The Bern Fault Zone: Does it exist or is it just geofantasy?

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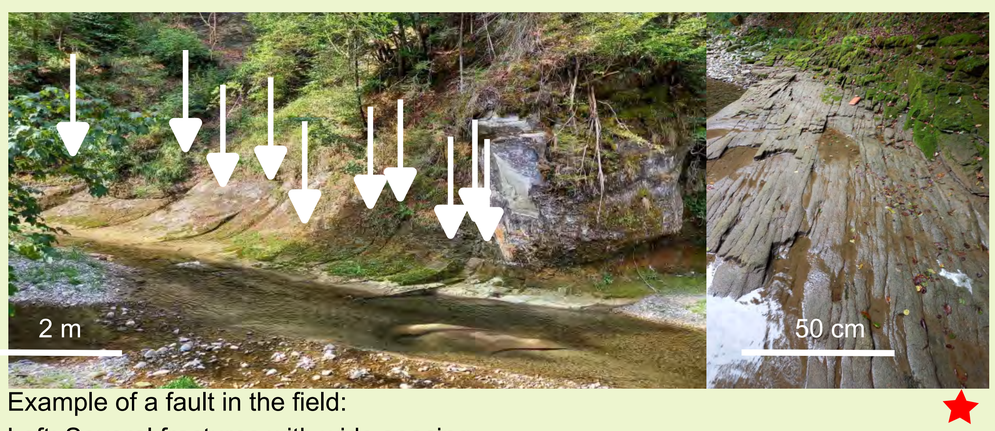
Introduction

The collected data of earthquakes show a **linear accumulation** of small to moderate (Magnitude 2-3) earthquakes in the region of Bern (Herwegh, 2021). Their seismic distribution and the comparison with other fault zones, leads to the **hypothesis of a fault zone** between Bern and the "Gantrisch" in the region of the "Schwarzwasser" (BFZ) (Mock & Herwegh, 2017) and the title question of this thesis. The **postulated seismic lineament** is oriented in NNE-SSW direction like the Fribourg Fault zone (FFZ) in the south-west (Isenschmid, 2019).

This study is based on three assumptions:
- Earthquakes accumulate along fault zones
- Fault zones appear morphologically at the surface as lineaments, faults/fractures and other topological features
- Such morphological features can be used to infer the course of the fault zone

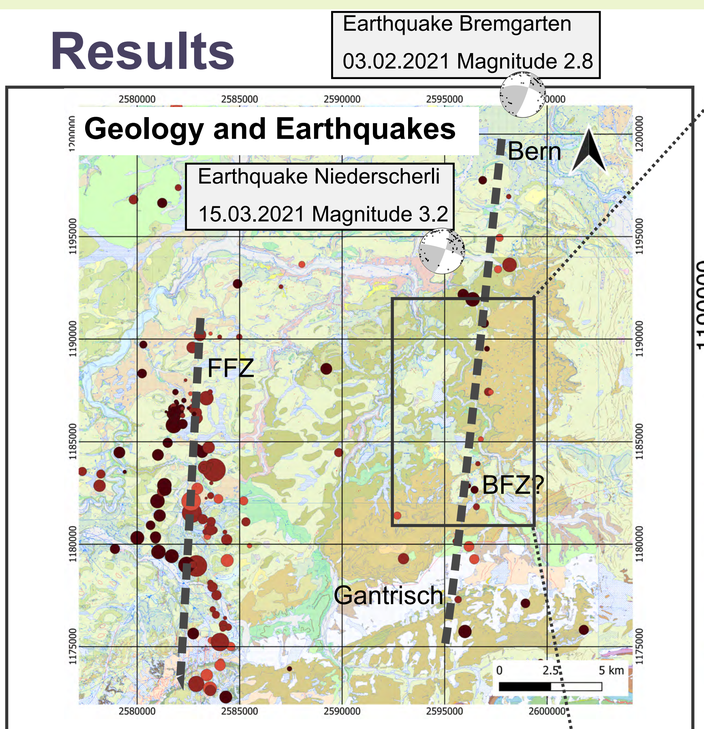
Methods

1. **Semi-automated mapping of potential fault planes**: identifying steep cliffs with calculations in QGIS to find potential fault planes
2. **Manual mapping of lineaments**: based on the digital elevation model (DEM), the geological vector cover, the river network and the orthophoto
3. **Field work:** Mapping and measuring fractures along the "Schwarzwasser"

