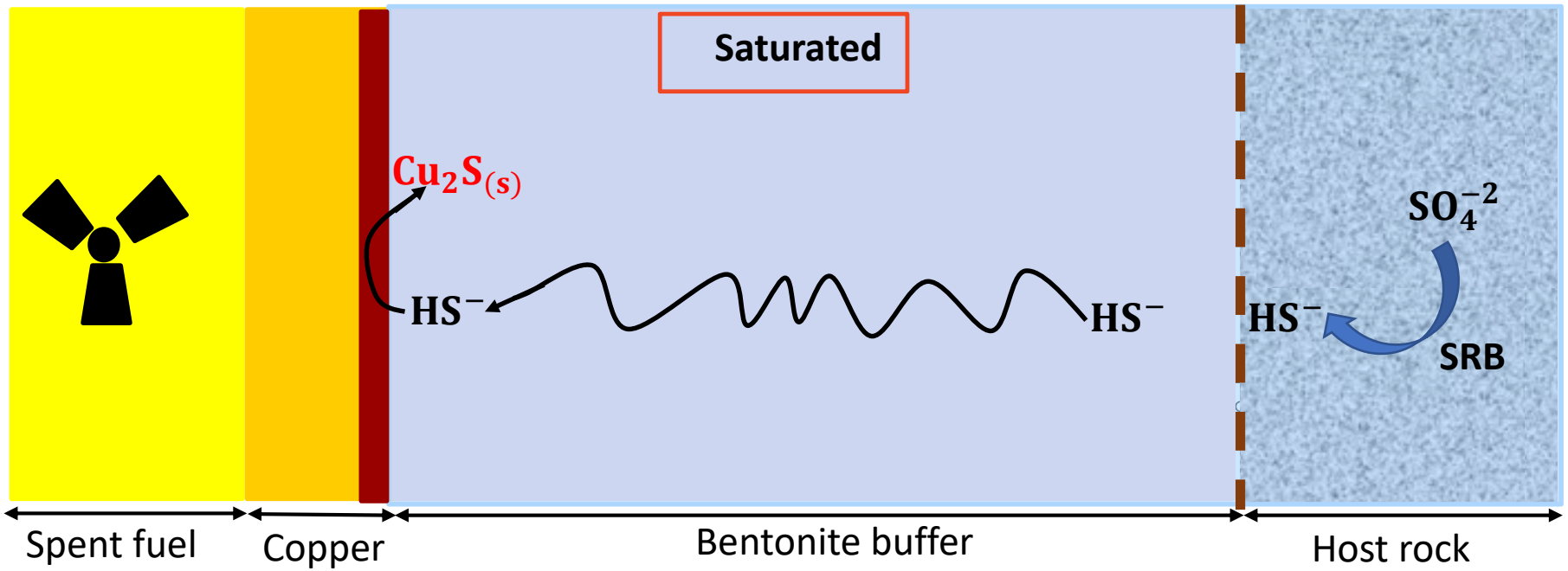
SUBSURFACE TRANSPORT



(Sena et al 2010)

MICROBIOLOGICALLY INFLUENCED CORROSION (MIC)



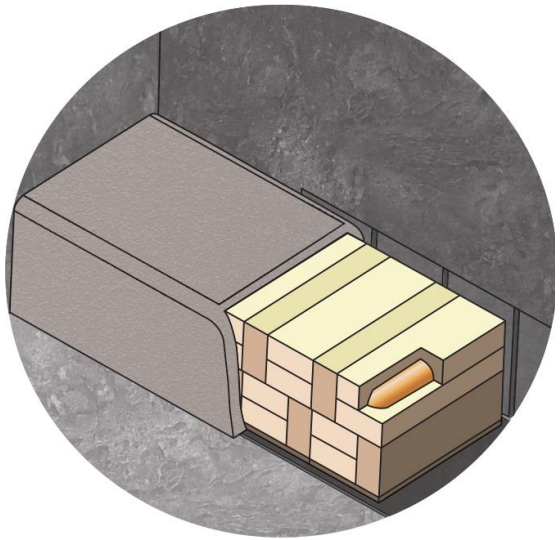
(Sena et al 2010)
(Cloet et al 2017)

WHY USE COMSOL?

DGR performance is governed by highly coupled multiphysics.

