GeoBlocks: Building blocks for the quantification of uncertainties in geological models

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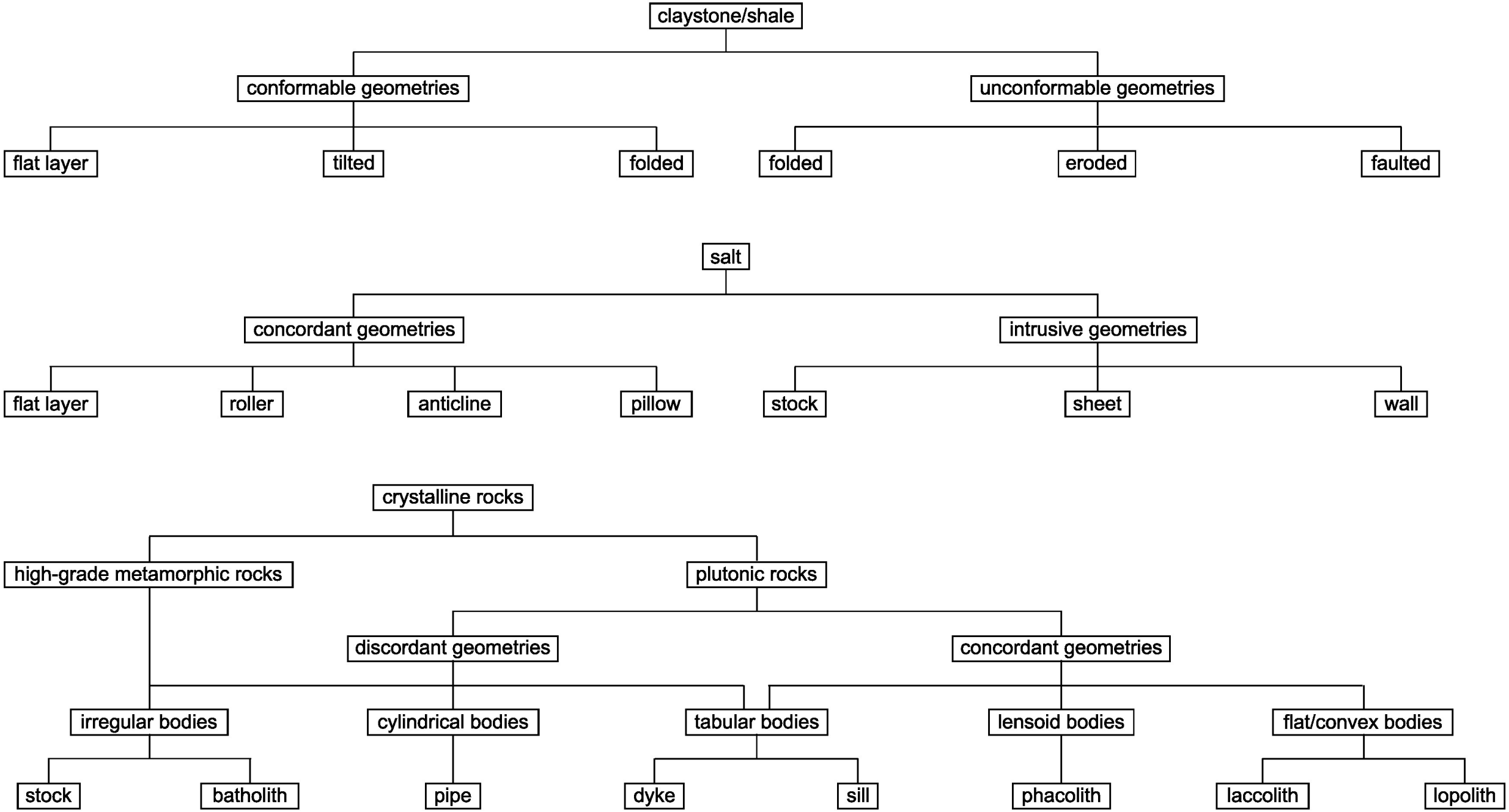
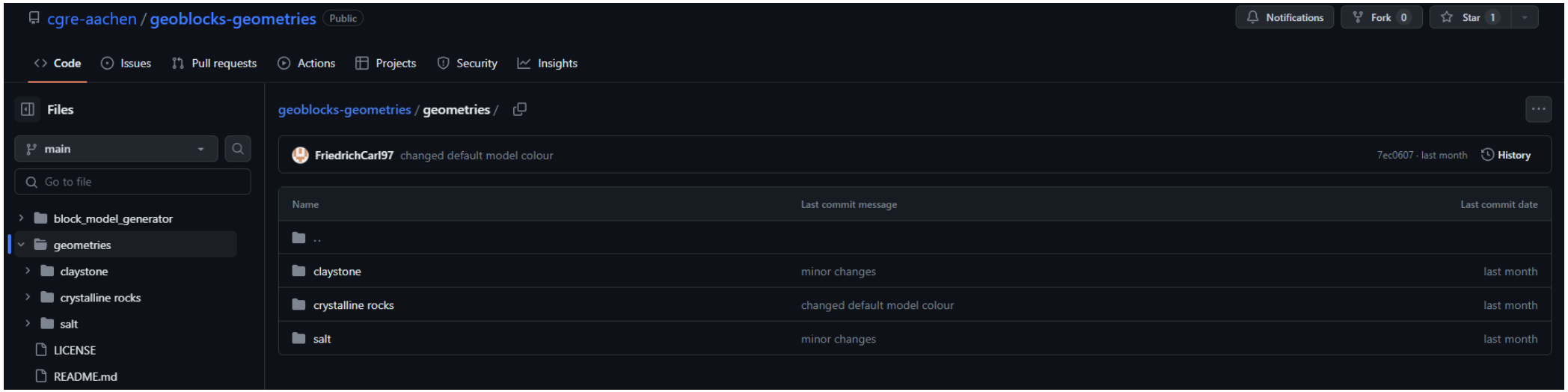
Catalogue of standard geometries