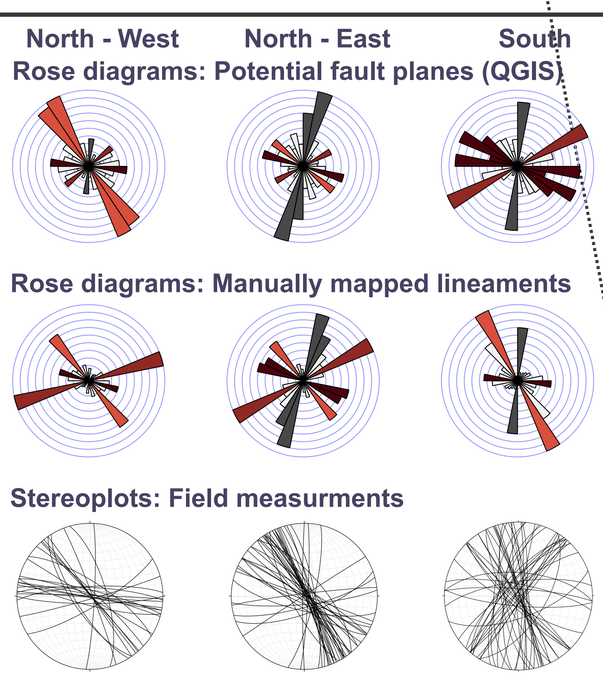


Example of a fault in the field:
Left: Several fractures with wide spacing
Right: Damaged zone (small fracture spacing, locally enhanced number of fractures)