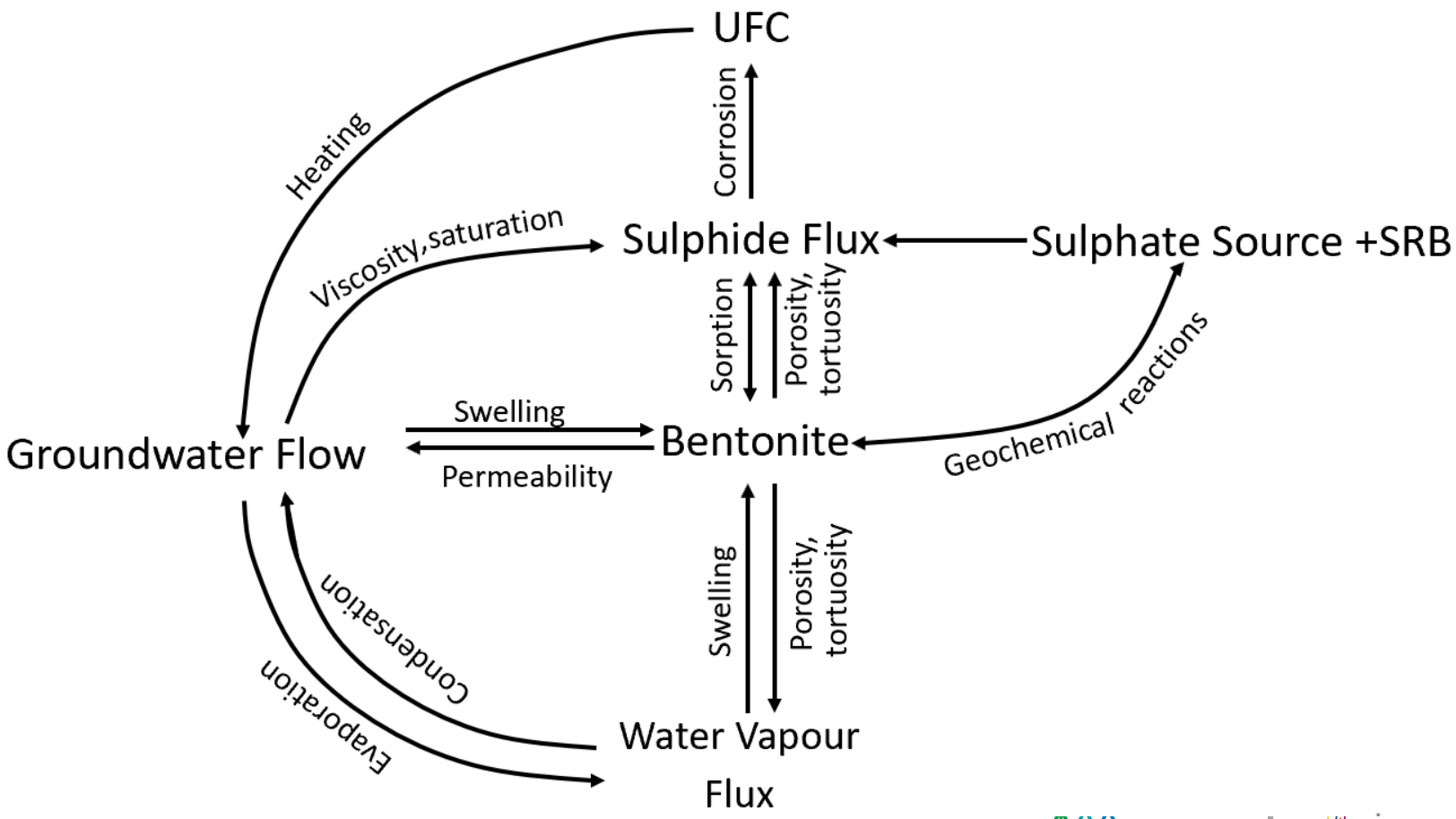
We are using COMSOL to answer these key questions:

- How long will it take to fully saturate the bentonite?
- How do various parameters affect DGR performance?
- What is the distribution of bisulphide flux over the UFC?



MODEL DEVELOPMENT

Conceptual Model



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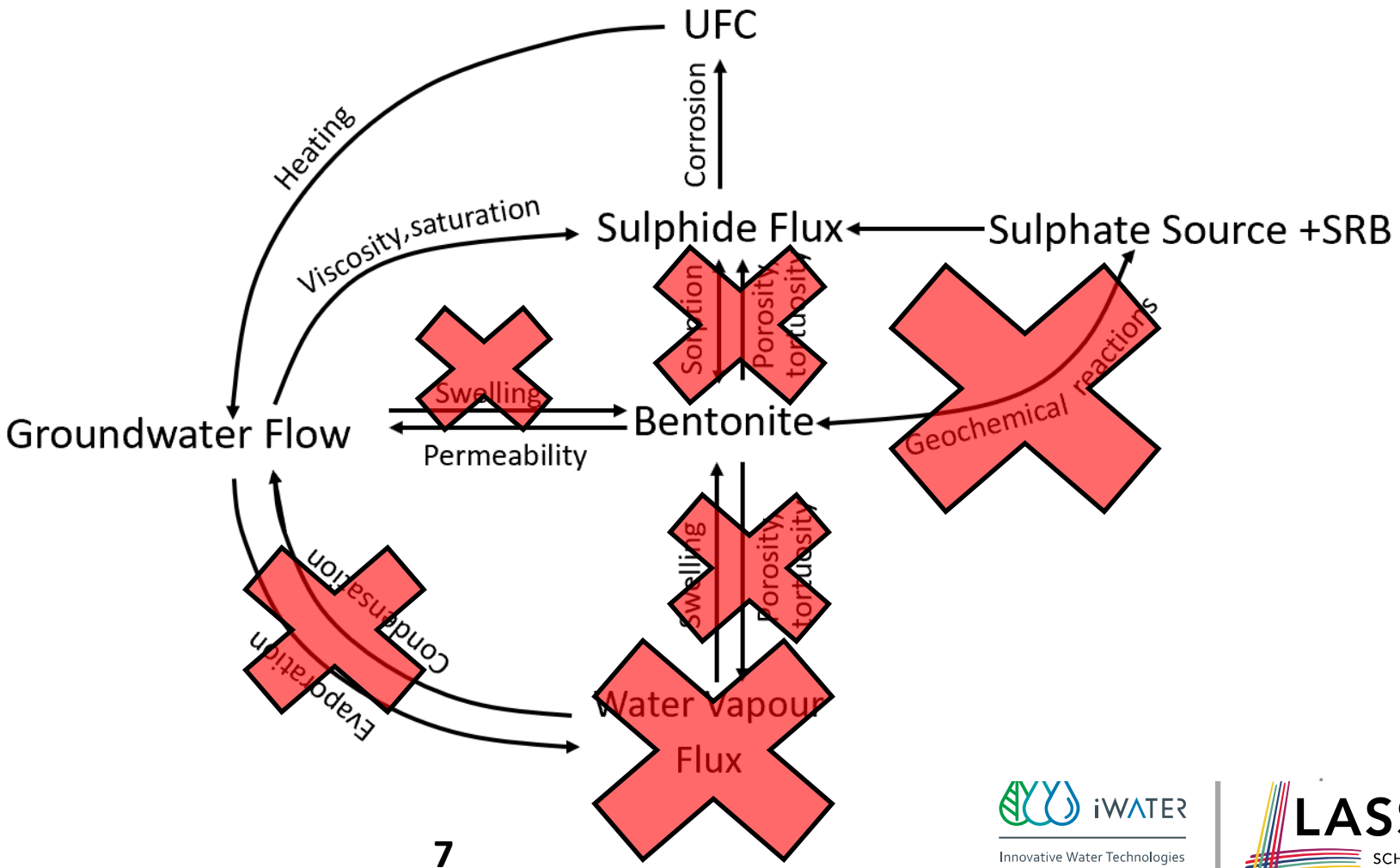
MODEL DEVELOPMENT