- Only some rocks (specific geological settings, material properties & structures) are considered for waste storage
- Structures approximated using regular geometric bodies → standard geometries are systematized


claystone/shale
conformable geometries
unconformable geometries
flat layer
tilted
folded
folded
eroded
faulted
salt
concordant geometries
intrusive geometries
flat layer
roller
anticline
pillow
stock
sheet
wall
crystalline rocks
high-grade metamorphic rocks
plutonic rocks
discordant geometries
concordant geometries
irregular bodies
cylindrical bodies
tabular bodies
lensoid bodies
flat/convex bodies
stock
batholith
pipe
dyke
sill
phacolith
laccolith
lopolith

Catalogue of standard geometries

- Only some rocks (specific geological settings, material properties & structures) are considered for waste storage
- Structures approximated using regular geometric bodies → standard geometries are systematized
- Applying systematizations, structures are constructed using GemPy and catalogued in online library



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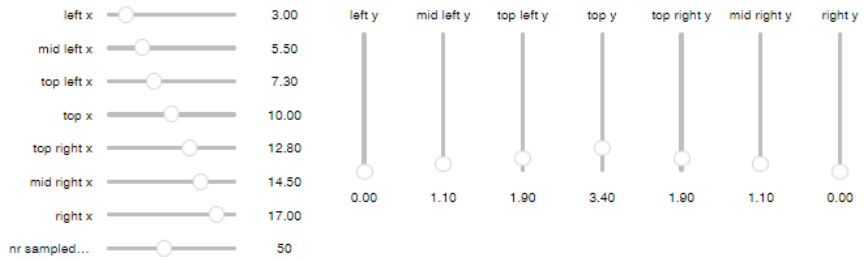

