



# The Role of Faults in Shaping Present-Day Stress Fields: Implications for 3D Subsurface Models

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## Research Question

Do active faults with displacements of up to a few tens of meters significantly influence the far-field in-situ stress state, or are variations in lateral stiffness and density contrasts between geomechanical units the dominant controlling factors?

### Proposed Approach

- To answer the research question, we use 3-D geomechanical-numerical models representing the Zürich Nordost (ZNO) in the Northern Switzerland (Figure 1).
- Fault-less models are compared to a Reference Model with faults, the best available representation of the ZNO region.
- All the models are calibrated to 45 high-quality stress magnitudes from an extensive drilling campaign- a quality and quantity extremely rare in geomechanical studies (Figure 2).

Reference Model: A model with faults implemented as contact surfaces, with friction values of 0.6 to allow sliding.

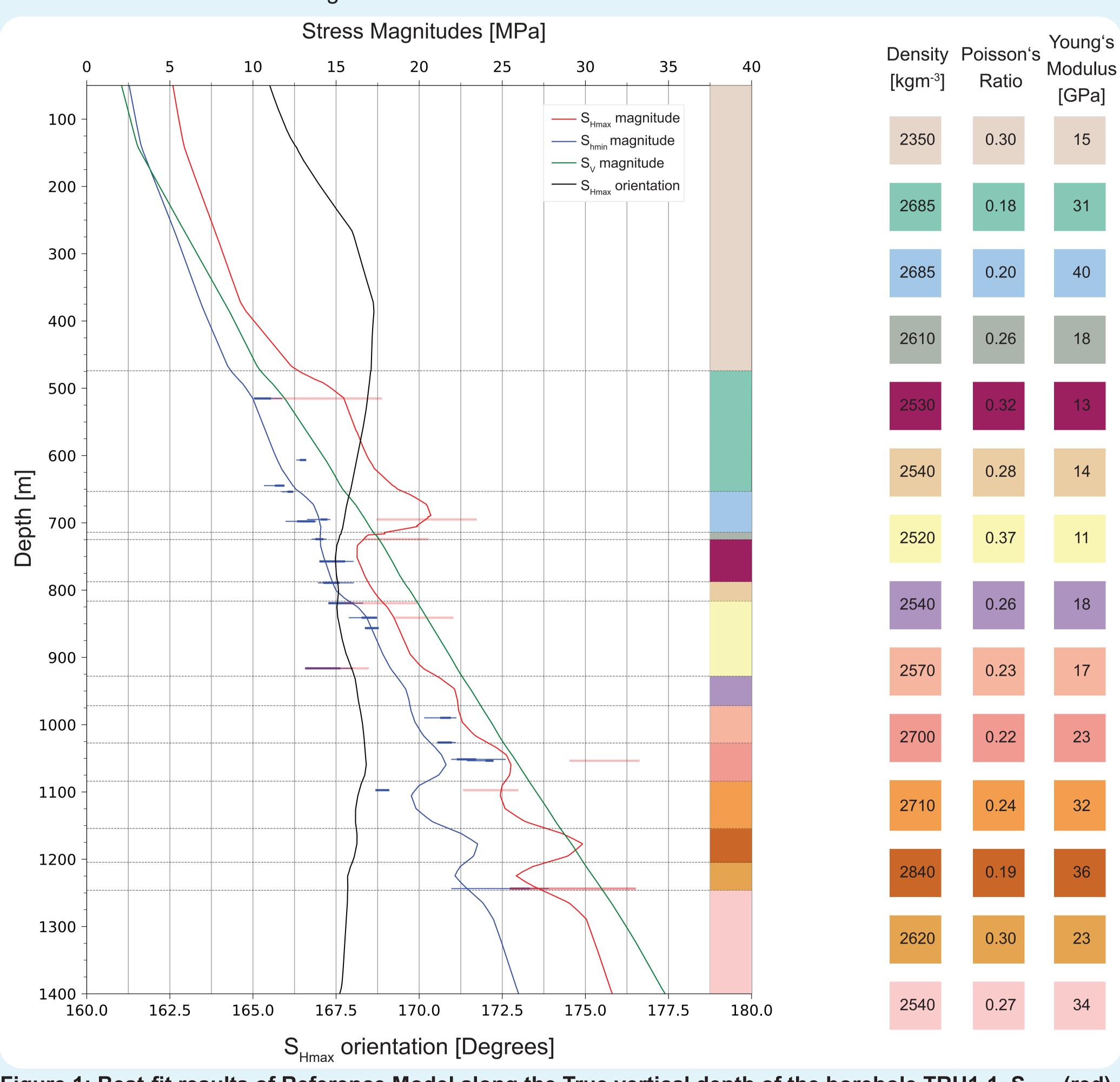


Figure 1: Best-fit results of Reference Model along the True vertical depth of the borehole TRU1-1. S<sub>Hmax</sub> (red) and S<sub>hmin</sub> (blue) magnitudes are plotted as ranges rather than point values to account for the uncertainties in the data. The geomechanical units and the corresponding mechanical properties are shown beside and color-coded.