Assumptions



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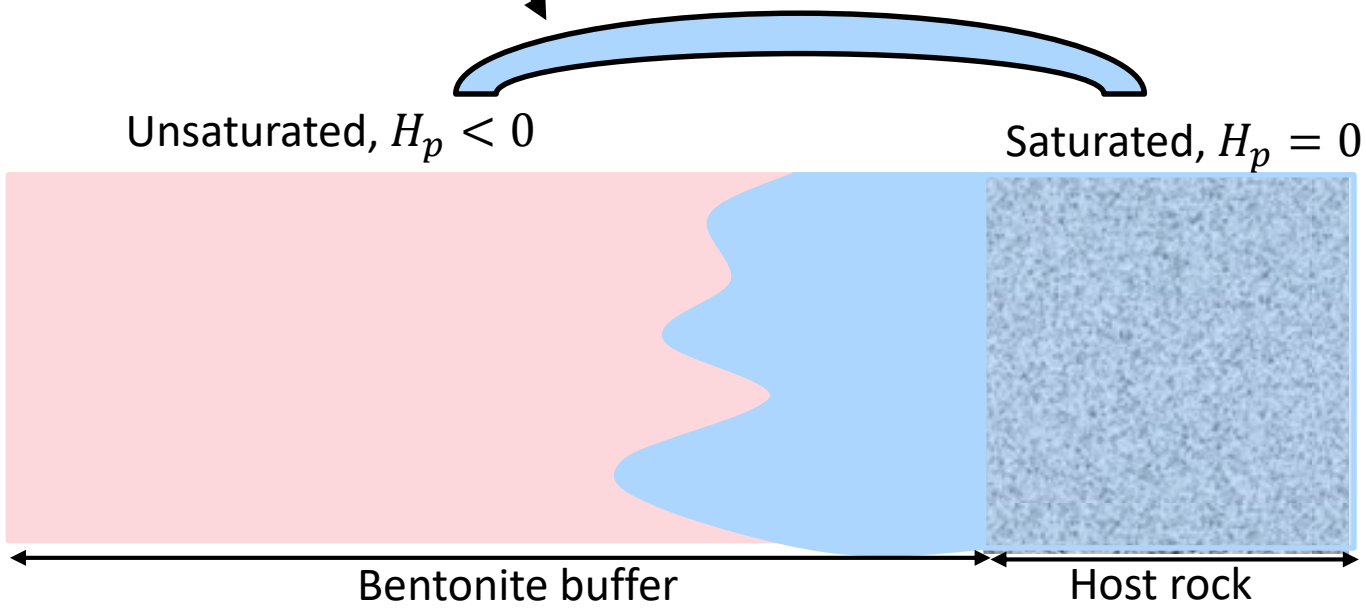
MODEL DEVELOPMENT

Subsurface Flow Module

Richards' Equation:

$$(C_m + SeS)\frac{\partial H_p}{\partial t} + \nabla \cdot \left(-K\nabla\left(H_p + z\right)\right) = 0$$