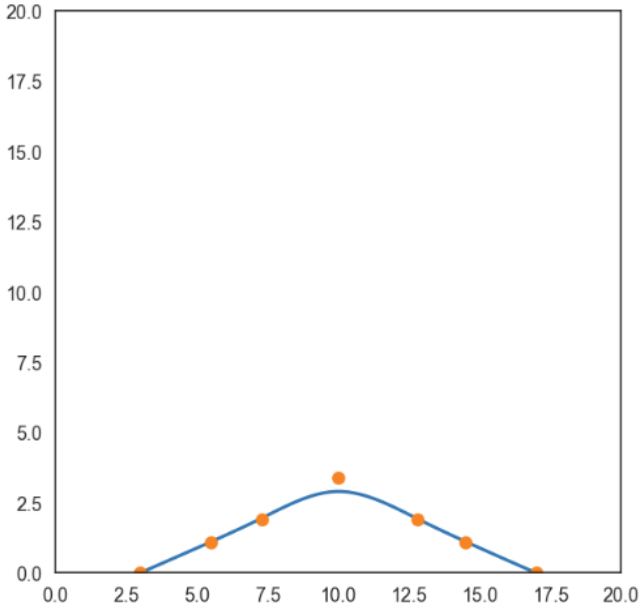

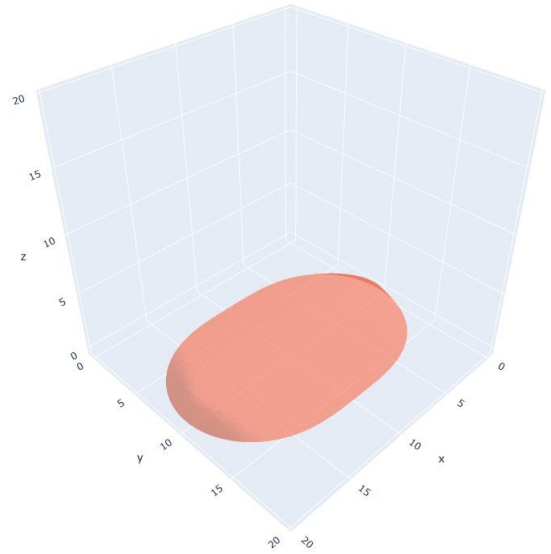

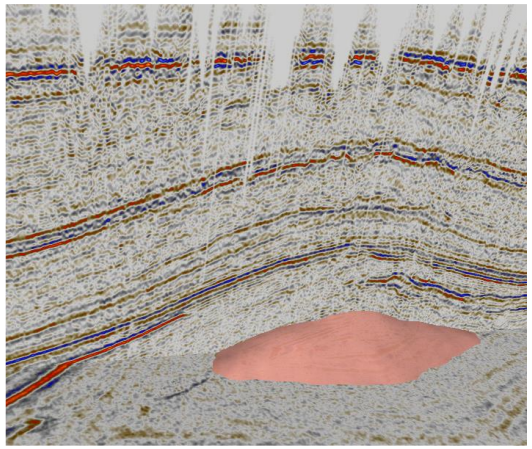

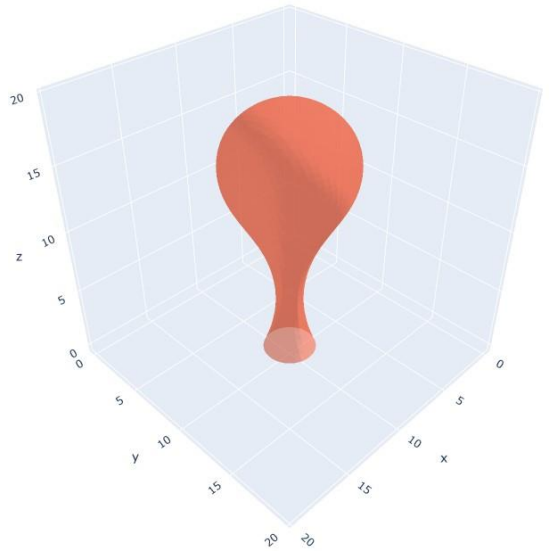

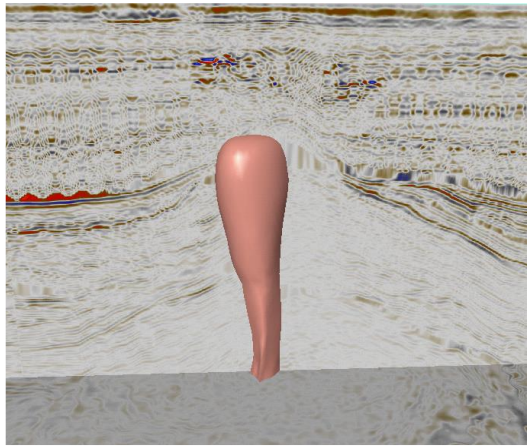

- For construction, NURBS curves where generated & interpolated in 3D

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Catalogue of standard geometries

- Focus on geometric shape of bodies, disregarding penetrating faults
- Focus exclusively on geometries likely to be considered in site-selection → exclusion of geological bodies lacking lateral/vertical extents required to be potential disposal site

Catalogue of standard geometries

- Catalogue serves as visual preface since we expect geomodelling workflow to depend on host rock and geometry
