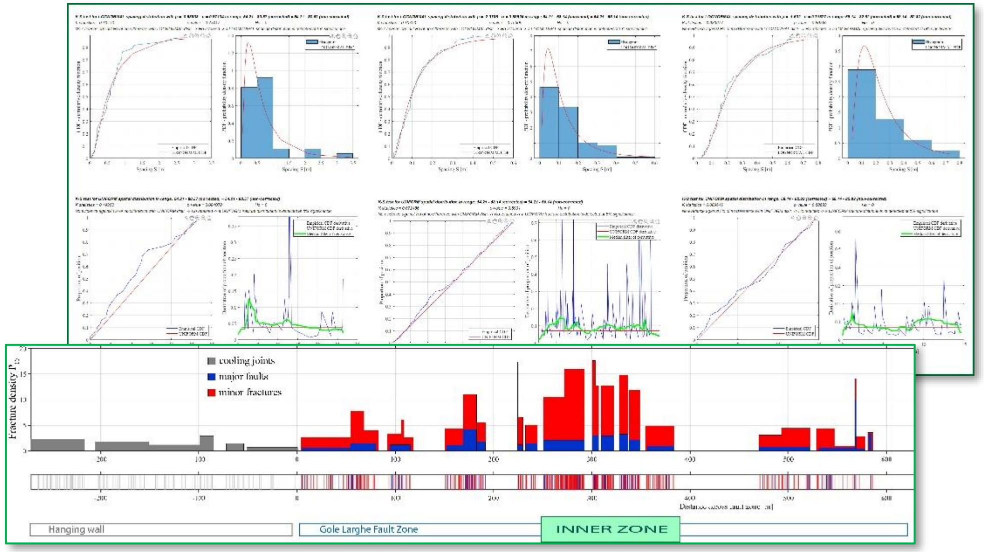
Detailed statistical analysis of the Gole Larghe Fault Zone fracture network (Italian Southern Alps) improves estimates of the energy budget for intraplate earthquakes in basement rocks



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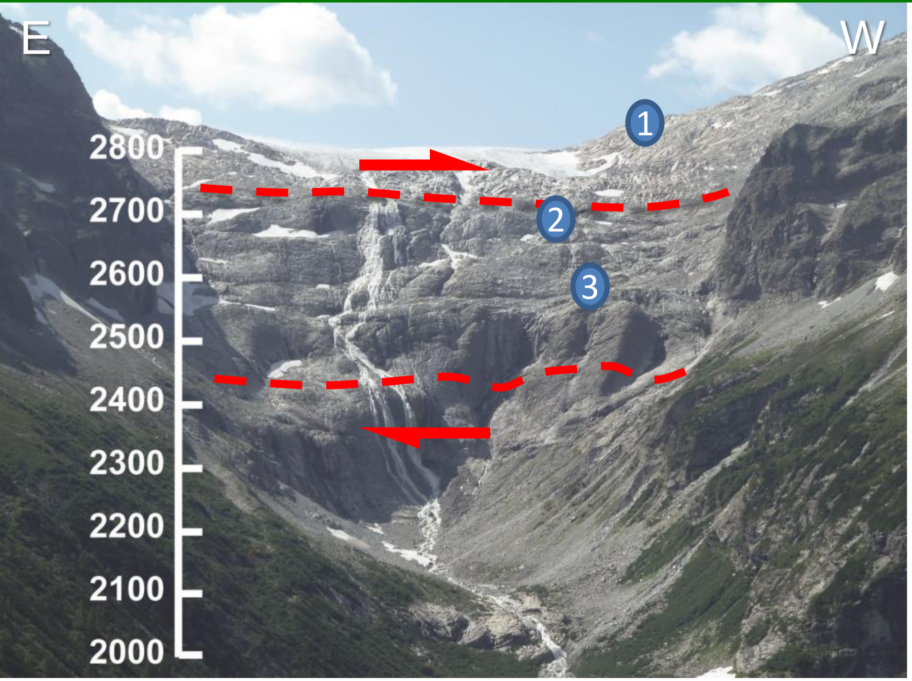
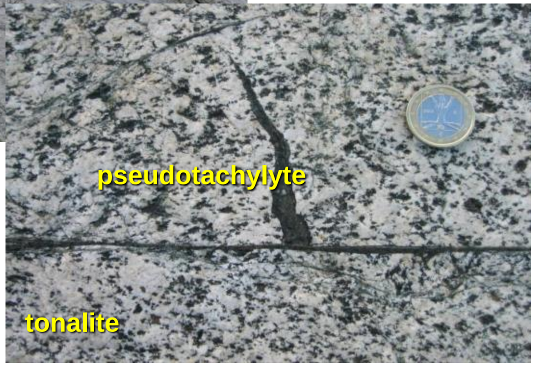
The Gole Larghe Fault Zone (GLFZ): a world-class outcrop of an exhumed seismic source