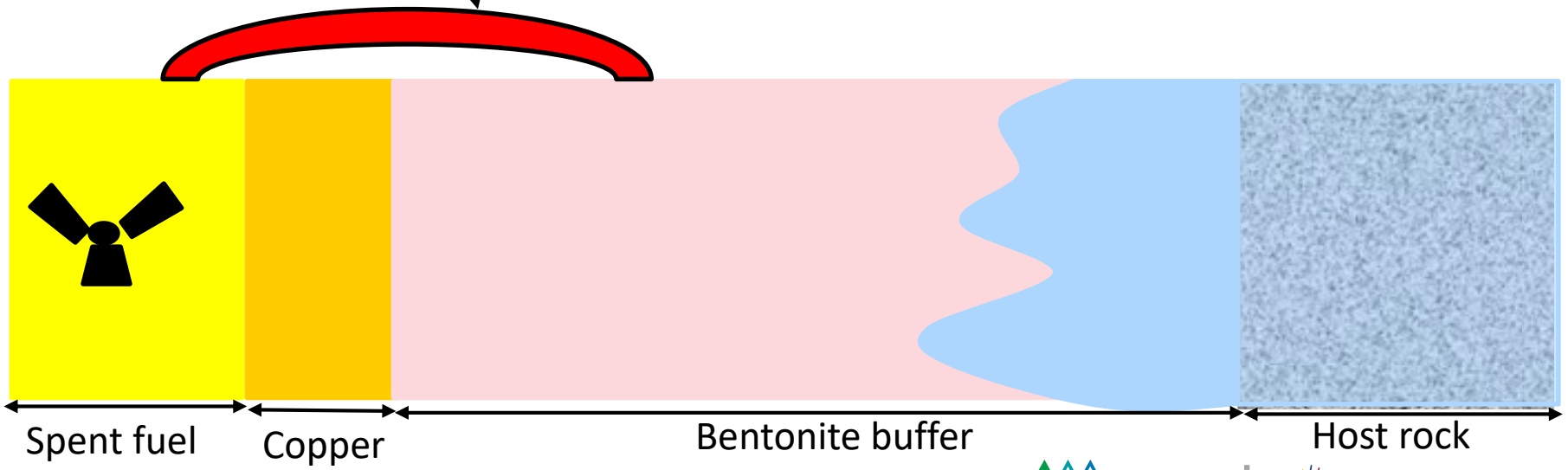


MODEL DEVELOPMENT

Subsurface Flow Module

Heat Transfer:

$$\rho c_p \frac{\partial T}{\partial t} = \nabla(k \cdot \nabla T) + q(t)$$

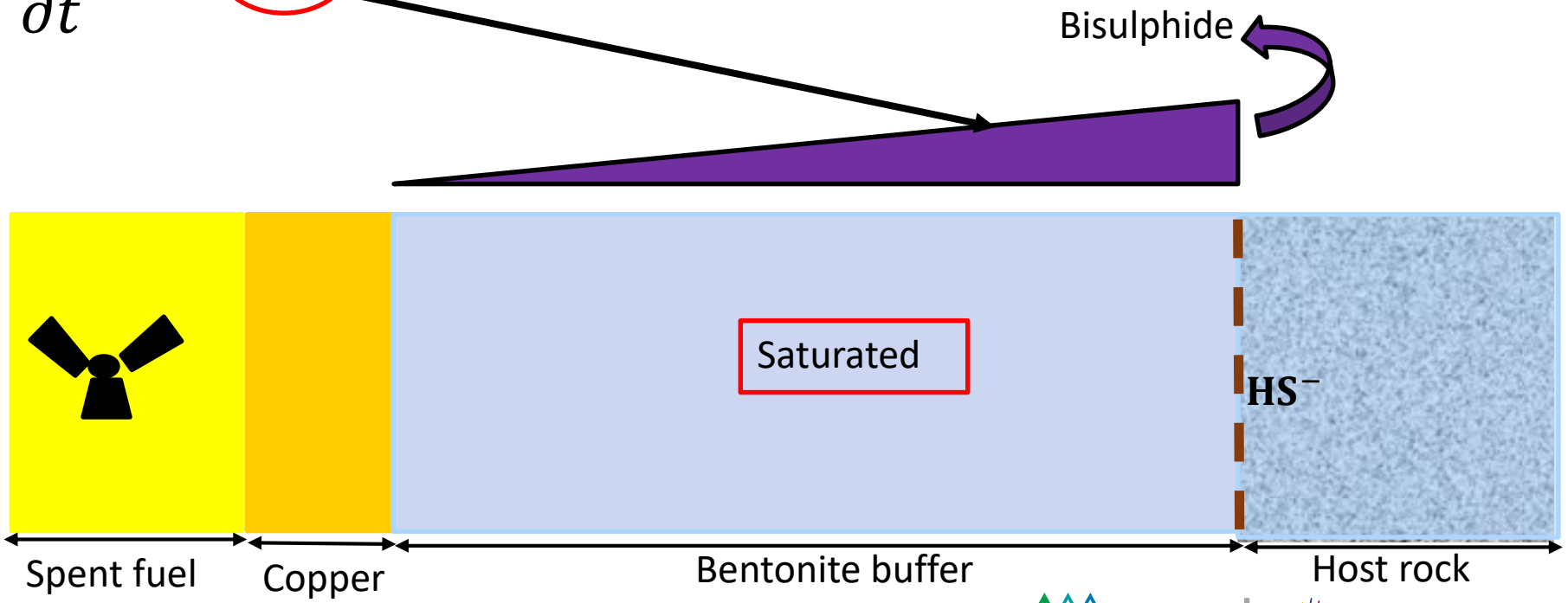


MODEL DEVELOPMENT

Subsurface Flow Module

Transport of Diluted Species (TDS):