- Open-access collection is convenient tool to visualize range of 3D geometries to geoscientists and stakeholders → aids in communication of uncertainties and decisions

Main uses of catalogue:

- Extract test data sets from standard geometries and use these data sets to determine:

➢ Which modelling algorithms work best respectively to model geometries (ongoing)

If you have more questions regarding this part, please contact
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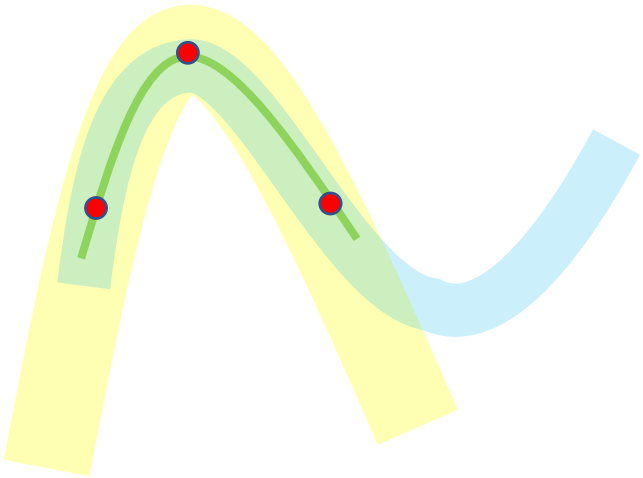
Test of interpolation methods - overview

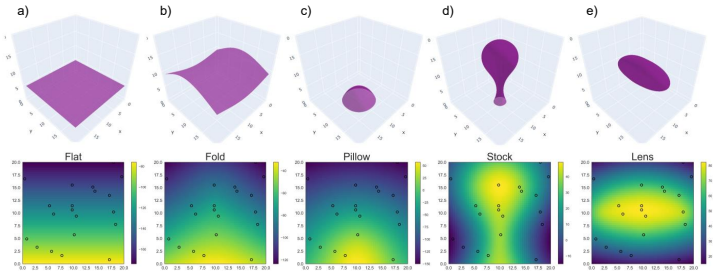
Problem

Different interpolation methods have different solution space, which may fit different host rock structures.