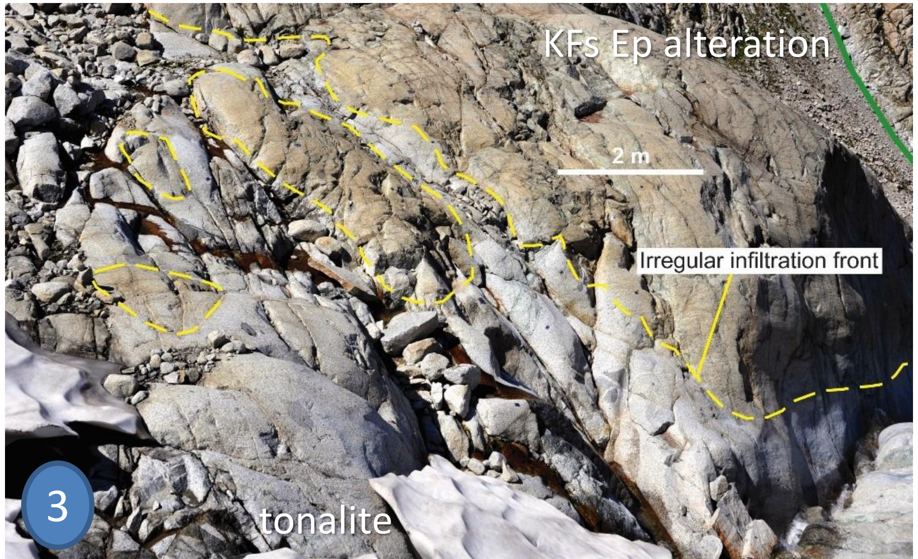
The GLFZ is a dextral-reverse fault in the Adamello Massif (Italian Southern Alps) with net slip of c. 1.5-2 km and a thickness of the fault zone of c. 600 m.

The GLFZ is composed of hundreds of individual fault strands. Most of them are decorated by green cataclasite and/or black pseudotachylyte.



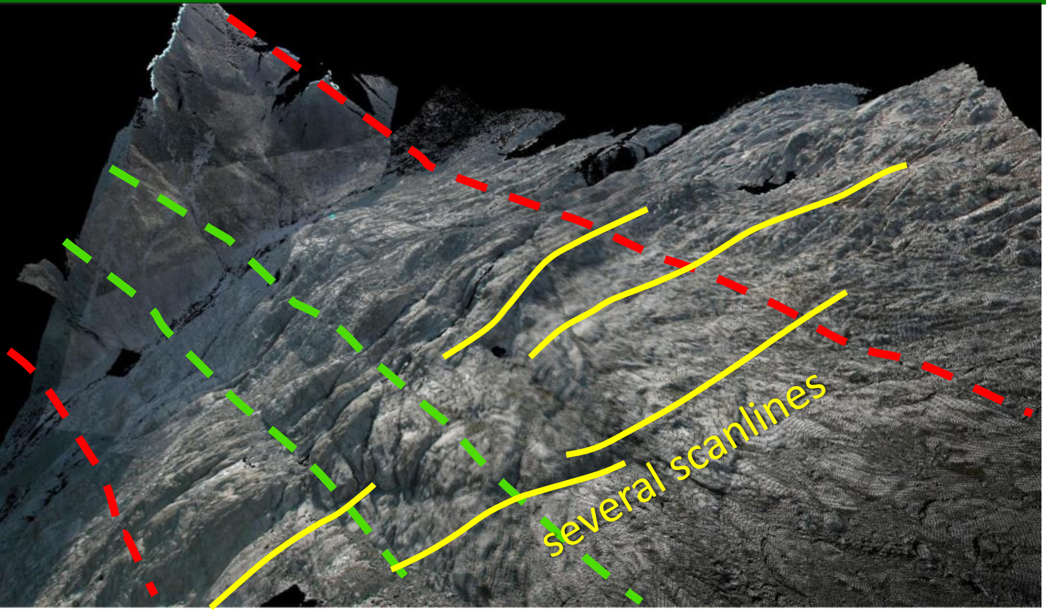
Major fault strands are interconnected by thousands of R, R’, P, T and other minor fractures.

