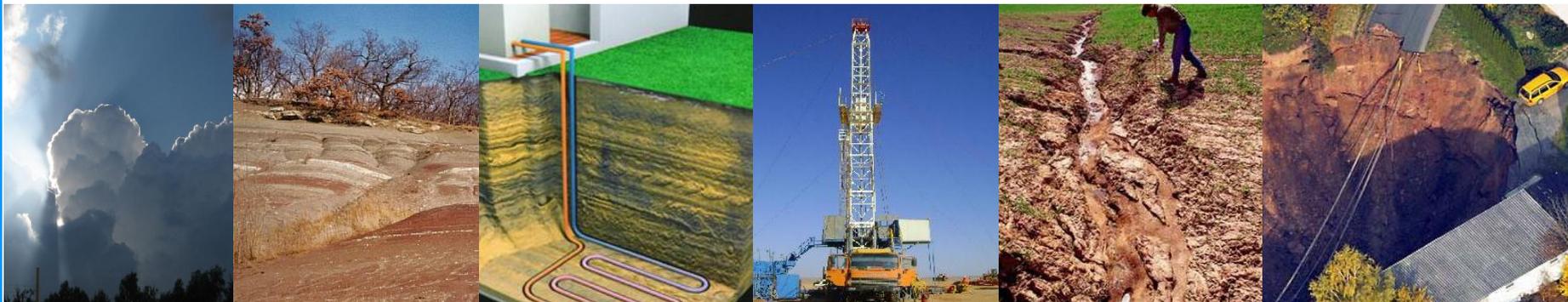


Towards „realistic“ fault zones in a 3D model of the Thuringian Basin

Jonas Kley, Stephan Donndorf, Alexander Malz and the INFLUINS Team:

Sabine Attinger, Georg Büchel, Reinhard Gaupp, David Hindle, Gerhard Jentzsch, Lutz Katzschmann, Erika Kothe, Olaf Kolditz, Nina Kukowski, Juraj Majzlan, Thomas Meier, Uwe Meyer, Kersten Roselt, Ronny Stolz, Kai Uwe Totsche, Lothar Viereck-Götte



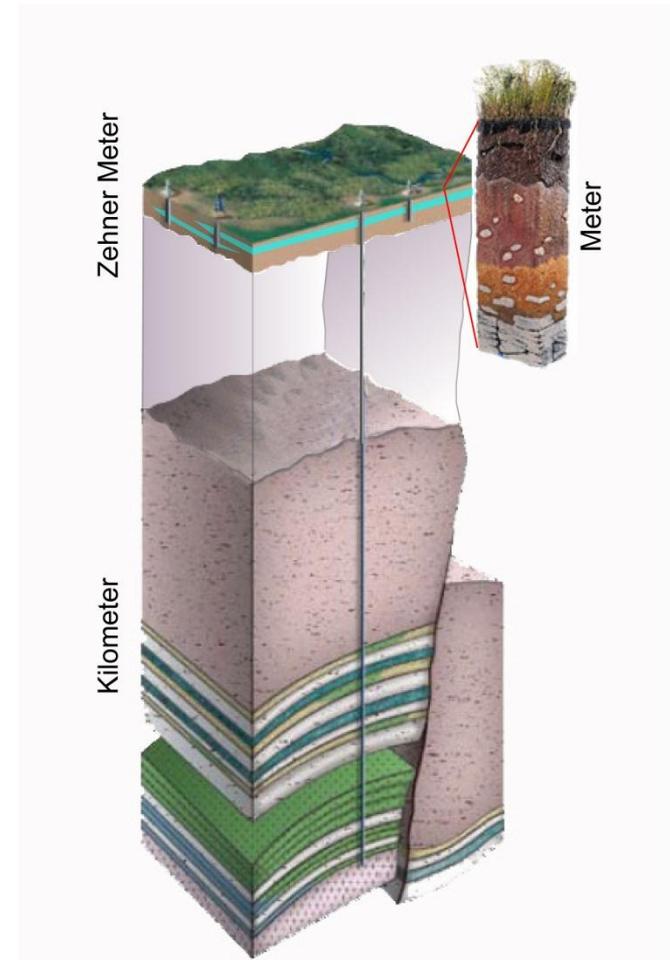
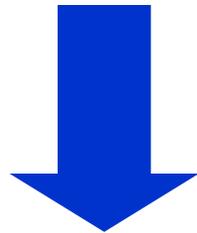
Project Data

- Collaborative Research Programme funded by the German Ministry for Education and Research and the Thuringian Ministry for Science and Culture
- 5-year project, 1.1.2010 – 31.12.2014
- Total budget ca. 14 Mio. €
- 12 partner institutions: Universities, research institutes, local and national government bodies, industry

Objective

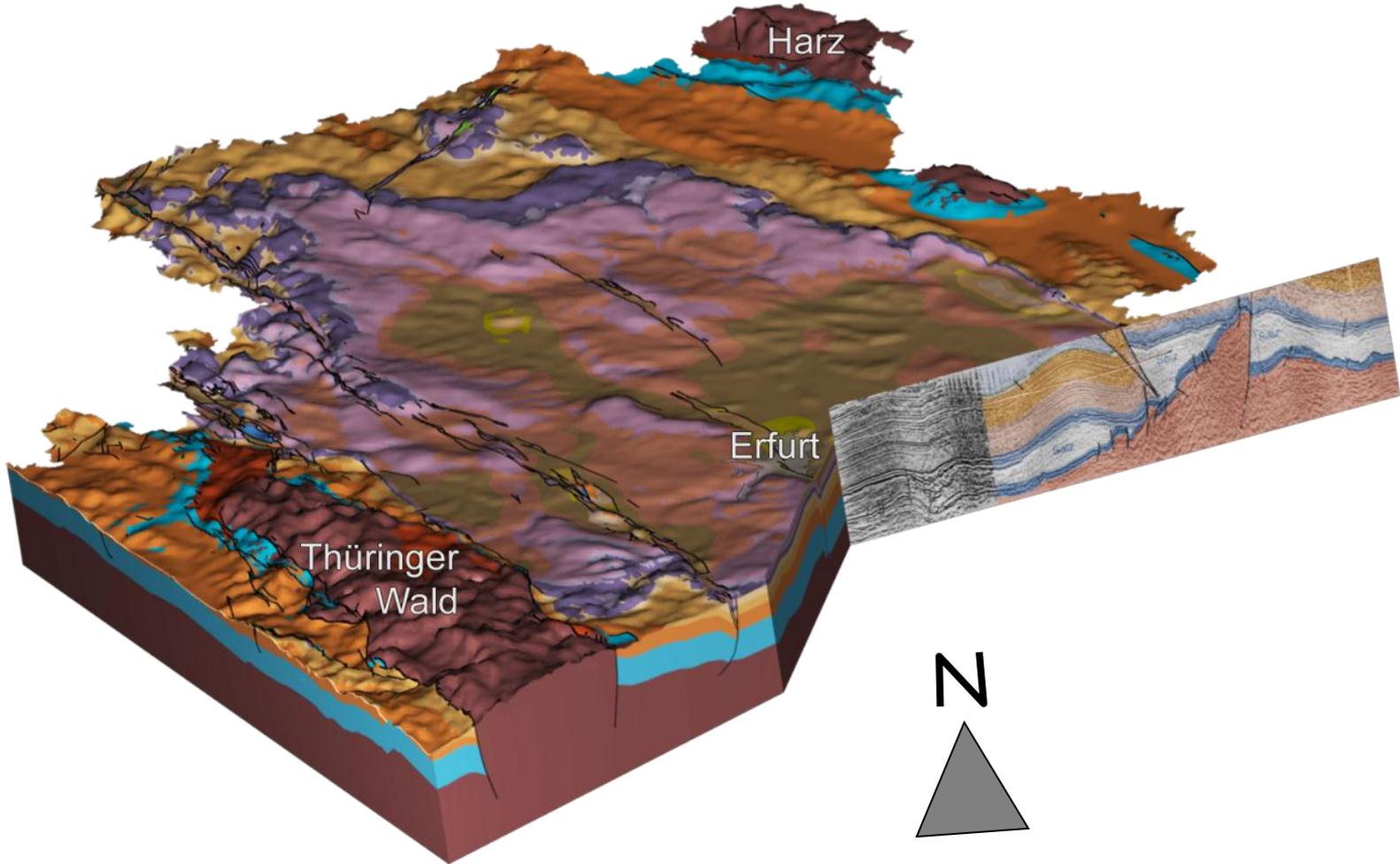
Combine different fields and scales of research into fluids:

- Near surface: Hydrogeology / Soil sciences
- To several km depth: Basin analysis



(More) complete, multiscale understanding of underground fluid motion in a specific region – [The Thuringian basin](#)

