Brittle-ductile deformation in carbonates of the Téné fault (Valais)

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Introduction

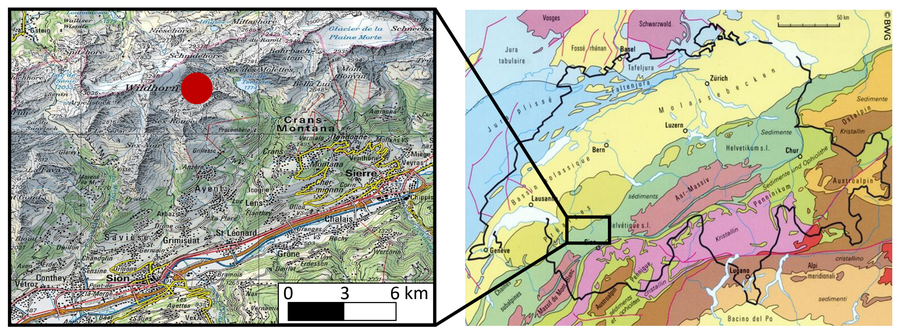
- The Valais is the seismically most active region in CH.
- Fault systems are responsible for this seismicity.
- Among these faults, the Téné fault is exceptionally well preserved, allowing to map brittle and ductile structures in 2D.
- The Téné fault is believed to be spatially connected to the nowadays seismic active fault system in the Valais.

Aim

- Determine fault architecture
- Characterize rupture processes and the interplay with fluids
- Establish a link between fault structures and active seismicity

Approach & Study Site

- Main methods: field work (mapping geological structures, sampling), image analysis (GIS), light-microscopy, SEM, CL.
- The study site lies within the Wildhorn nappe in the Helvetic nappes.