In the footwall and particularly in the hanging wall, background fracturing is present, related to cooling of the tonalitic granodioritic pluton which hosts the GLFZ.

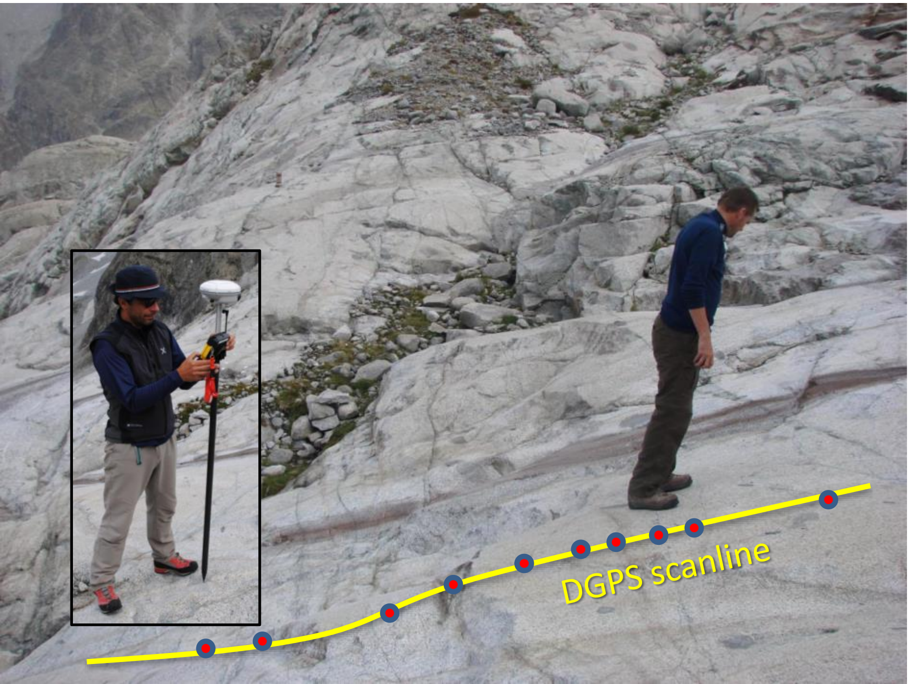


The inner portion of the fault zone (not a proper fault core since there is not much strain localization) shows a strong alteration and mineralization due to hydrothermal fluid flow and fluid-rock interaction.