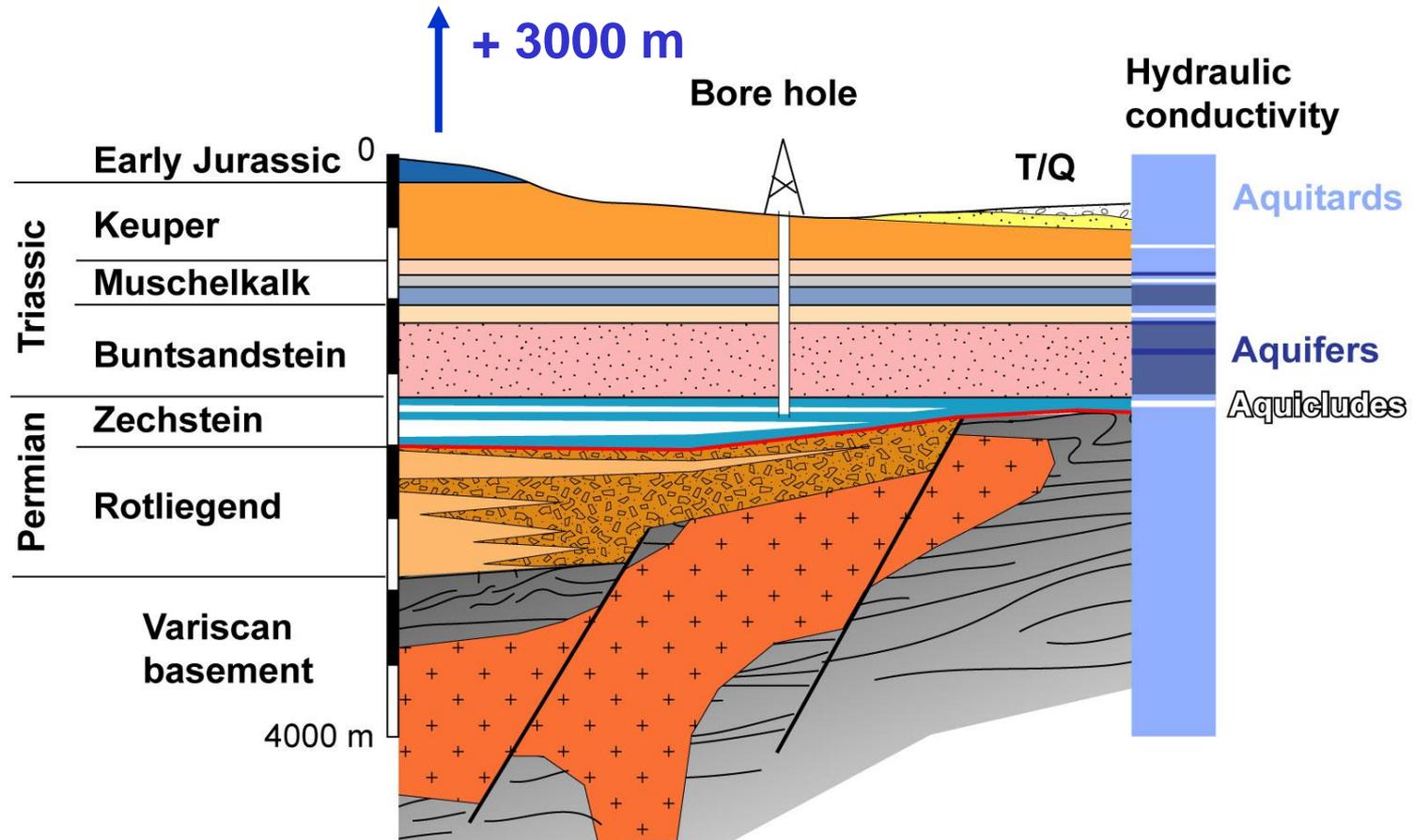
Geology of the Thuringian Basin



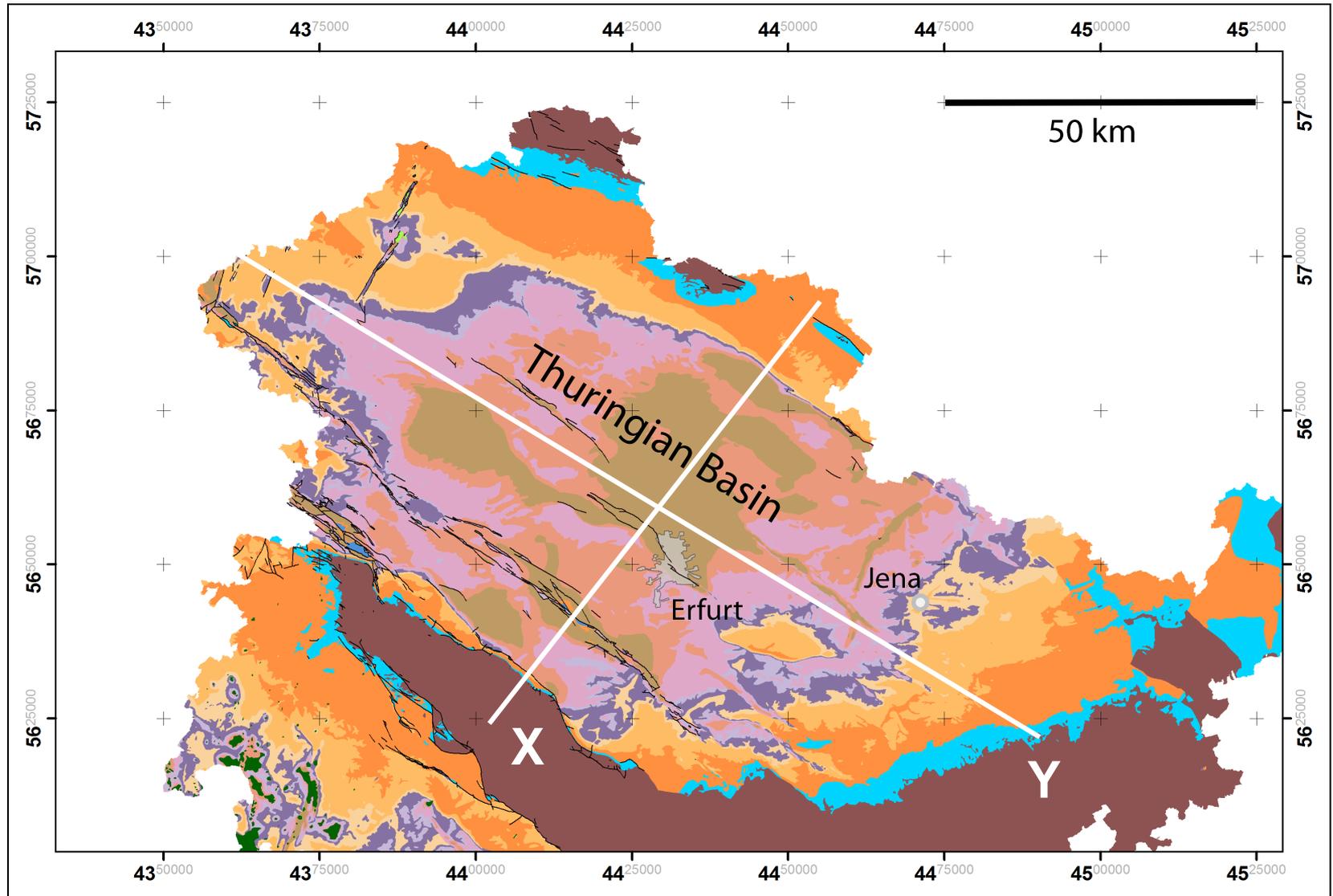
In

S. Donndorf

Stratigraphy and hydraulic properties