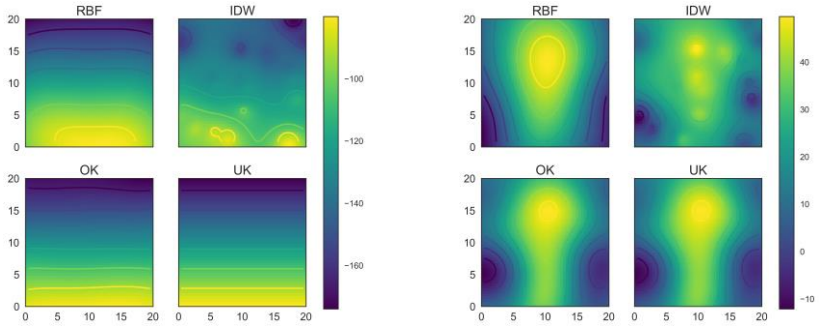


Method

We use standard geometries for the four types of host rock, and use different interpolation methods to model them.



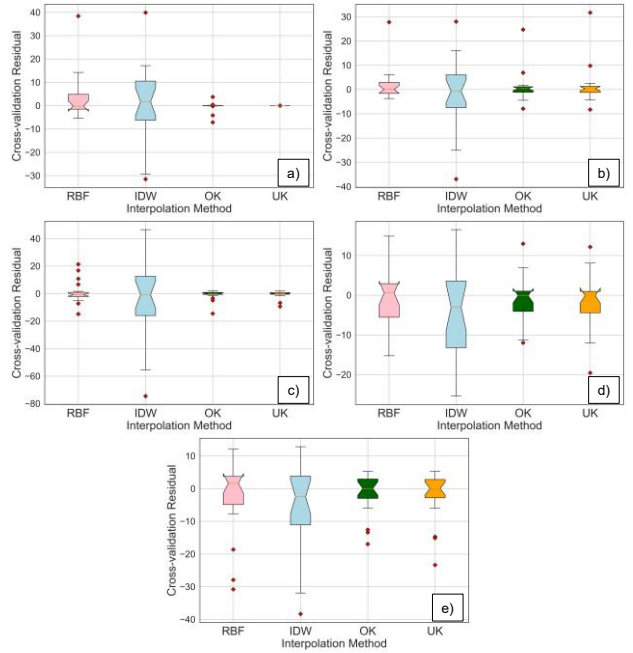
Standard models and sampled points from middle cross-section (a) Flat model (b) Fold model (c) Pillow model (d) Stock model (e) Lens model



Interpolation result with 20 sampled points: flat model (left); stock model (right)

Aim

After comparing the performance of different interpolation methods, we will know which method works better for which type of host rock or structure.



Boxplots of cross-validation result. (a) Flat model (b) Fold model (c) Pillow model (e) Stock model (e) Lens model