$$\frac{\partial C}{\partial t} = D\nabla^2 C$$



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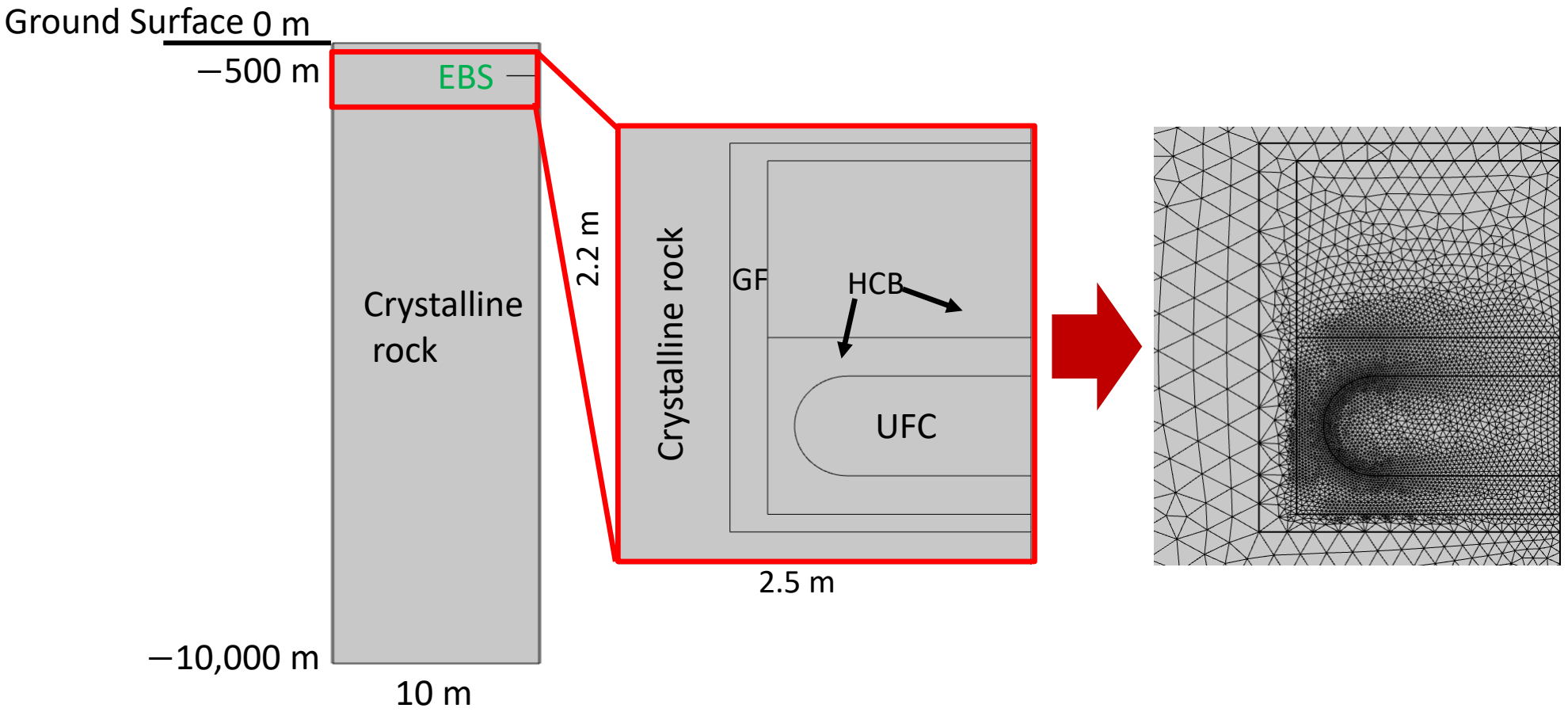
MODEL DEVELOPMENT