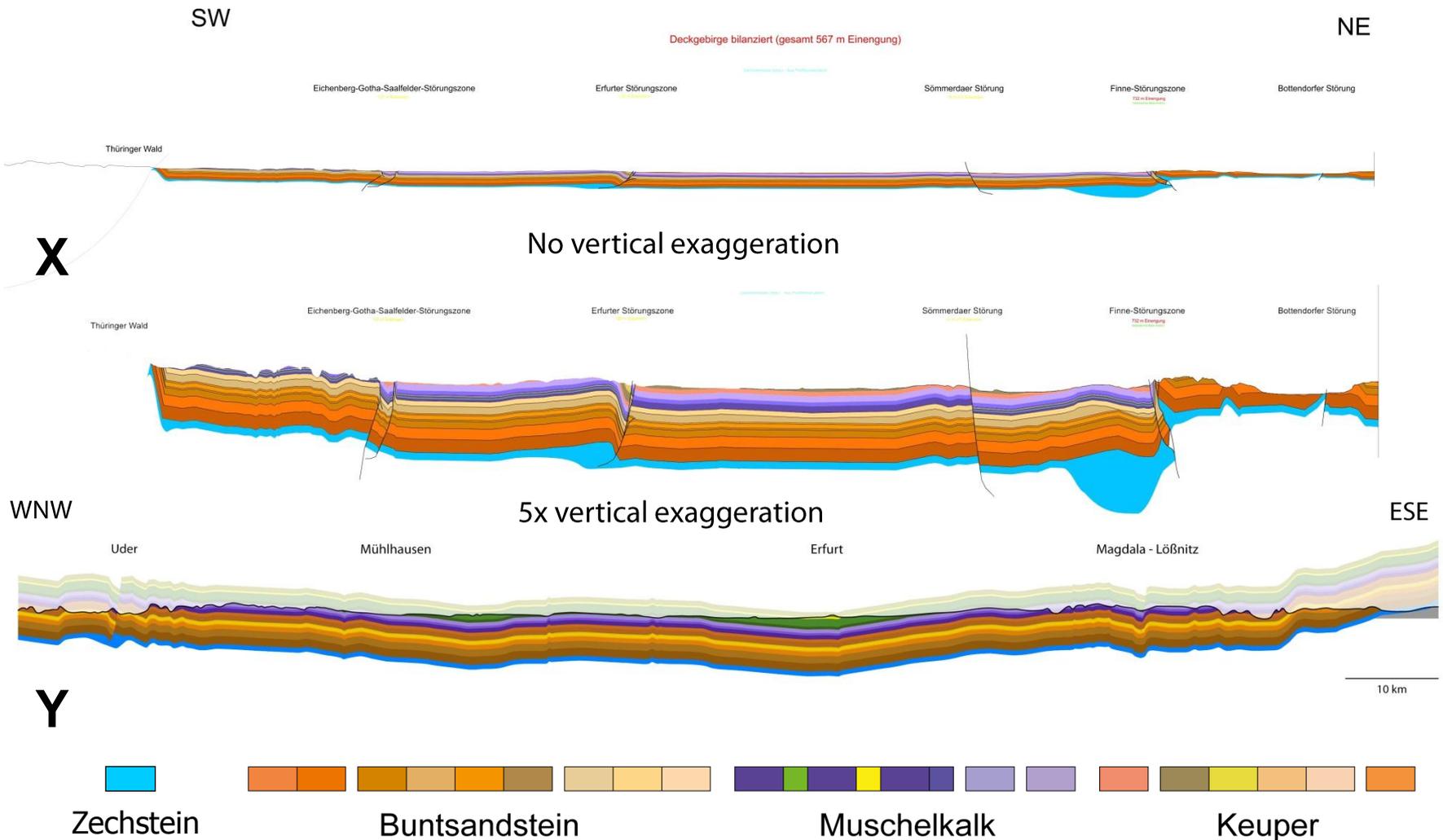


Regional cross-sections

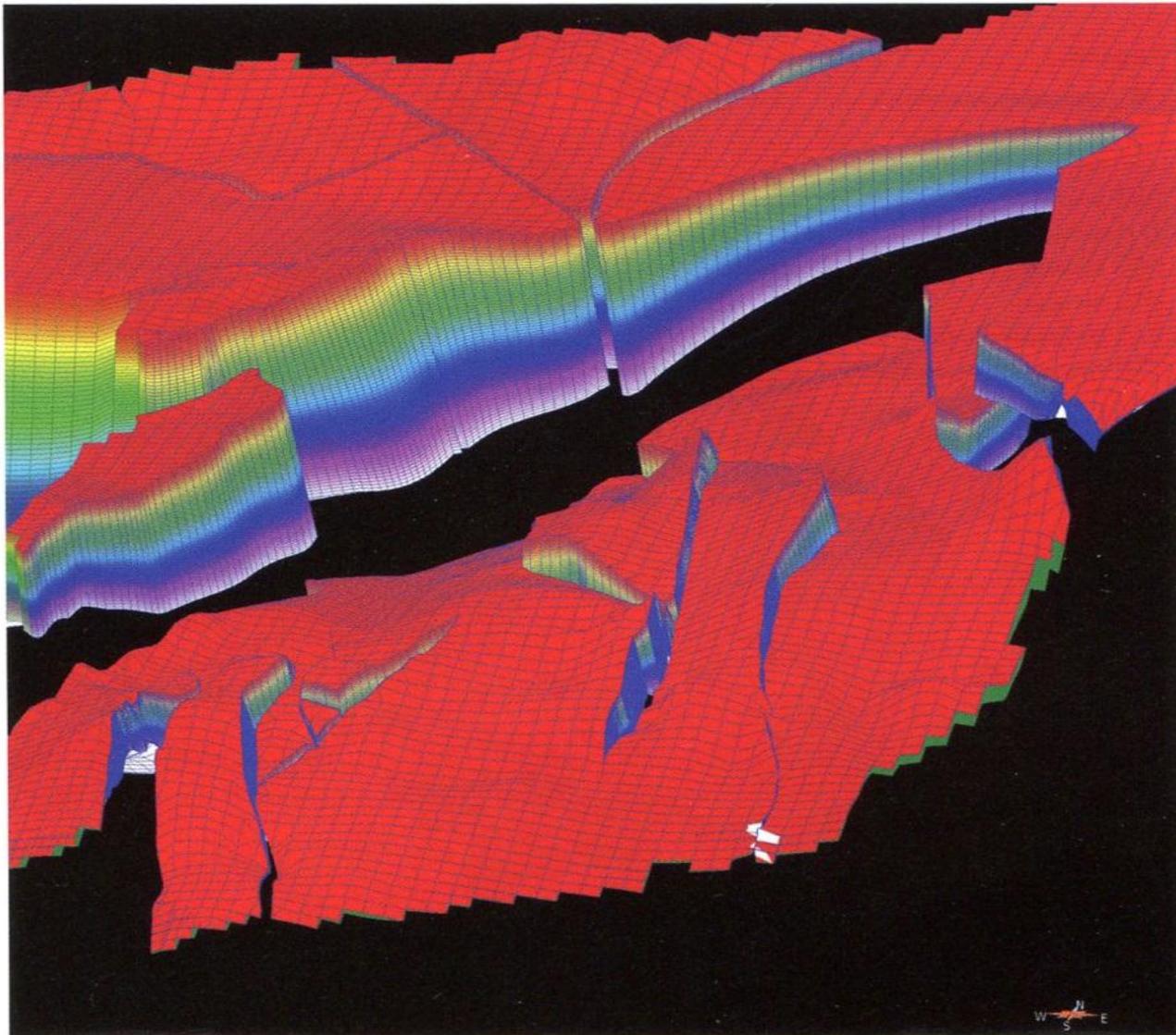


Map simplified from 1: 200.000 Geol. Map, Thuringian Geol. Survey (TLUG)