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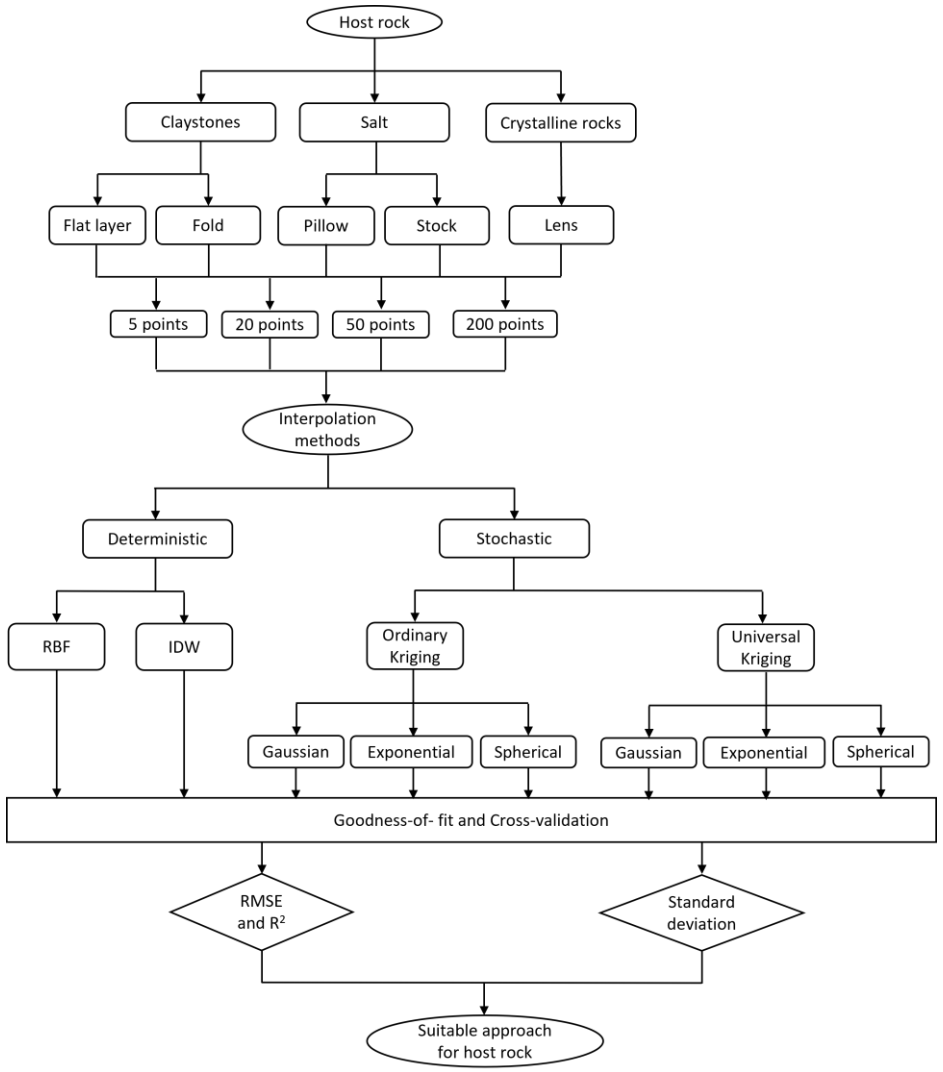
Test of interpolation methods - workflow



Cross-validation:
The proposed task involves a procedure where one input data point is removed at a time, and the interpolation is performed for the location of the removed point using the remaining samples. The residual between the actual value of the removed data point and its estimate is then calculated. This process is repeated iteratively until every sample has been interpolated.

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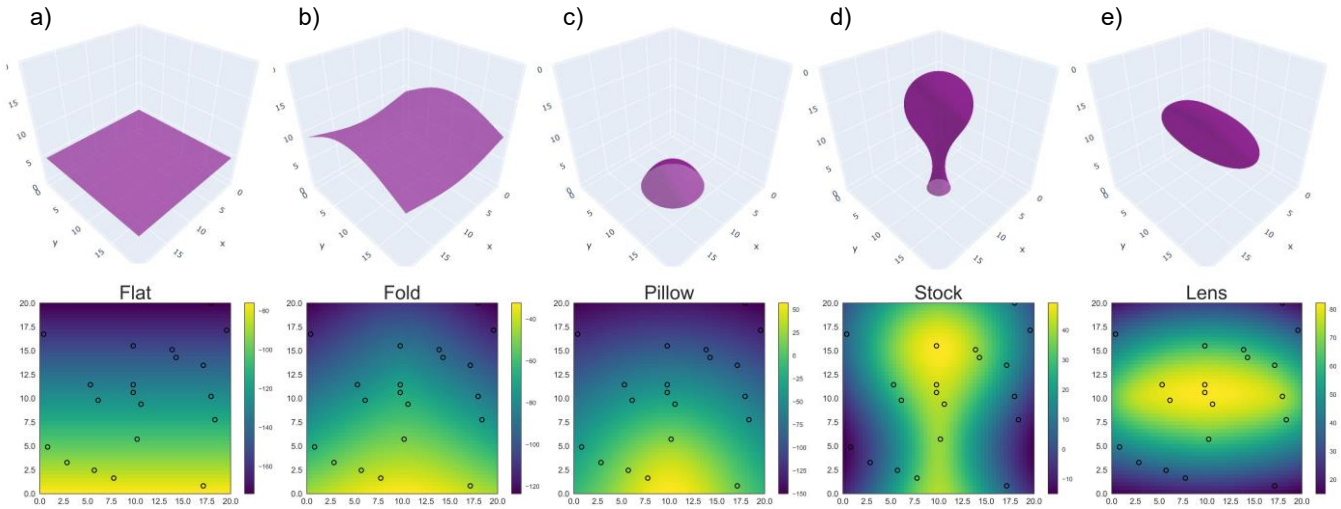
Interpolation methods