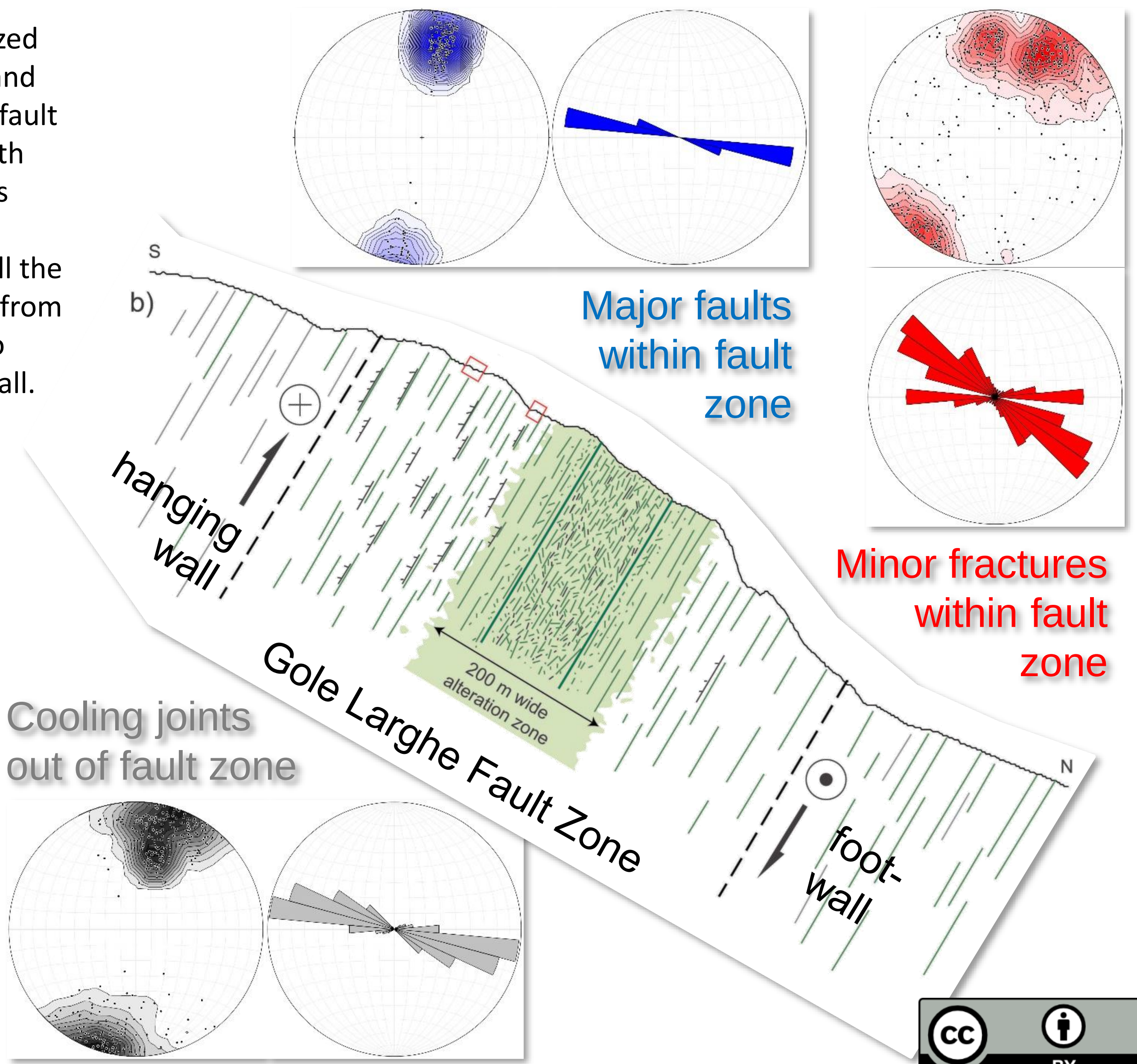
Fault zone architecture



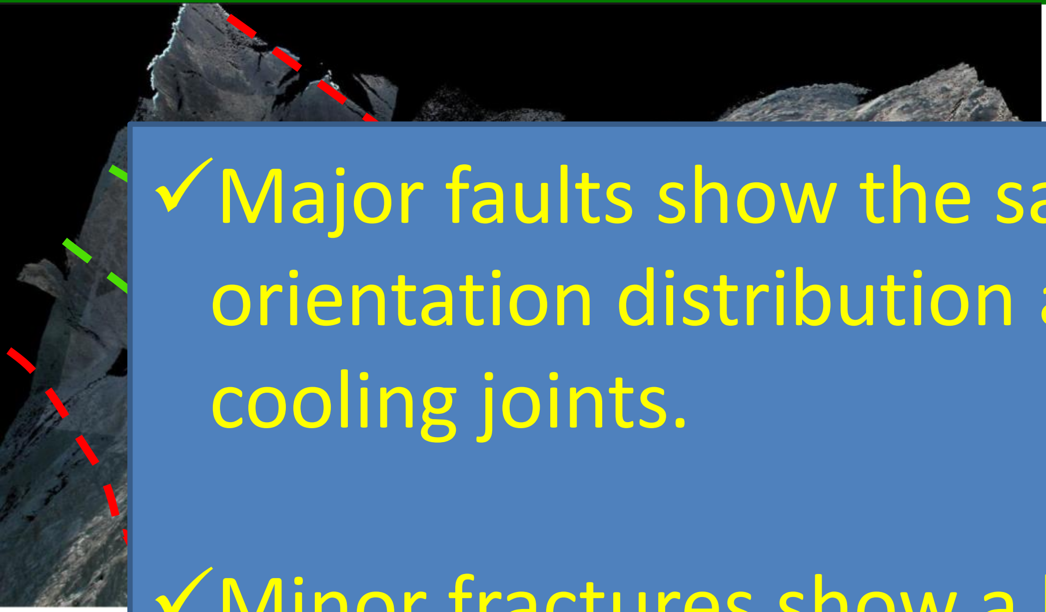
We have characterized fractures and individual fault strands with continuous scanlines covering all the fault zone from footwall to hanging wall.