Sections of the Thuringian Basin



Tasks of the structural geology sub-project

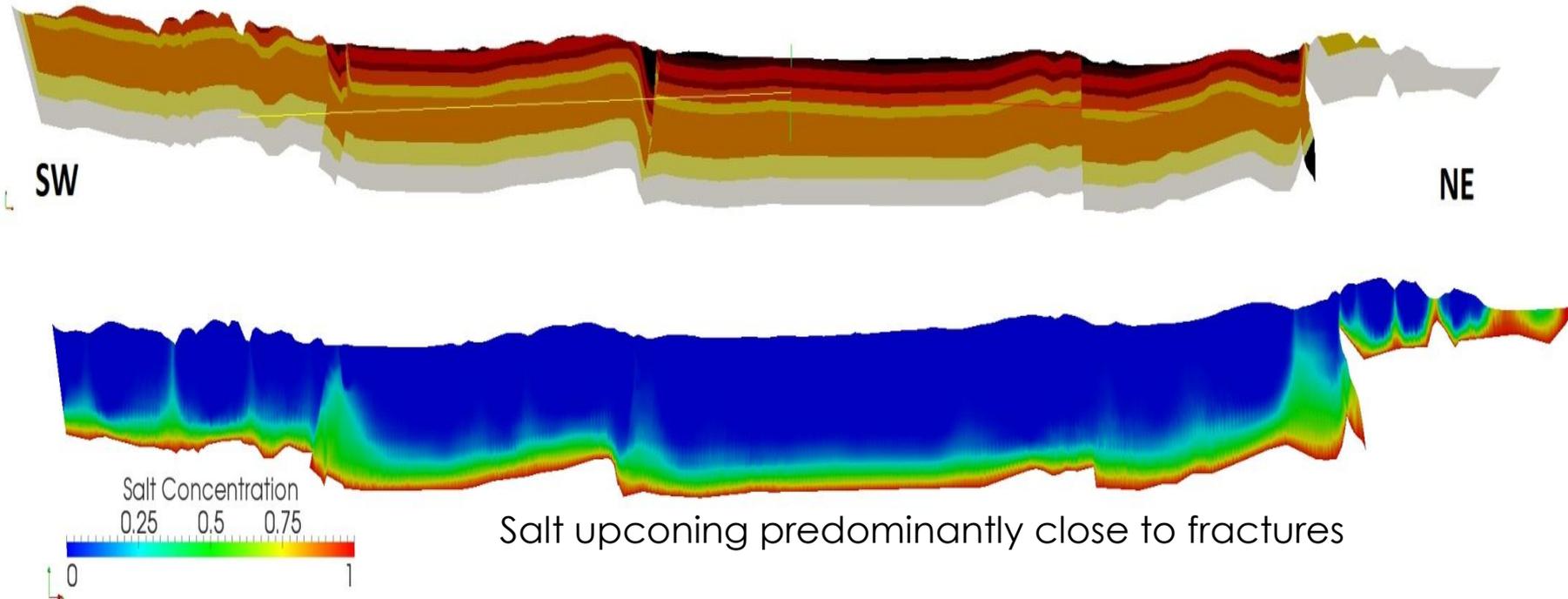


In

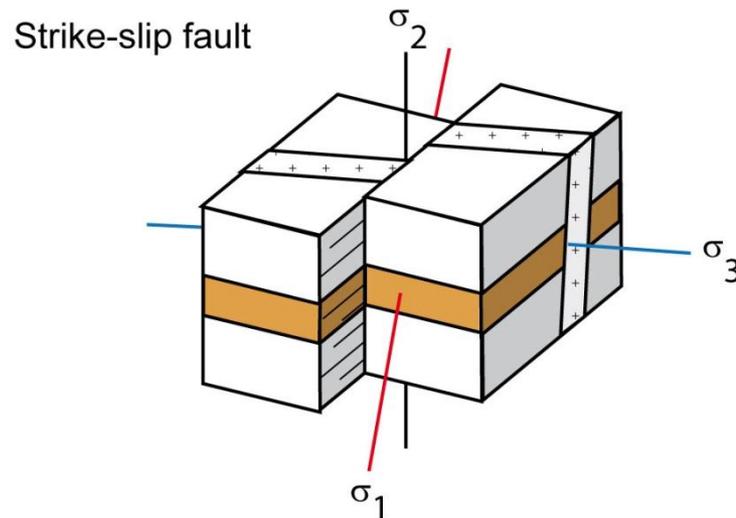
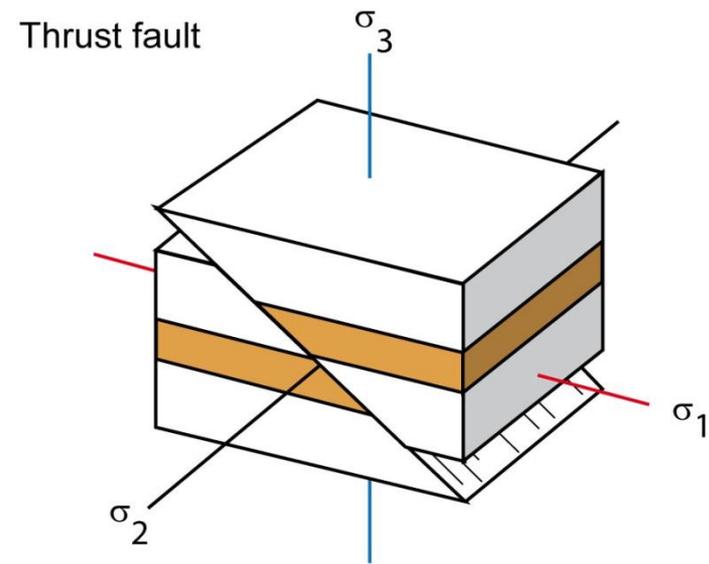
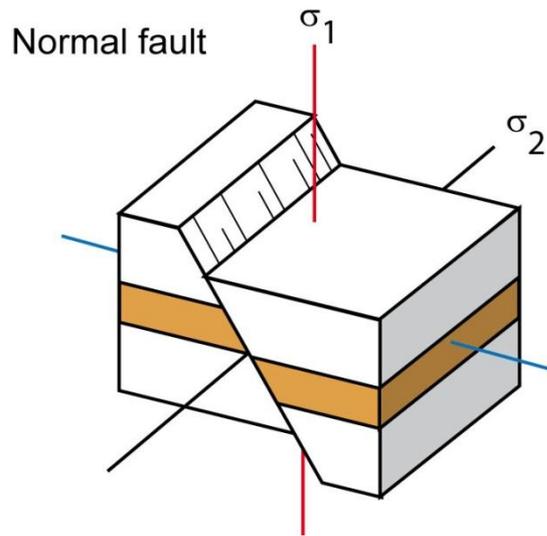
Why care?

Faults exert an important control on fluid flow. They may channel fluids or divide a basin into more or less isolated compartments

2D Numerical model



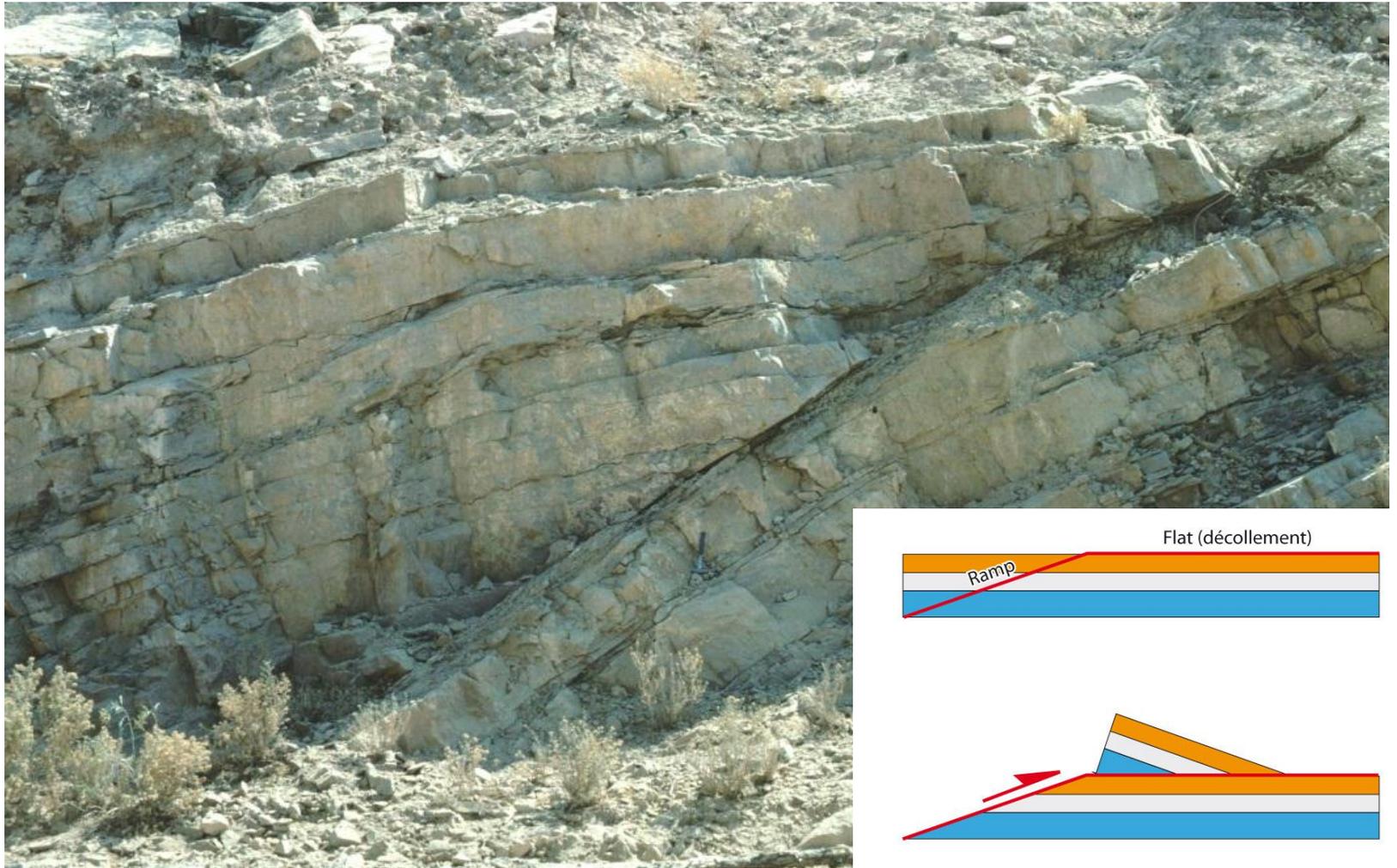
Faults in textbooks...