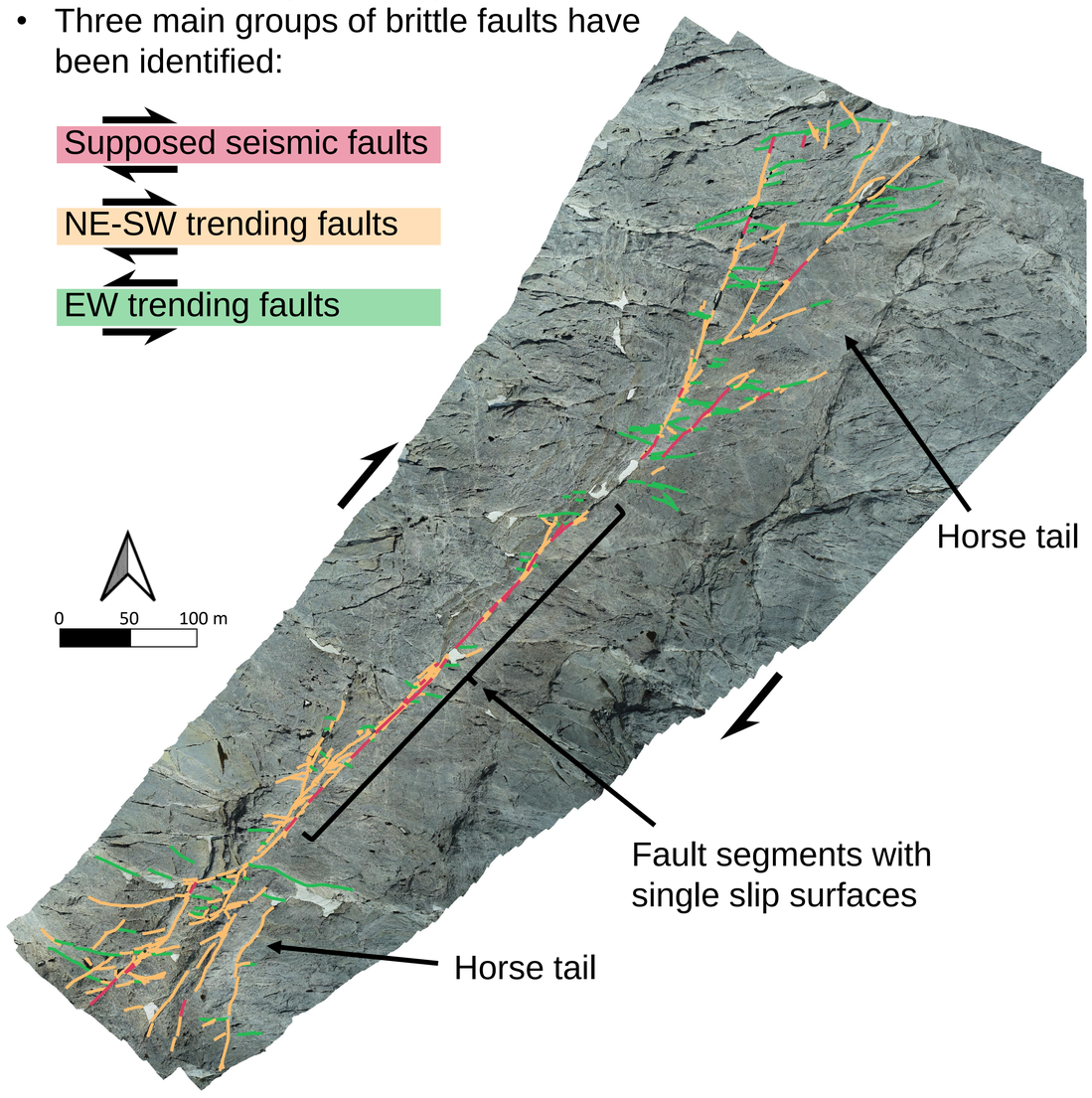
Fault Architecture

- The Téné fault is an almost vertical, NE-SW trending strike-slip fault.
- Three main groups of brittle faults have been identified:

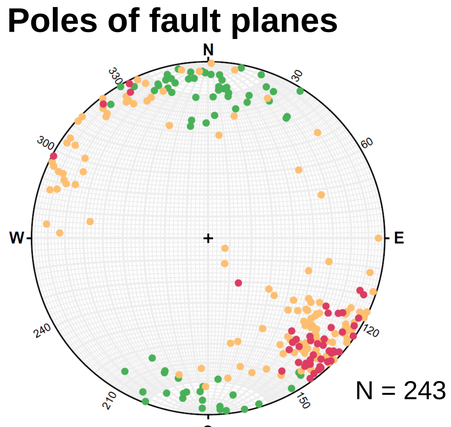
Supposed seismic faults

NE-SW trending faults

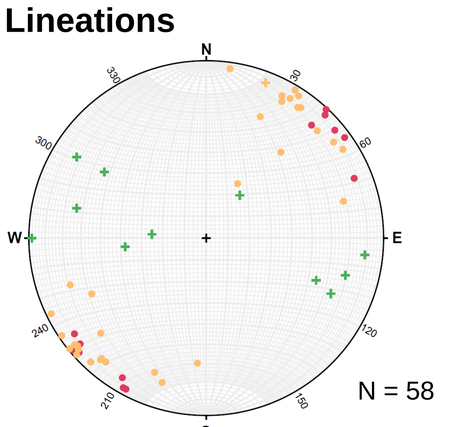
EW trending faults



Poles of fault planes



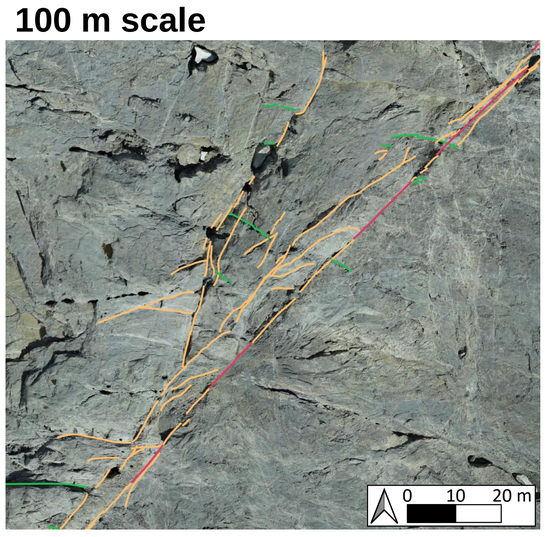
Lineations



Shear senses: ● Dextral ✚ Sinistral

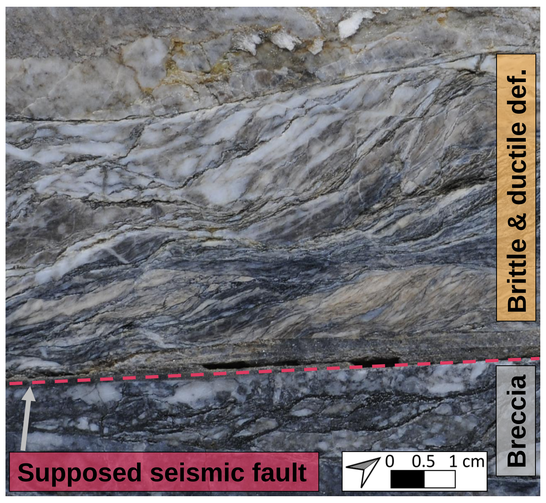
Scale Relationships

100 m scale

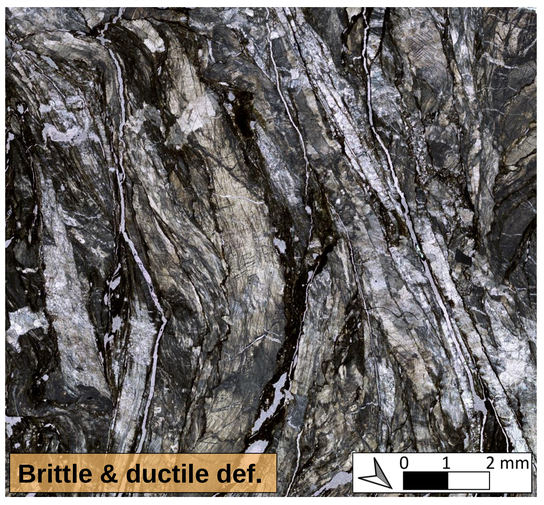


- The supposed seismic faults form perfectly straight, discontinuous segments. They are embedded in a network of NE-SW trending faults.
- Supposed seismic faults only show characteristics of the brittle regime (slickensides, breccias, cataclasites, fractures, veins). On the other hand, the remaining faults often show an interplay between brittle and ductile deformation processes.

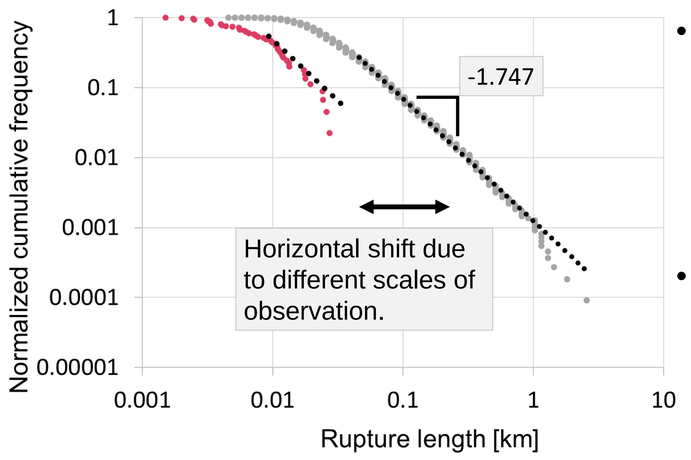
cm scale



mm scale



Link of Fault Structures with Active Seismicity



- Earthquake magnitudes can be converted into estimated rupture lengths, which are then compared with the field measurements.
- The fault length-frequency scaling relation of the supposed seismic faults is similar to that of the SED measurements. This is indicated by the similar slope.

Preliminary Conclusions

- ❖ The perfectly straight lines of the supposed seismic faults are an indication for fast rupture processes. In contrast to that, the remaining faults are more undulating and have been subject to both brittle and ductile deformation (aseismic).
- ❖ The discontinuity of the supposed seismic fault segments can be interpreted as small areas of a main fault zone which ruptured repeatedly during different seismic events.
- ❖ The distribution of the rupture lengths of the supposed seismic faults correlates with the frequency of earthquakes we can measure today (Gutenberg-Richter law). This may indicate a similar frequency of earthquakes of a certain magnitude in recent times and in times when the nowadays exposed faults were active. This also implies that the measured small magnitude earthquakes (from SED) are undersampled and that the distribution can be expanded down to fault lengths of about 3 m (≈ magnitude -1).

REFERENCES: SED, Earthquake Catalogue of Switzerland 2009: www.ecos09.seismo.ethz.ch (1.3.2022)

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