Data points were recorded by DGPS (± 1 cm) with structural attributes (strike, dip, fault rocks, fault rock thickness, kinematics, etc.)

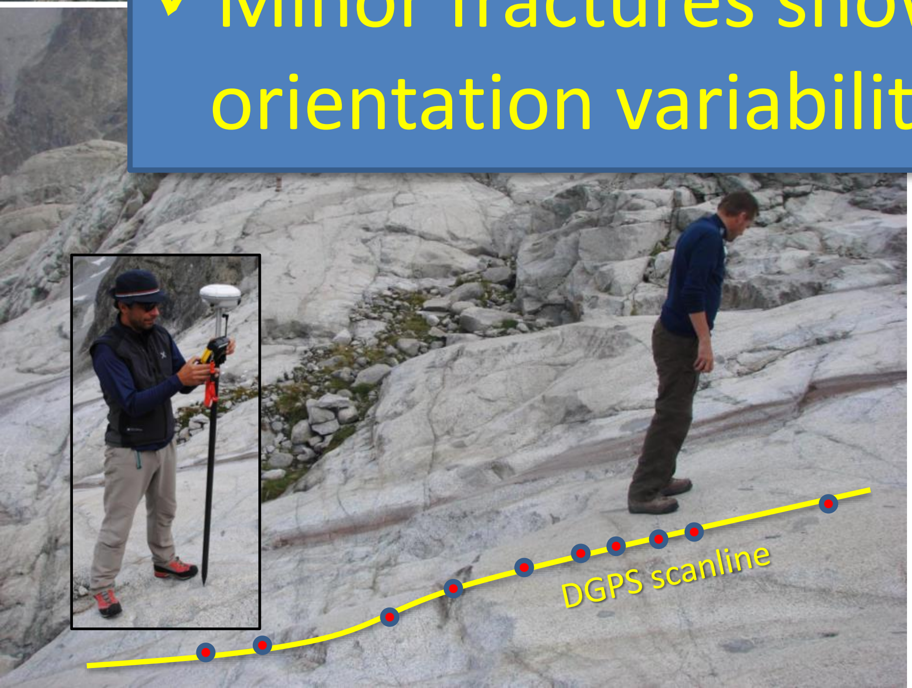


Fault zone architecture



We have characterized fractures and

- ✓Major faults show the same orientation distribution as cooling joints.
- ✓Minor fractures show a larger orientation variability.