No-Faults Model: A sister model from the reference model, where all the faults, except Neuhausen fault with a friction value of 50, are removed.

Coarse Resolution Model: Lateral resolution is 110 m, vertical resolution is 10-100 m and total of 2,826,240 elements. Mechanical property assignment is through a quicker and efficient method.

Fine Resolution Model: Lateral resolution is 80 m, vertical resolution is 6-85 m and total of 5,974,150 elements. Mechanical property assignment is through a quicker and efficient method.

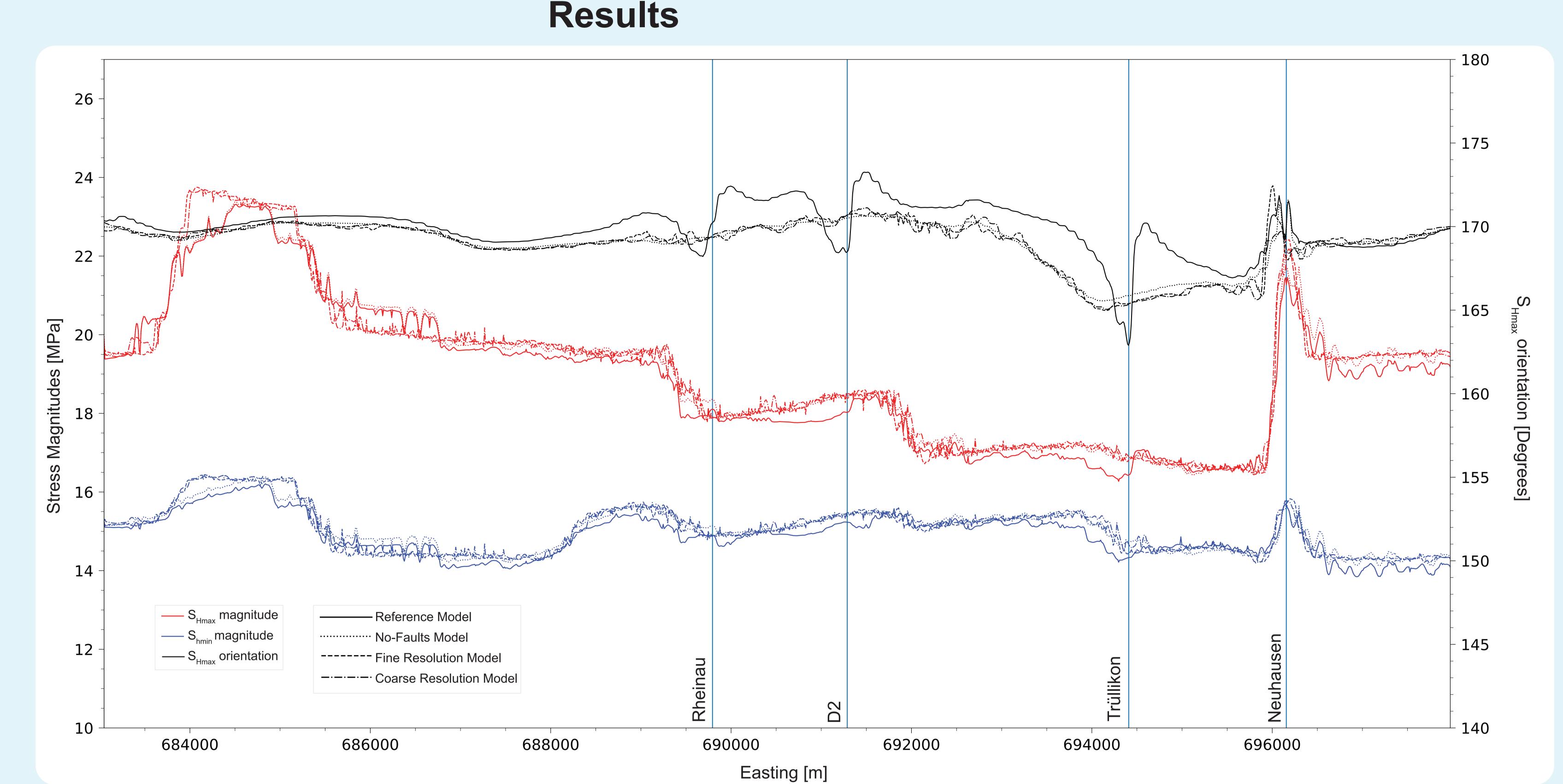


Figure 3: Comparison of stress magnitudes and orientation along a E-W profile passing through TRU1-1 borehole at Northing = 277548 and Depth = -300 b.s.l.