...and faults in nature

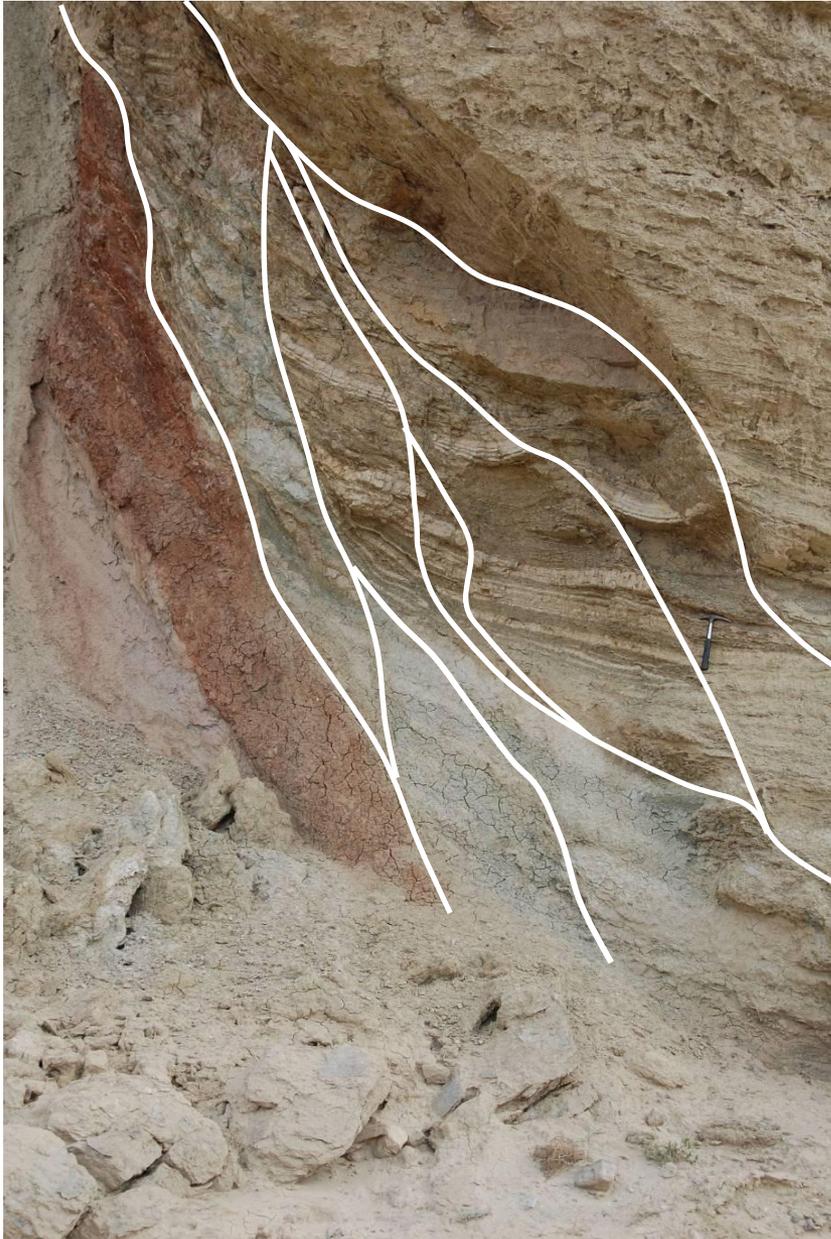


Sets of similar faults, curved fault planes, associated folds

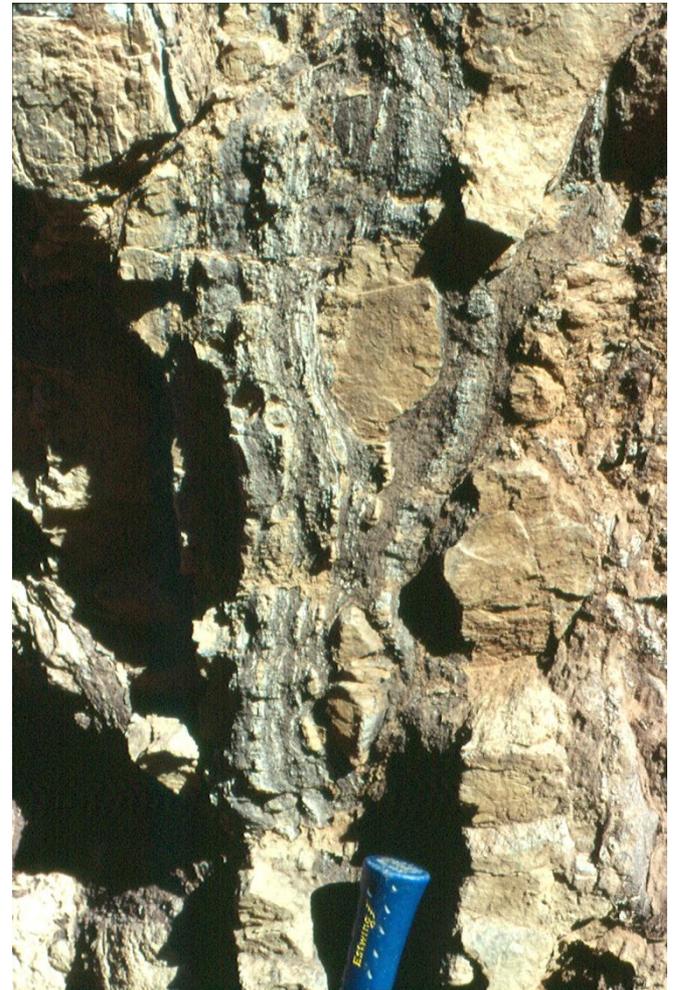


„Ramps“ and „Flats“: Staircase fault trajectories; folded fault?

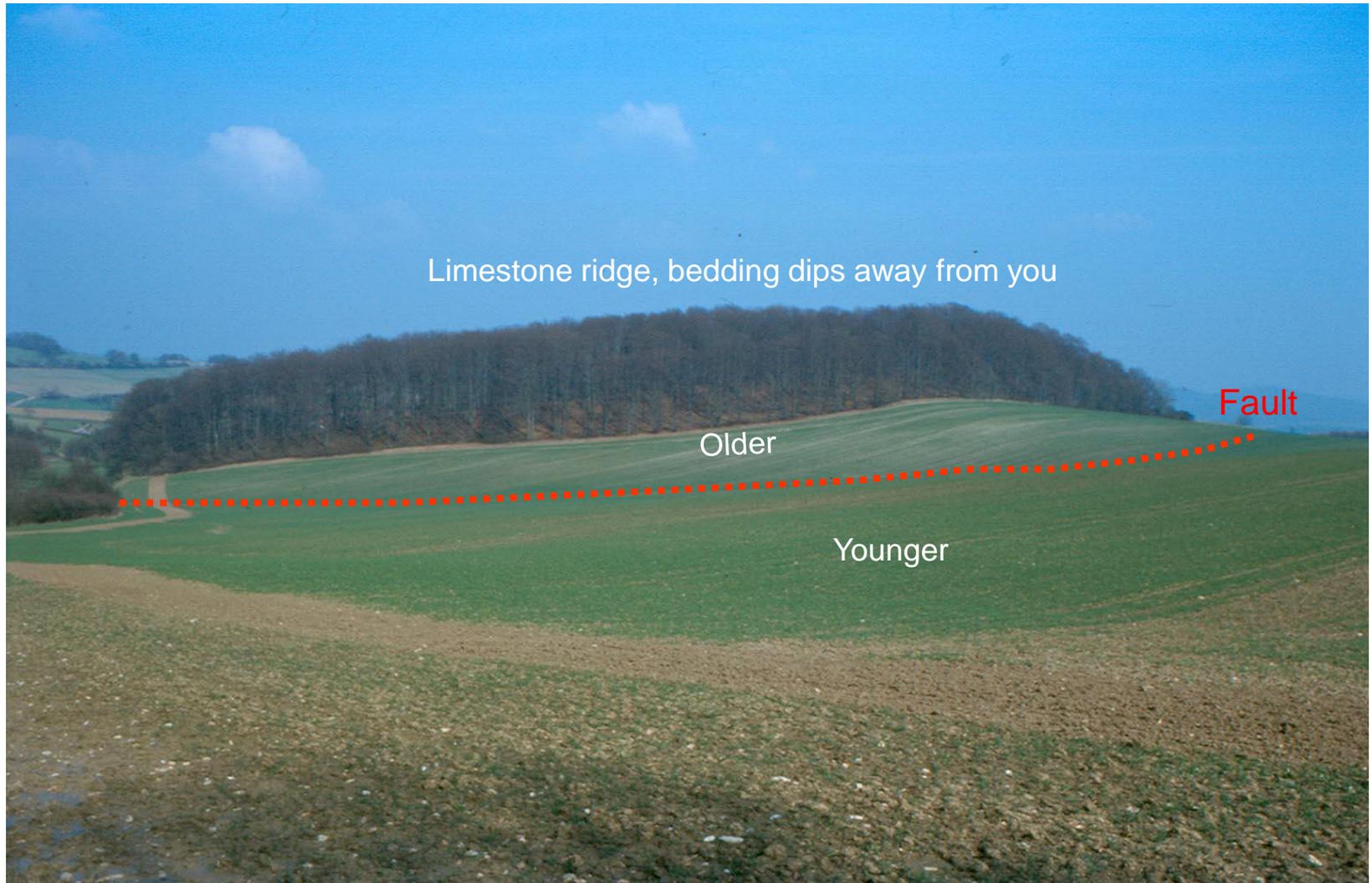
Faults in nature (III)



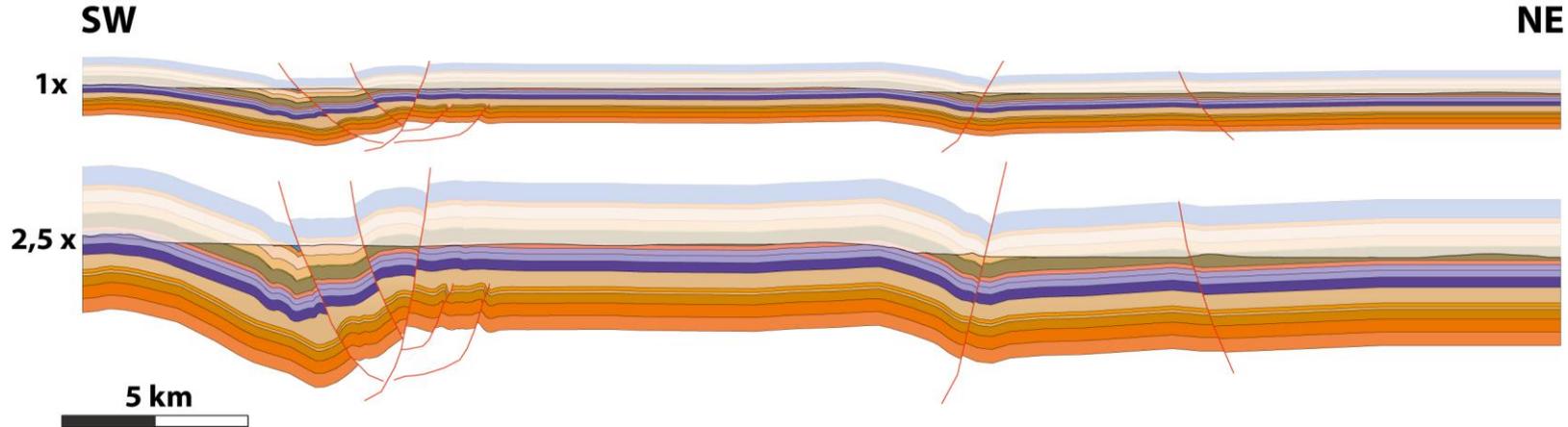
- Anastomosing fault networks
- Fault gouge, fault breccia etc.