Domain & Mesh



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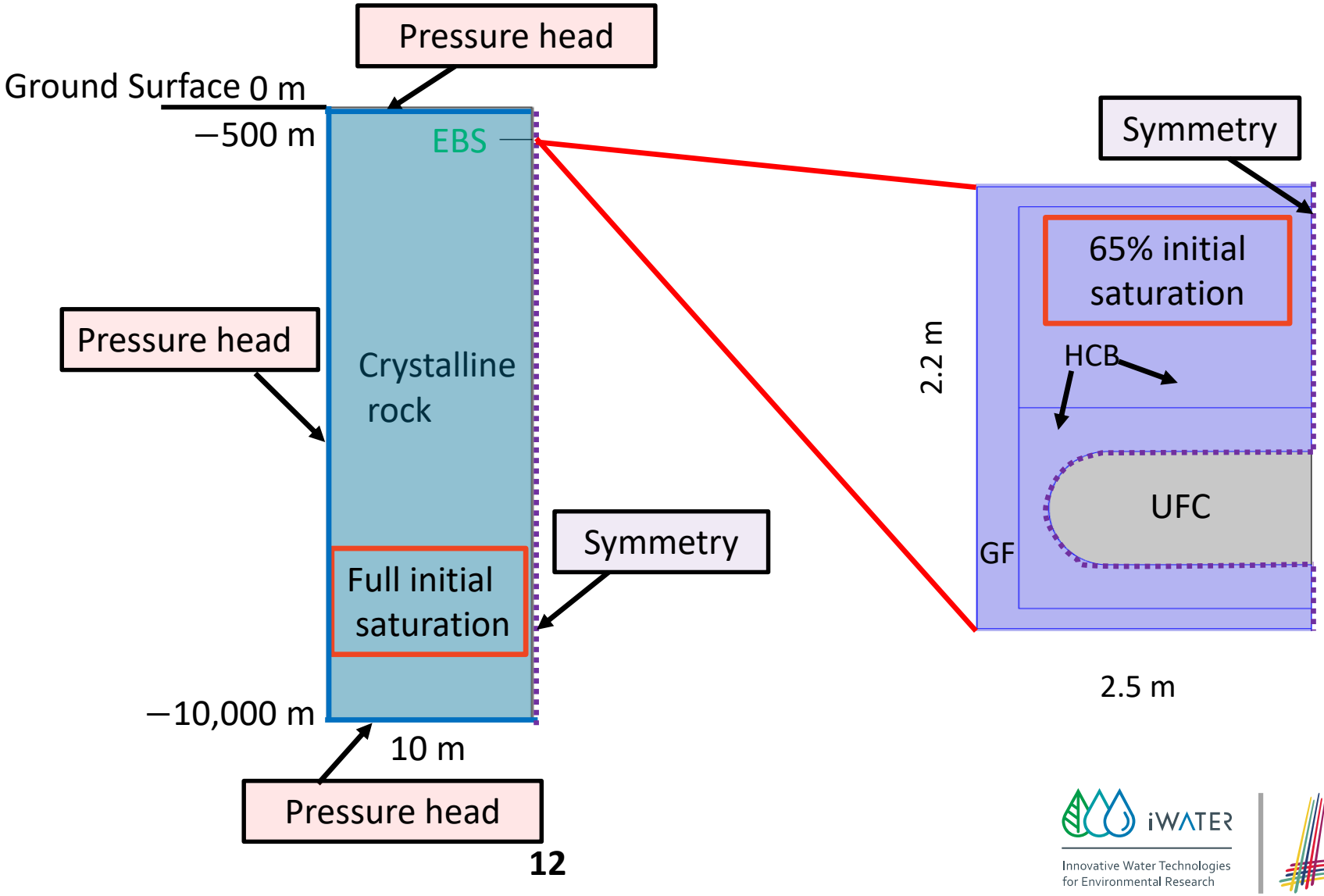
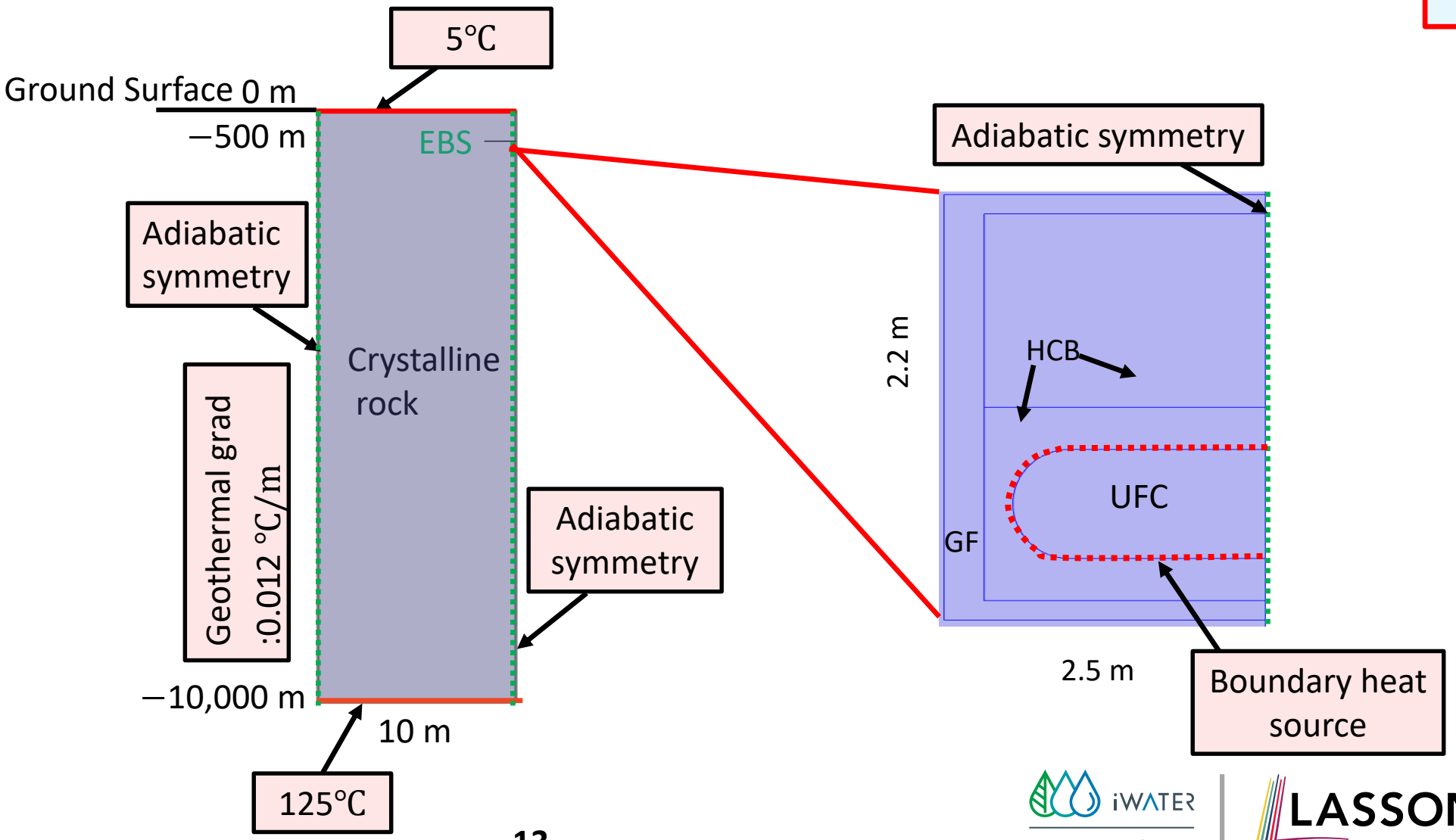
MODEL DEVELOPMENT

Richards' Eq.