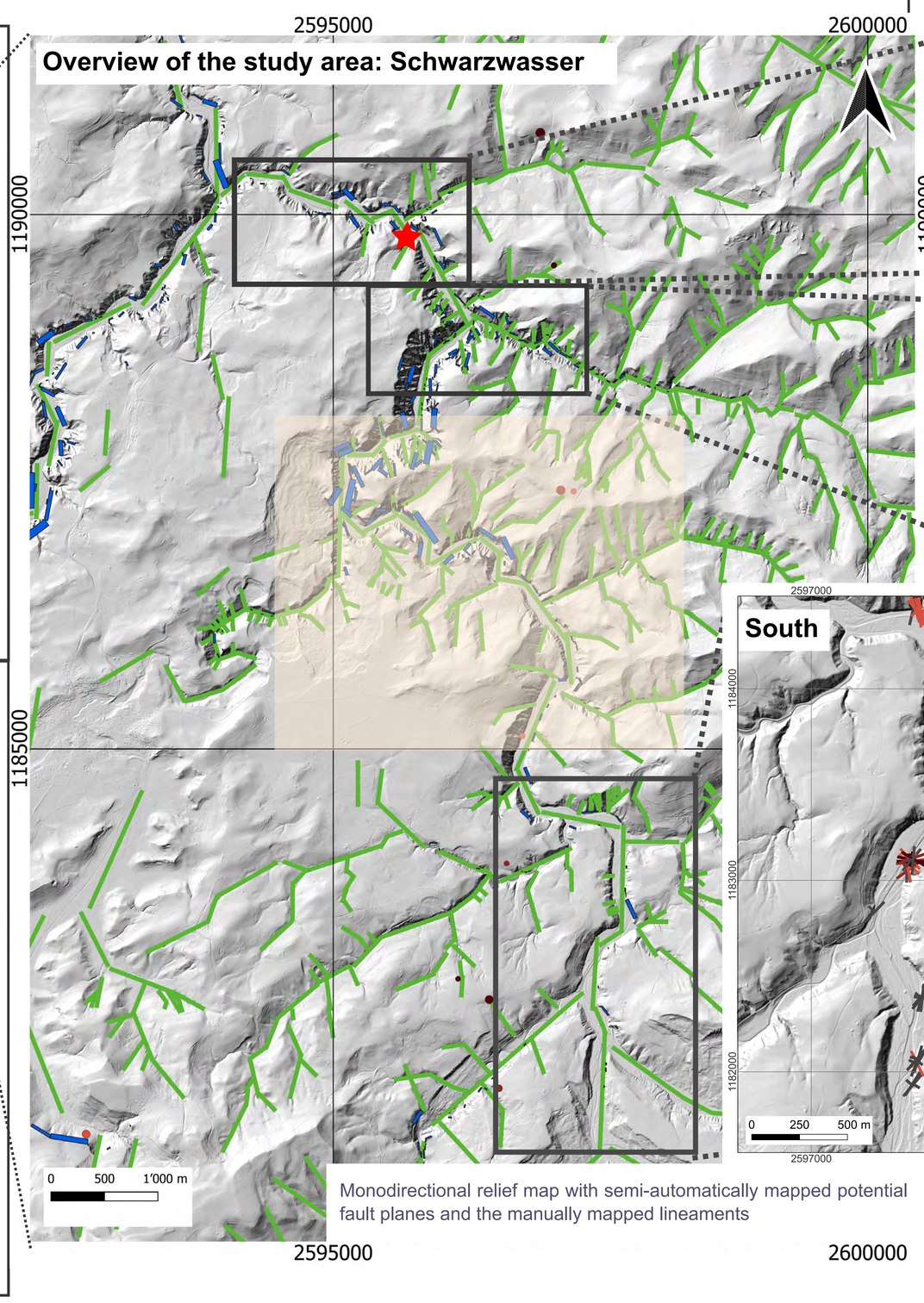
Results



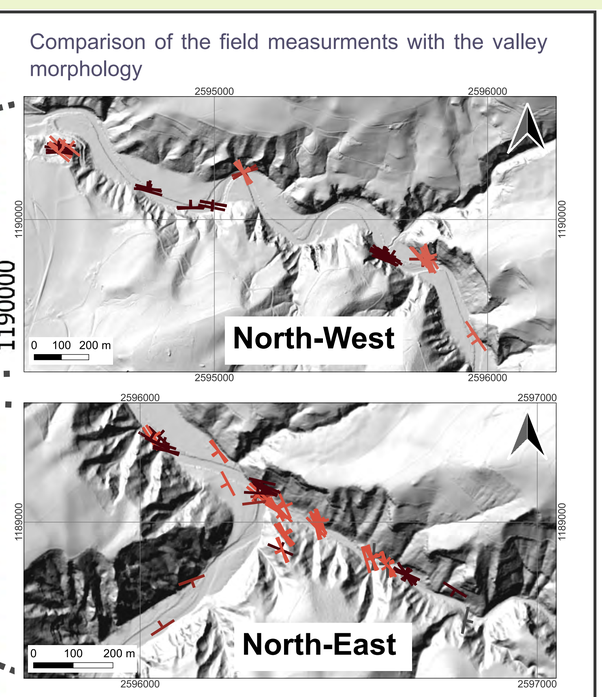
From the seismic distribution in the study area and the local plane solutions (Diehl, 2023) the Bern Fault zone (BFZ) can be established with a sinistral shear sense parallel to the Fribourg Fault zone (FFZ).



Four main orientations are highlighted in the results because they reoccur with all methods and in all parts of the study area.



Monodirectional relief map with semi-automatically mapped potential fault planes and the manually mapped lineaments



Legend

Earthquakes Hypocenter Depth
- < 2 km
- 2 - 6 km
- > 6 km

Geology in the study area
OMM (Upper Marine Molasse)
- Sense - Formation
- Belpberg - Formation

Quarternary
- Niederterrasse
- Hochterrasse

Mapping
- Manually mapped lineaments
- Potential fault planes (QGIS)
- Strike - dip of field data

Area still to be studied

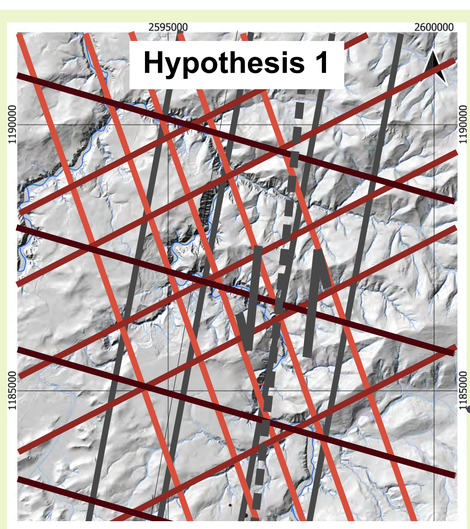
Photospot

Basemaps: Monodirectional relief and Geocover from ©swisstopo
Earthquake dataset from Diehl et al. (2021)

Conclusions

The results lead to the following conclusions about the Bern Fault zone:
1. Orientations of the measured faults **correlates with the valley morphology**
2. **4 main fault directions** can be observed
3. The appearance of the fault directions in the **different areas is heterogenous**

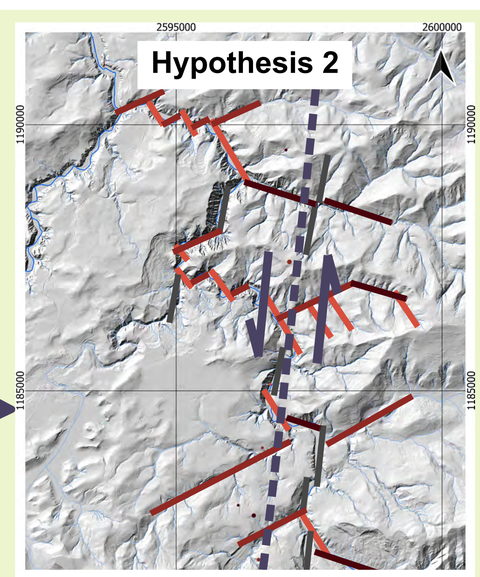
These Conclusions lead to two hypotheses for the underlying fault system:



Pervasive fault system (schematic)
Faults in the same directions as the four main orientations go through the whole area. The grey lines are parallel to the postulated seismic lineament with a possibly sinistral movement.

Outlook

1. Closing the gap in the field work, are there other potential morphological features?
2. Creating a 3D model with possible fault planes and hypocenters
3. Taking samples from fractures with secondary calcite precipitation (to date the fault)



Individual fault segments (schematic)
The area is divided in parts with fault segments in the four main fault directions.

Diehl, T., Kissling, E., Herwegh, M. & Schmid, S. M., 2021, Improving Absolute Hypocenter Accuracy With 3D Pg and Sg Body-Wave inversion Procedures and Application to Earthquakes in the Central Alps Region. Journal of Geophysical Research: Solid Earth, 126
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