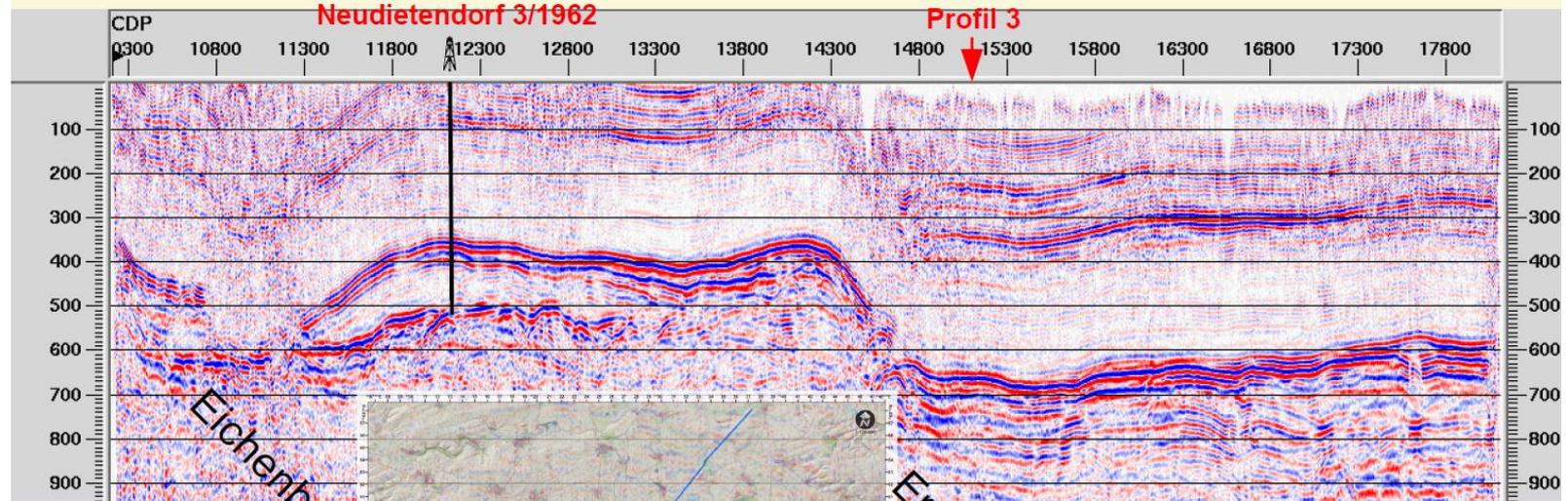
Faults in nature: the humid climate misery



Depth-extrapolated surface geology and a new seismic line



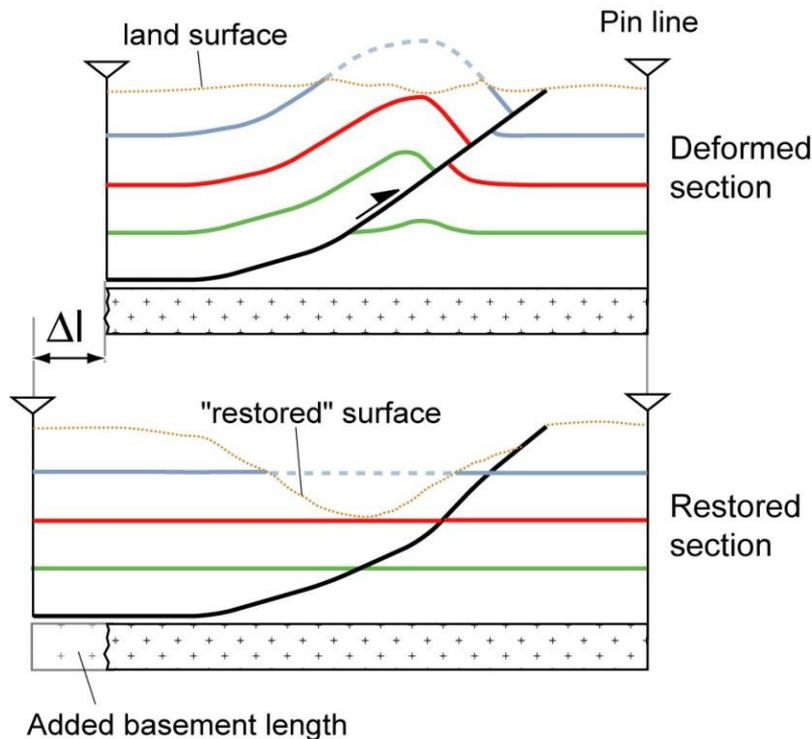
DMO-corrected brute stack: profile #1



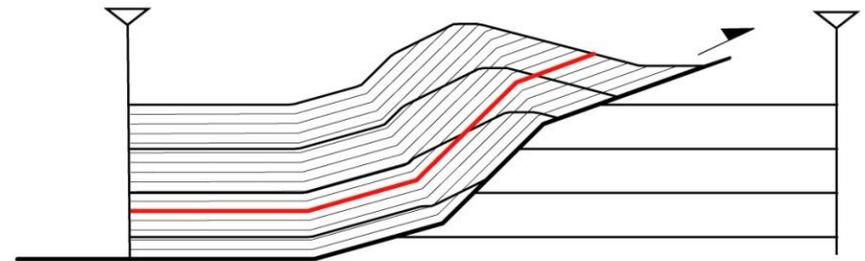
Extrapolating structures to depth: The cross-section balancing method

- Use constant volume / area / length assumption to check validity of cross-section interpretation