MODEL DEVELOPMENT

Heat Transfer



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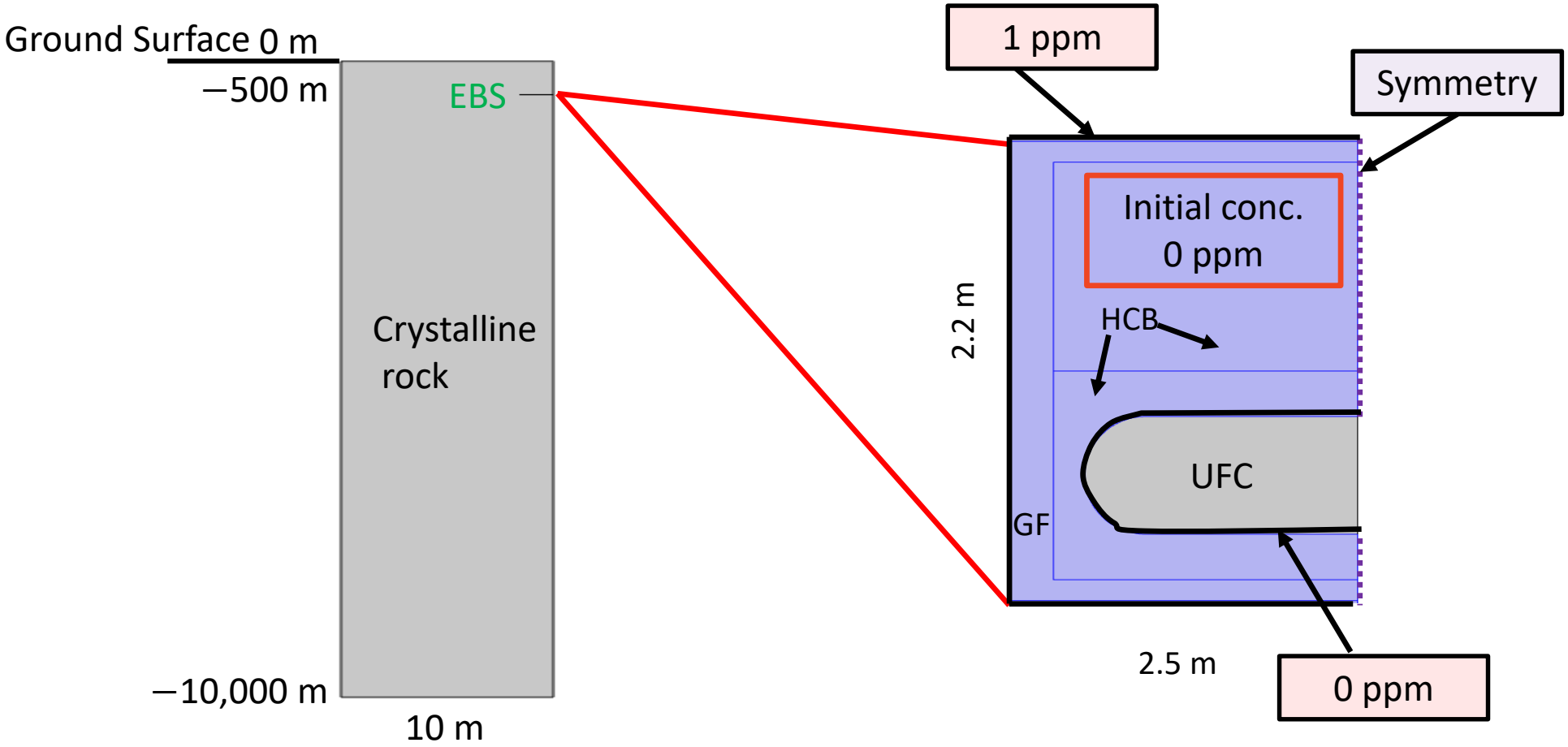
MODEL DEVELOPMENT

TDS
(Aqueous bisulfide transport)



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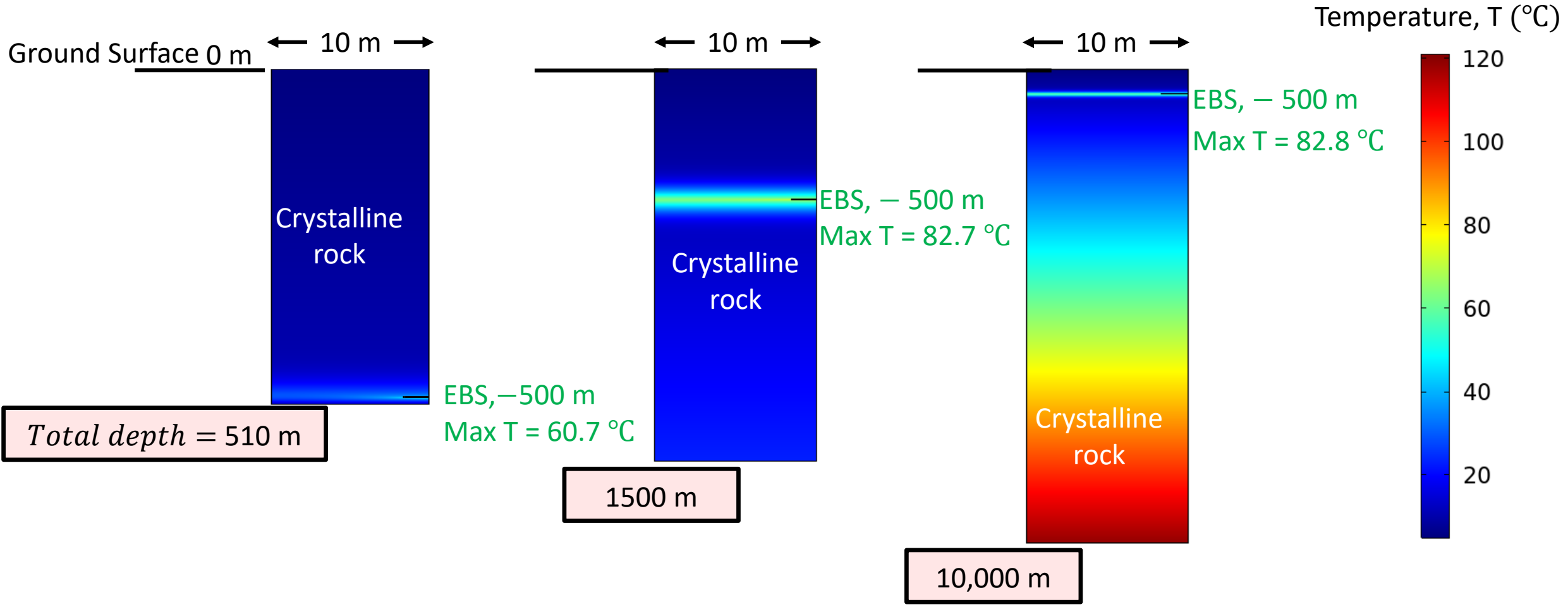
SENSITIVITY ANALYSIS