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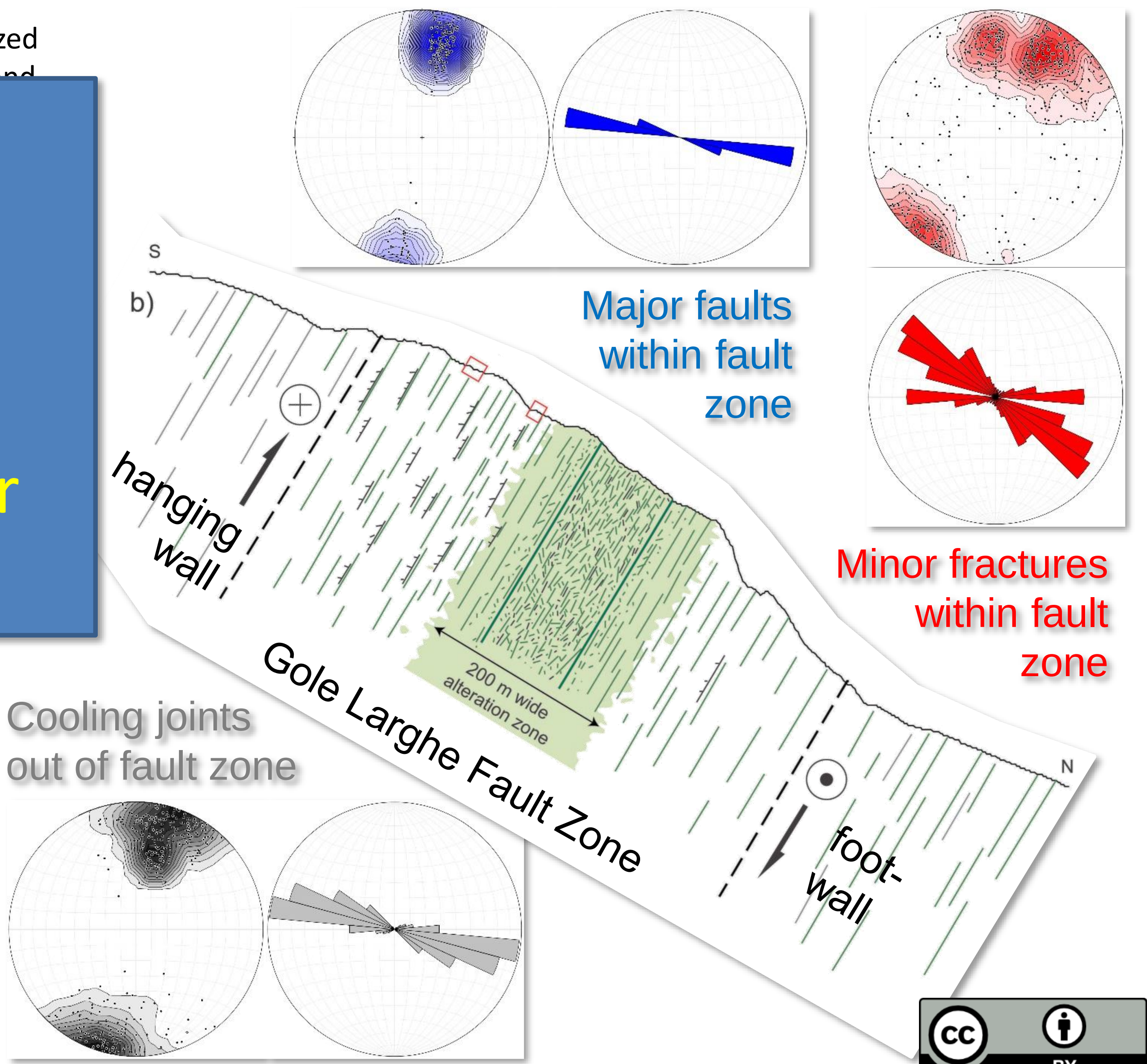
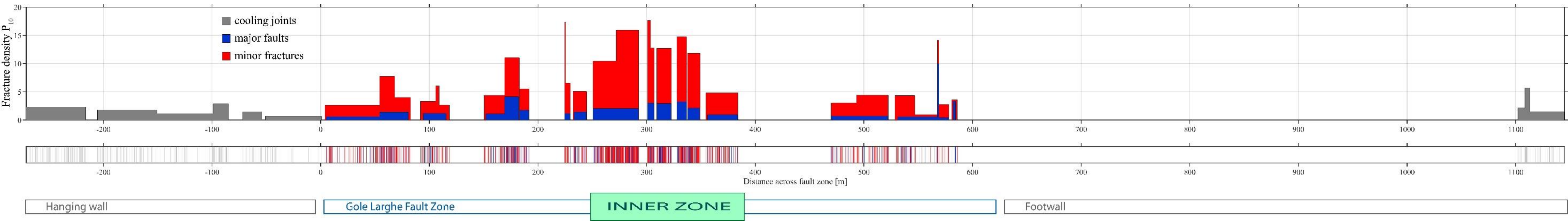