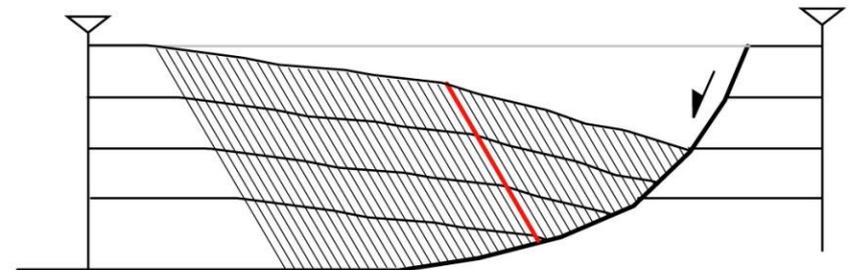
Bed length balance



Fault-parallel flow



Inclined shear

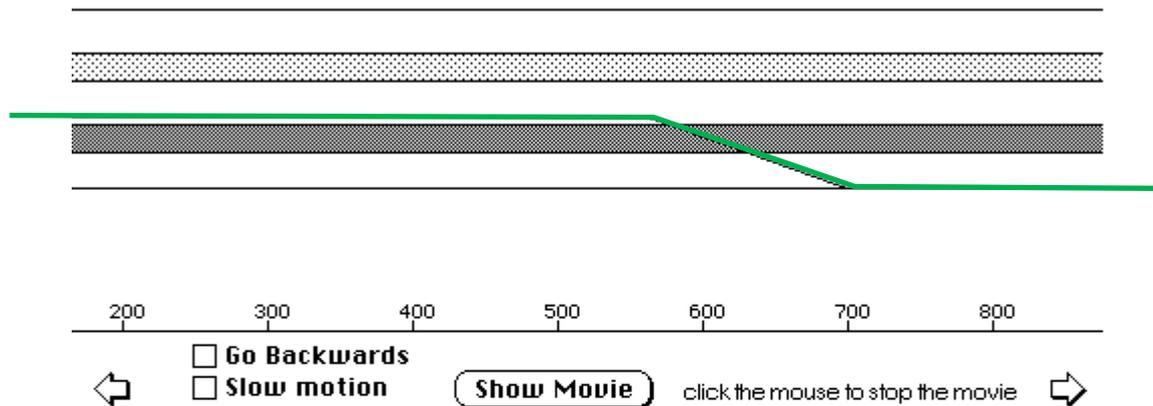


Extrapolating structures to depth: The cross-section balancing method

- Use fold shapes to infer fault geometries

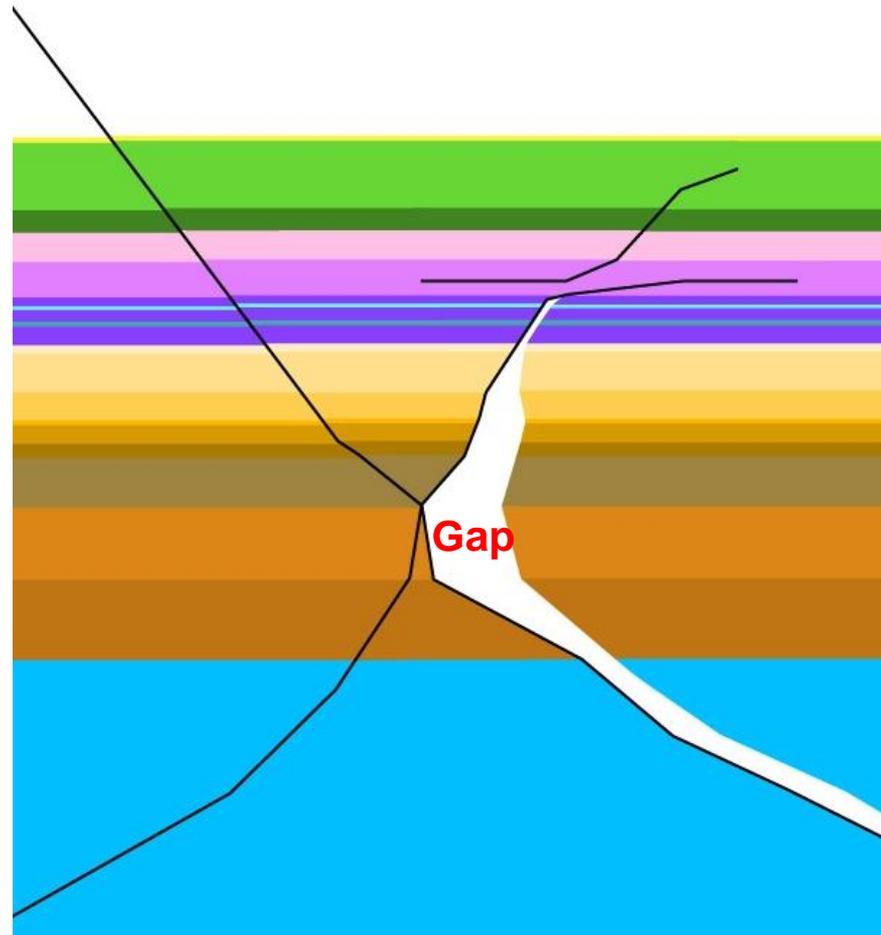
Fault bend fold - The Movie

by Rick Allmendinger © 1990
 individual frames were produced by
 MacThrustRamp™

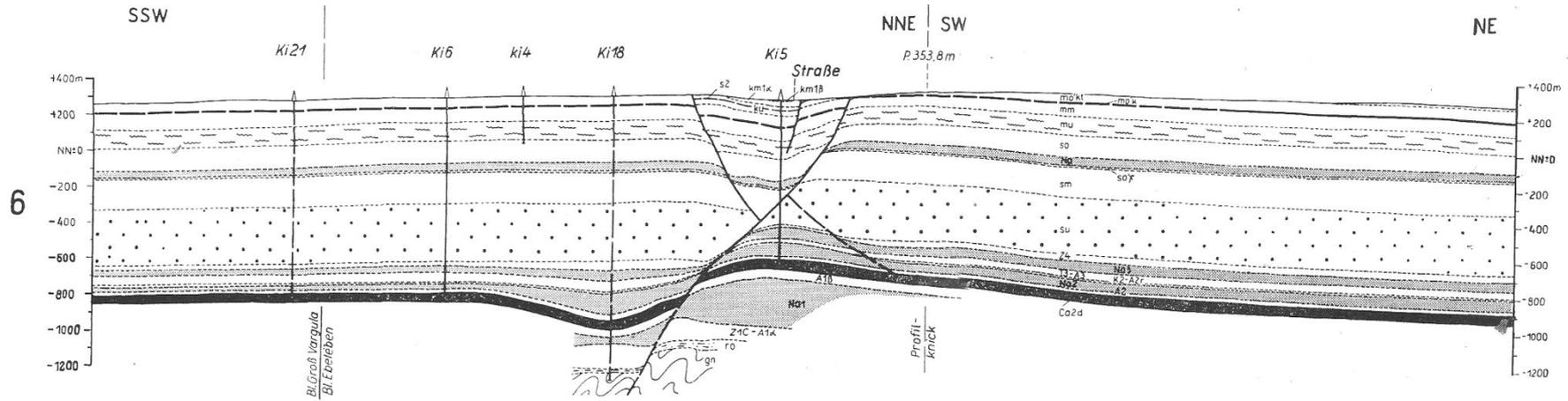


Extrapolating structures to depth: The cross-section balancing method

- Use constant volume / area / length assumption to check validity of cross-section interpretations



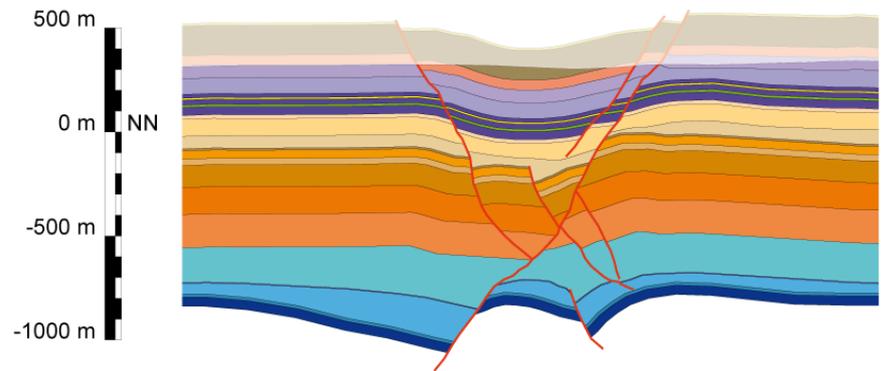
The Schlotheim structure as a case study



Grumbt 1964

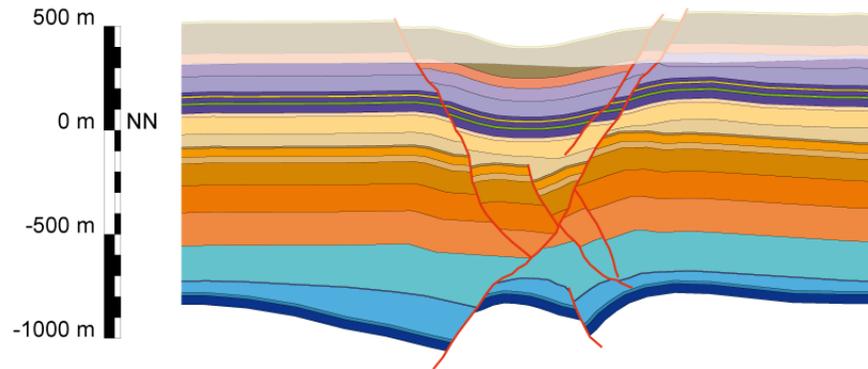
SW **NE**

cross section 3B

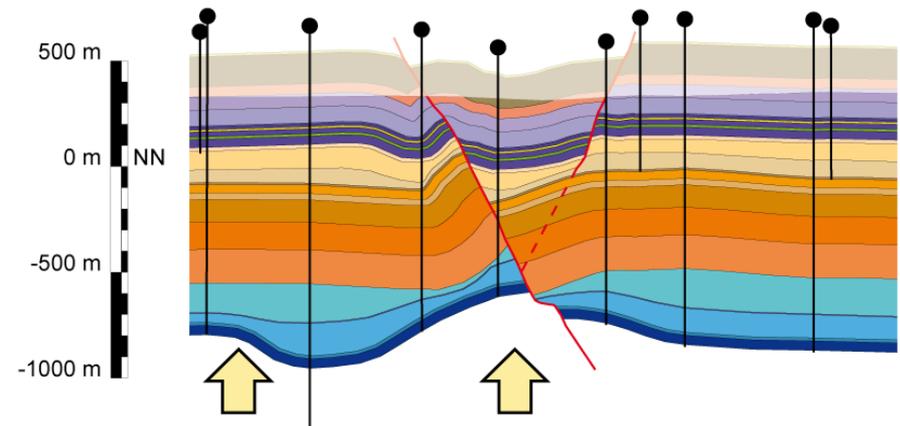


Malz 2011

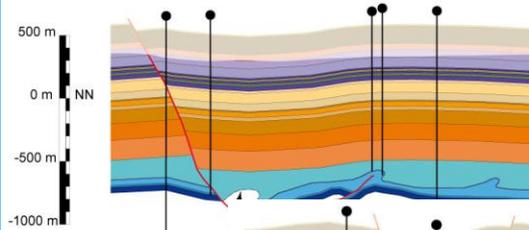
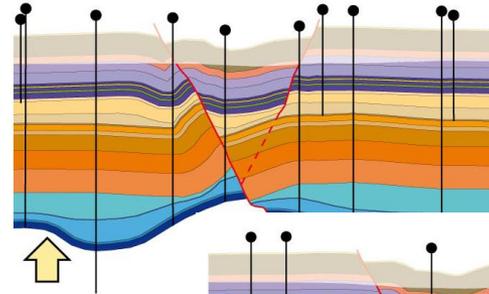
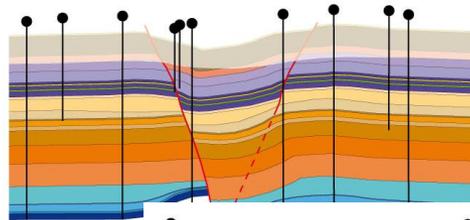
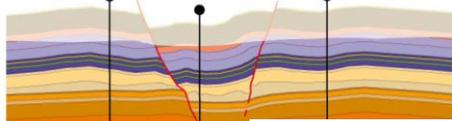
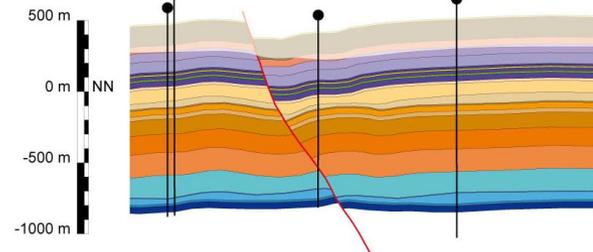
Two contrasting balanced models