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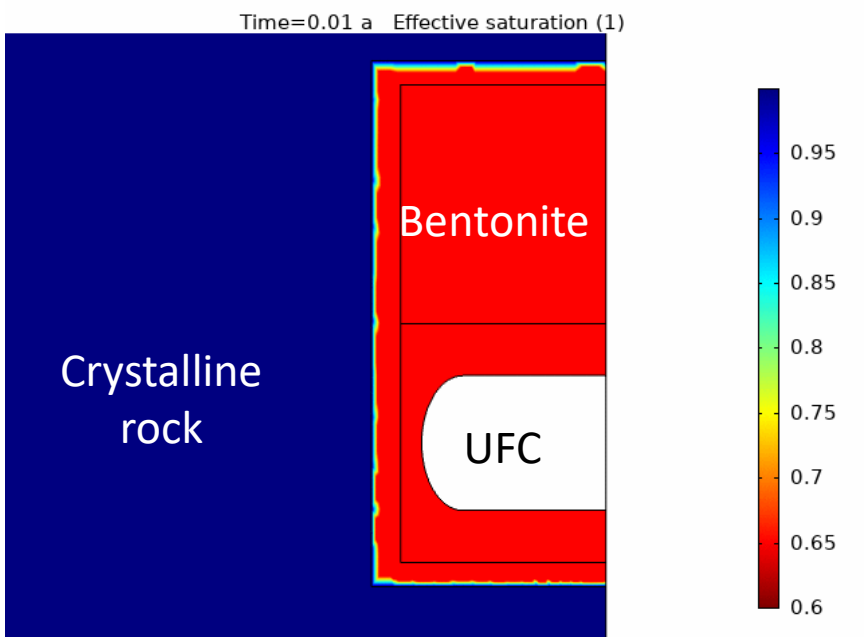
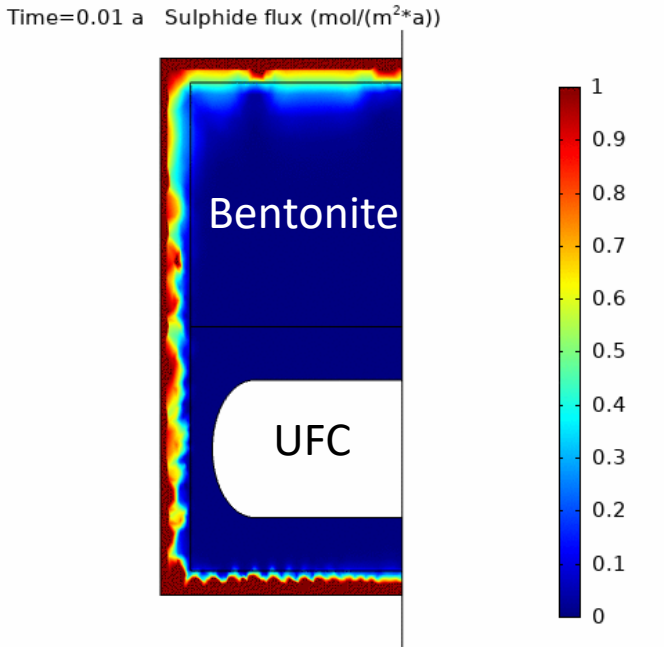
RESULTS

Average Saturation



Bisulphide Flux



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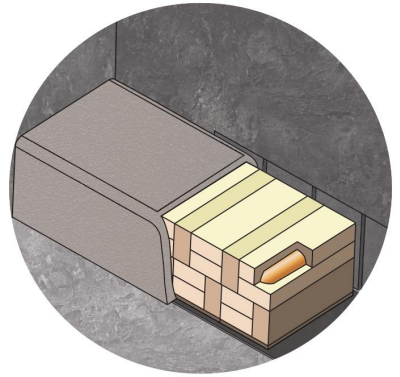
CONCLUSIONS



- A coupled thermal-saturation-transport model was developed to aid in the performance assessment of the Canadian DGR.
- The model was able to simulate aqueous transport in variably saturated and non-isothermal conditions.
- Various sensitivity analysis were performed using the model, including domain depth which showed that this was an important parameter to consider to obtain accurate temperature profiles.
- Higher bisulphide flux occurred at the hemi-spherical UFC end caps due to UFC geometry and saturation profile.

THANK YOU!