- In this study, we only compared four of the most widely used interpolation methods (with abbreviations) :
- Deterministic methods:
- Inverse distance weighting (IDW) with power of two and
- Radial basis function (RBF) with multiquadric kernel function.
- Stochastic methods:
- Ordinary kriging (OK) and
- Universal kriging (UK) both with gaussian, spherical, and exponential variogram models.

Geometry

- In our study, we focus on claystones/shales, salt, and crystalline rocks, as these rock types are assigned as potential host rocks for nuclear waste storage in Germany (BGE, 2020). For claystones/shales, we consider two fundamental geometries: a **flat** undeformed conformable layer and a homogeneously **folded** conformable layer. In the case of salt, we construct a stratiform salt **pillow** model and a steep salt **stock** model. The geometries of crystalline rocks are similar to salt rocks, with the addition of a **lens-shaped** phacolith.



Test of interpolation methods - results

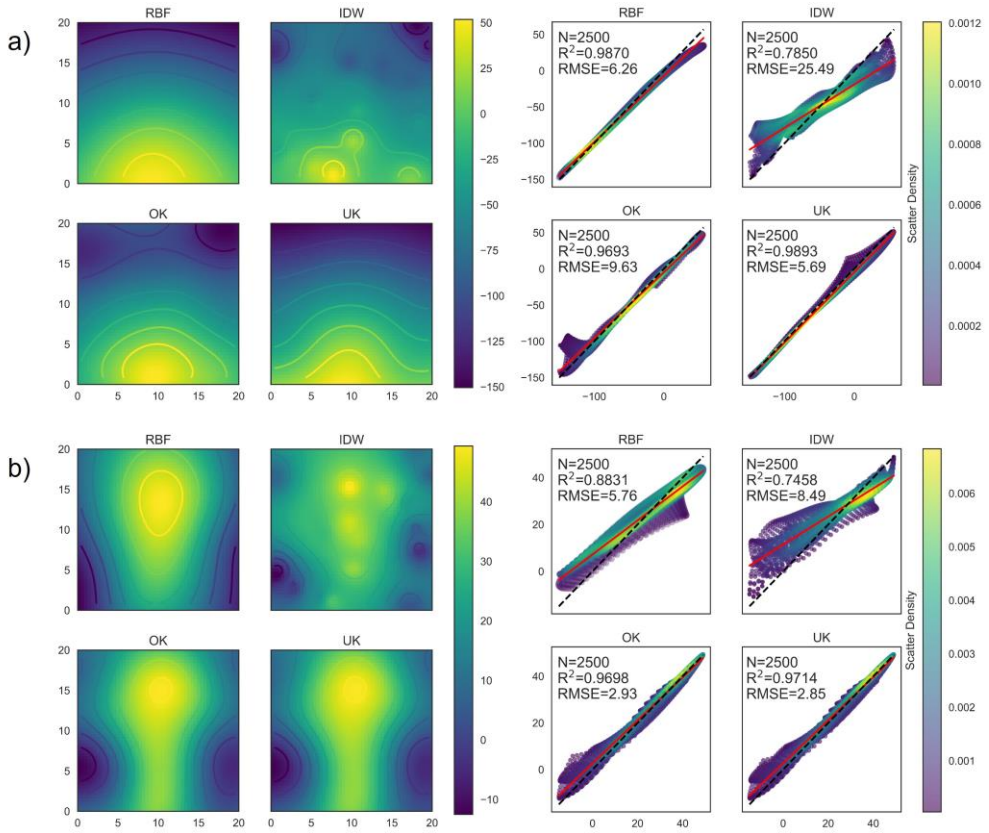


Fig : Interpolation result (left) and scatterplots of the sampled points versus interpolated point (right). The color bar in left plot represents the value interpolated from input data; The color bar in right plot represents the KDE (Kernel density estimation) value. (a) Flat model (b) Stock model

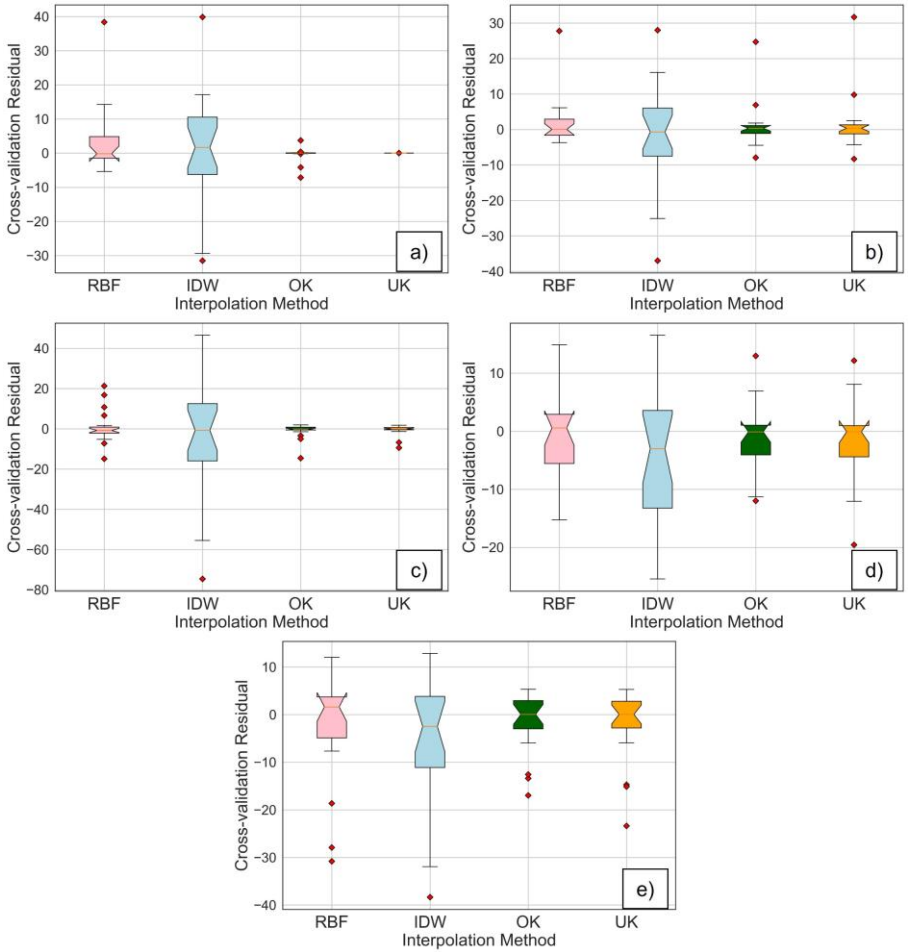


Fig : Boxplots of cross-validation result. (a) Flat model (b) Fold model (c) Pillow model (e) Stock model (e) Lens model

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If you have more questions regarding this part, please contact
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Outlook

- First publication
- Development of statistical and geometrical parameters/methods to compare geological models

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Thanks for your attention!
Questions?