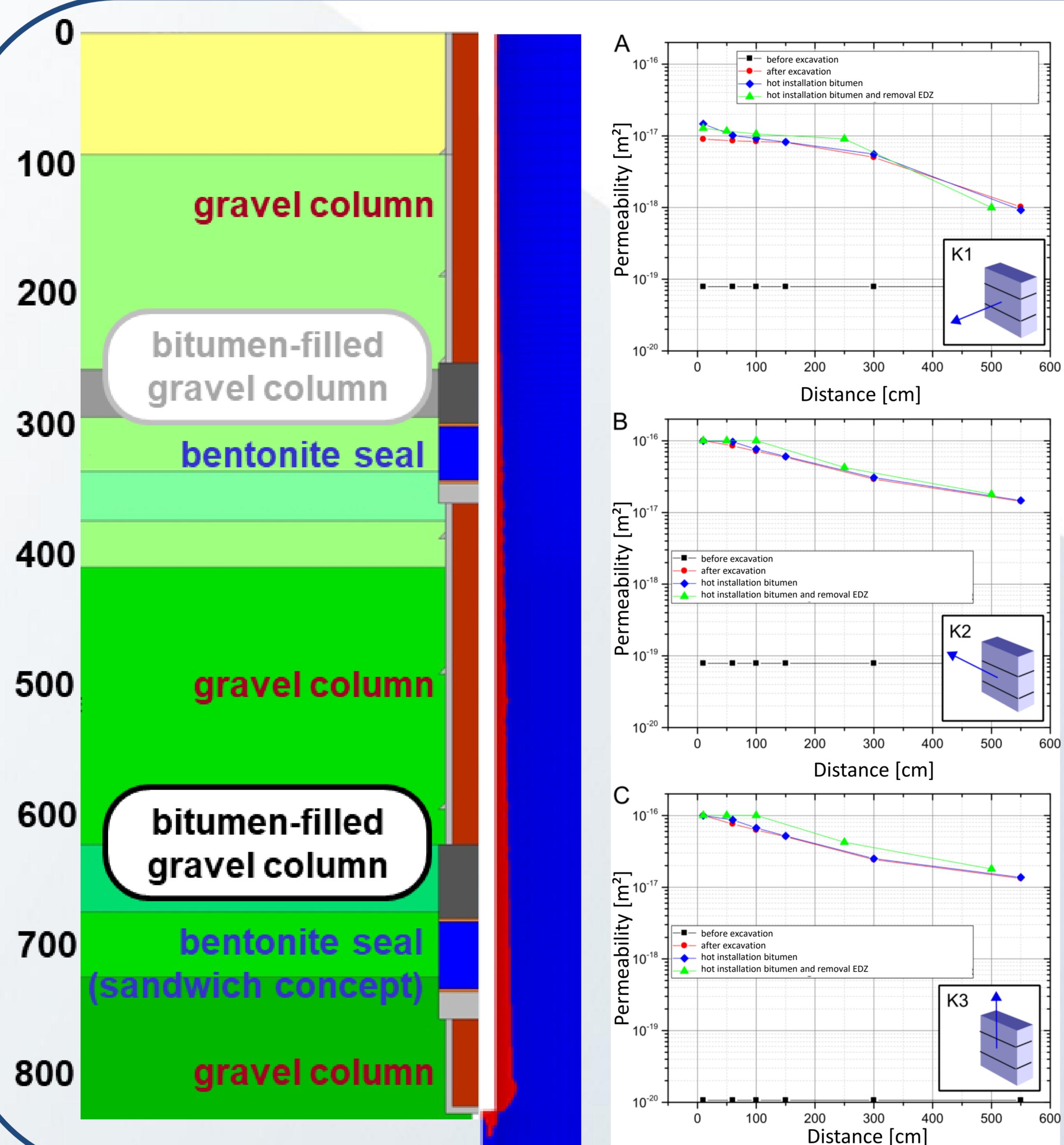


# Shaft sealing elements made of bitumen – numerical analysis of the construction process and long-term behaviour

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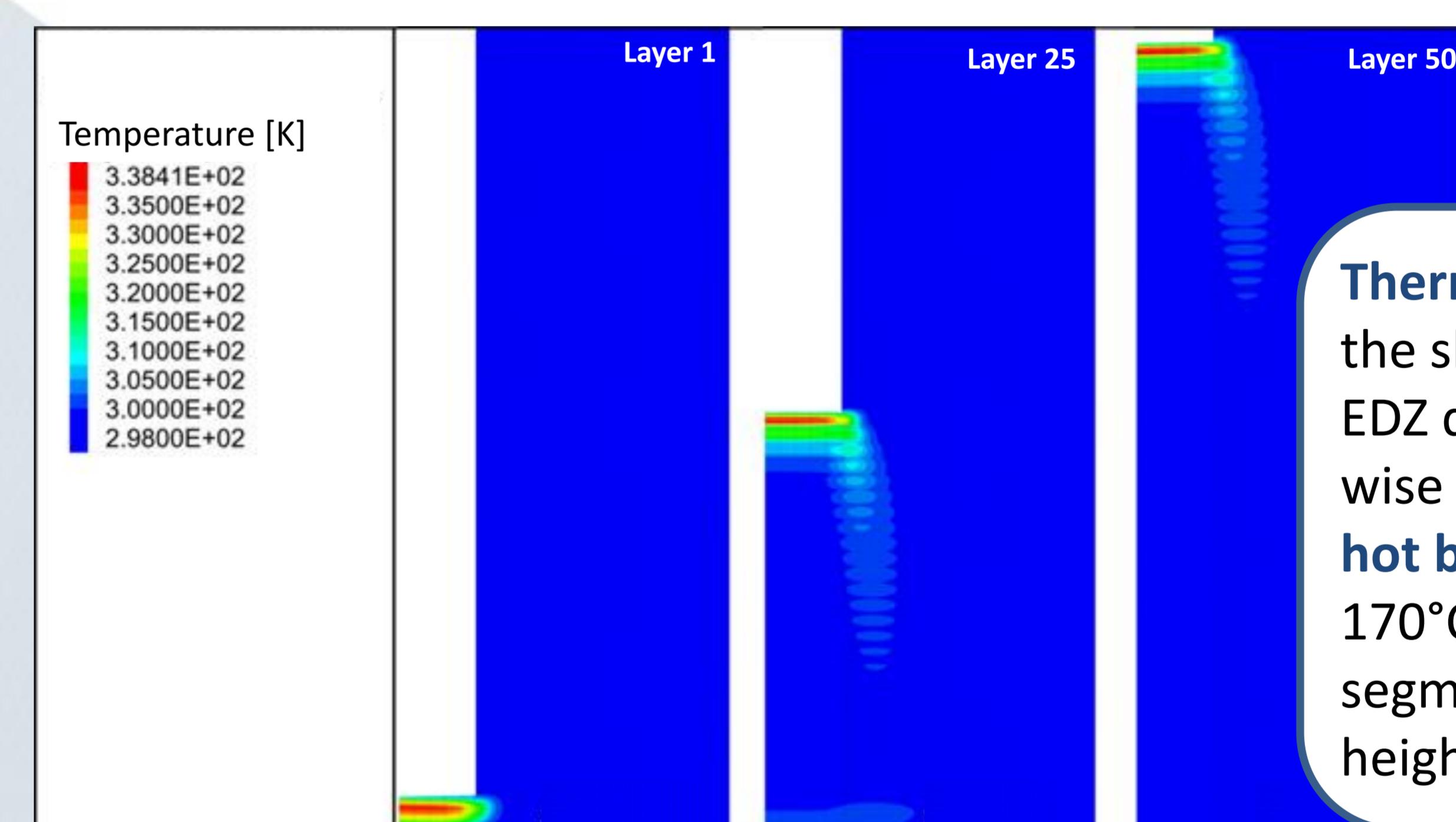
## Background

BGE TECHNOLOGY GmbH in collaboration with Technical University Bergakademie Freiberg has been developing shaft sealing concepts for repositories in claystone formations, including the use of bitumen. Hence, open questions like the technical need of a partly removal of the EDZ or the risk of an additional damage related to the hot installation of bitumen cannot be answered satisfactorily, today. Therefore, BGE TECHNOLOGY GmbH performed different numerical modelling of a generic, 800 m deep and 10 m wide shaft in a claystone formation. Main goals were **the estimation of the depth of the EDZ, a quantitative analysis of the permeability changes inside the EDZ especially in combination with the thermal impact of hot installed bitumen** as well as **the prediction of the long-term flow behaviour of the bitumen**. The lessons learned will help to improve the shaft sealing concepts for a potential German repository in claystone formations and bitumen-based sealing elements.



## Sealing Concept and Excavation Damaged Zone

In a first step permeability change during excavation and shaft closure was investigated, by the use of a stress and deformation dependent model of permeability evolution in FLAC3D. The analysis shows that the **shaft sinking changes significantly the main characteristics of the permeation**. Further analysis related to thermal impacts based on bitumen installation and a partly removal of the EDZ show that **the damages induced by the thermal impact are marginal compared to the removal of additional rock material**.



**Thermal impact** to the shaft contour and EDZ during the layer wise installation of **hot bitumen** (up to 170°C) in 1 m segments and total height of 50 m

## Fluid-like long-term behaviour of bitumen

The long-term behaviour of bitumen, which is characterised by very high and strongly temperature depending viscosity, was investigated. TOUGH2 simulations have been performed, where three different viscosities were considered: under 30°C, 40°C and 50°C. In result, less than 10% of bitumen will flow in EDZ after 100.000 years. Only under the assumption of continuously high temperatures (50°C) around 24% of bitumen will flow from the top of column into the EDZ. Therefore, bitumen can be considered as stable in the position inside the shaft sealing.