SW
NE
cross section 3B


Extension only

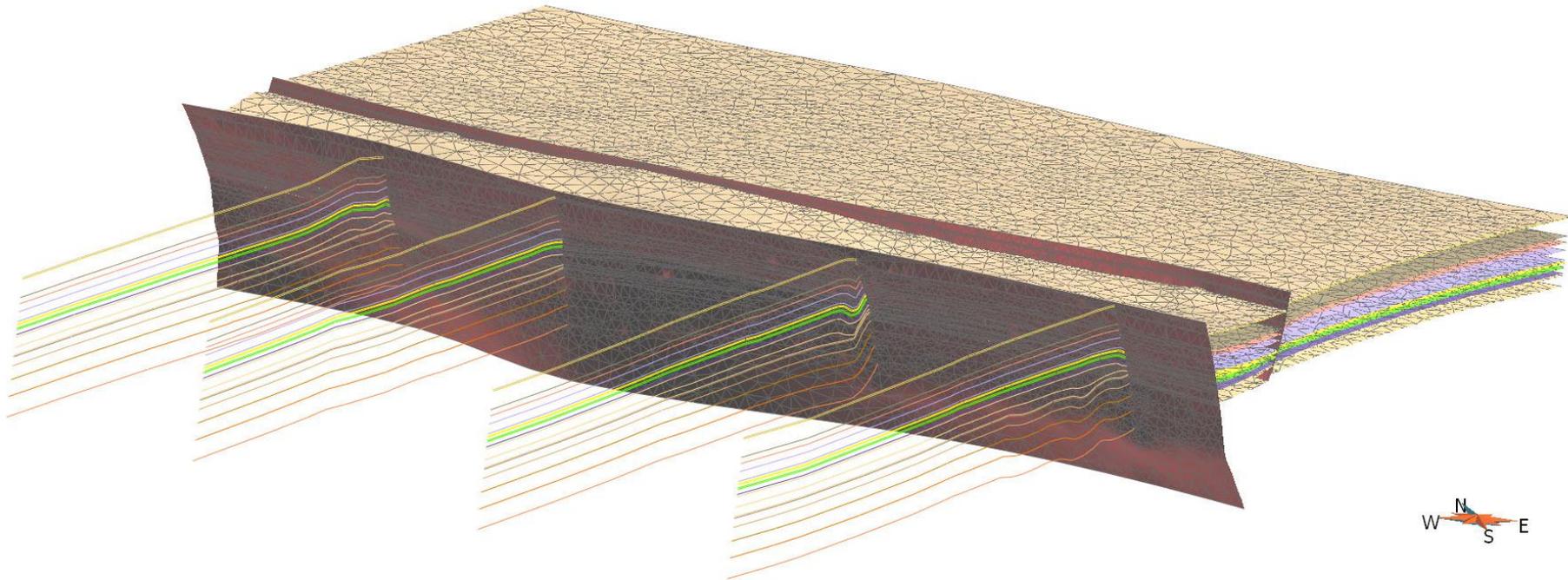
SW
NE
cross section 3B


Extension followed by shortening

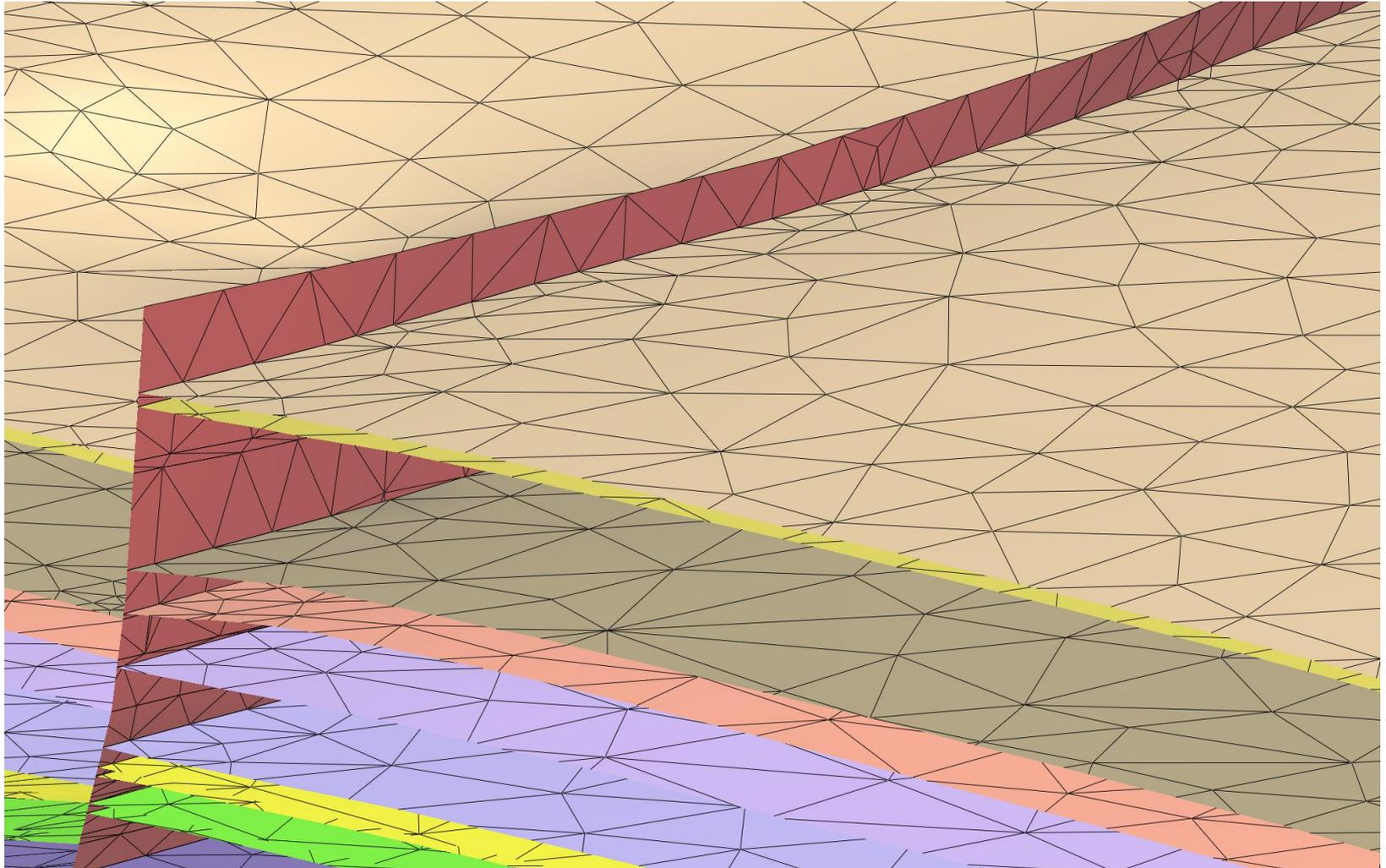
SW
NE
cross section 1

 maybe mixt
different (Zech:

cross section 5


Serial balanced cross-sections

Stratigraphic surfaces and faults interpolated to 3D in gOcad



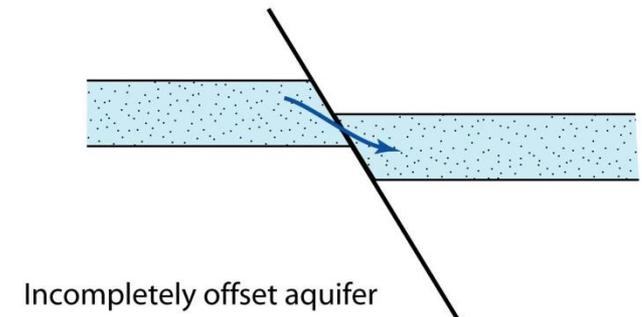
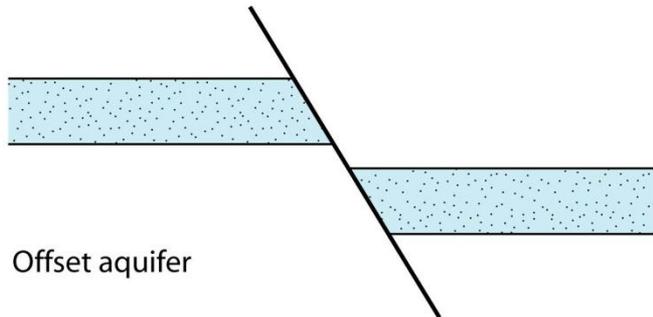
Automated fitting of stratigraphic and fault surface meshes



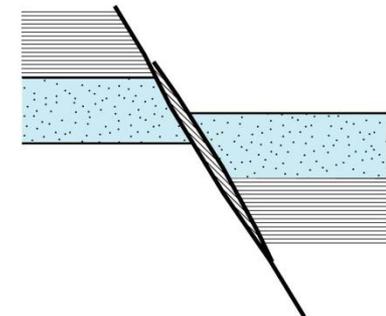
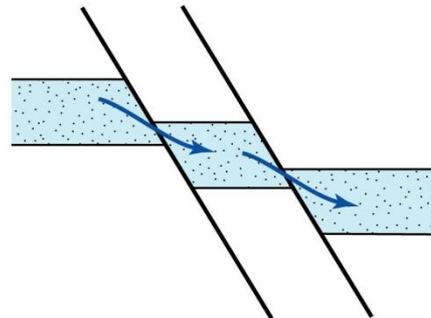
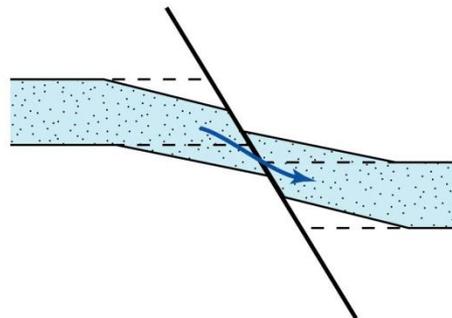
In

Predicting and implementing hydraulic properties: a problem of scale

Regional scale (prediction)



Local scale (actual situation)



A plan for implementing geometrically and hydraulically viable faults

Constraints:

- Overall fault geometry: predictable
- Small-scale associated structures: unpredictable
- Aquifer connectivity across faults: predictable within limits
- Fault rock type: predictable within limits

In large scale models, correct hydraulic parameters will have to be attached to faults despite incorrect geometry

Faults will be functions for spatially resolved fluid transfer between adjacent blocks?



Foto: M. Müller

Thank you for your attention!



Das INFLUINS - Konsortium



Hochschulen



seit 1558 Friedrich-Schiller-Universität Jena



Forschungsinstitute

Max-Planck-Institut
für Biogeochemie



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