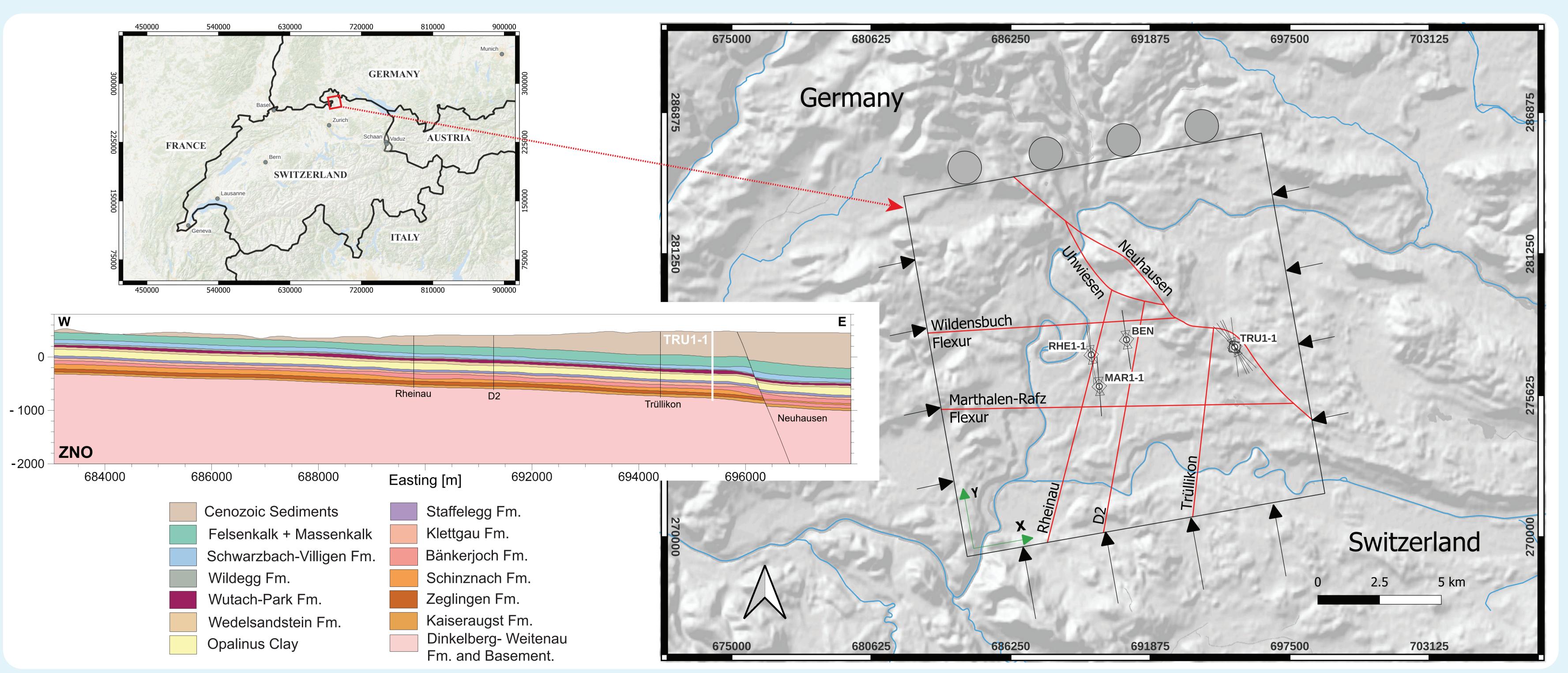


Figure 2: The geological background and geographical location of the ZNO siting region. The CRS used is EPSG: 21781 CH1903/LV03. The surface traces of the faults are shown as red lines, along with the borehole location. The color schema used to illustrate the geomechanical units are same as Figure 1.

#### Conclusion

- From Figure 3, it can be observed that the stress magnitudes and orientations from the models without faults are smooth across the faults with no offset but have an abrupt change in stress while crossing the Neuhausen fault.
- The spatial influence of active faults, with an offset of few 10's m on the far-field in-situ stress state extends only ~ few 100's m from the fault core.
- The changes caused in the stresses are influenced by lateral stiffness rather than fault displacement.
- The changes within the different models are far less compared to the inherent uncertainty ranges of the stress magnitudes (Figure 1).

#### References

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