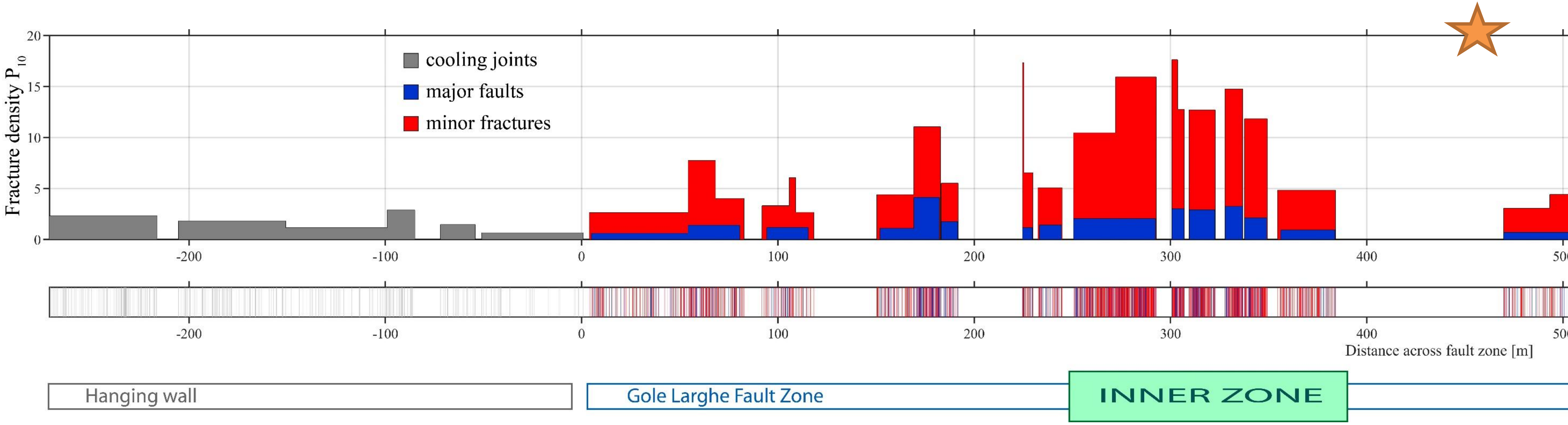
Fault zone architecture quantified: fracture density across the GLFZ



A 1150 m scanline…

… see details in next slides.

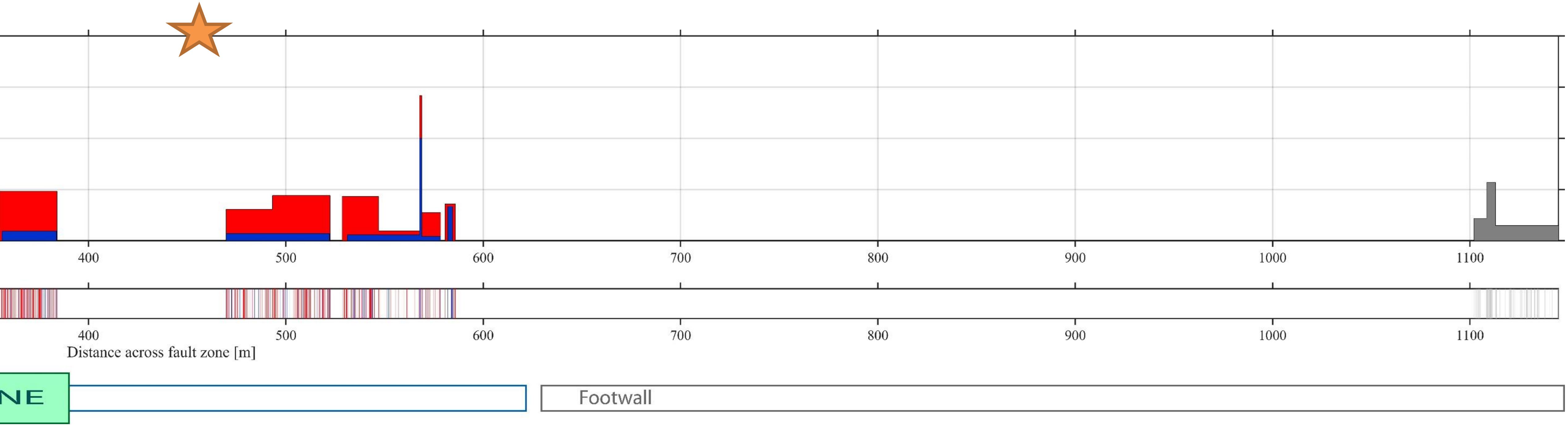
Fault zone architecture quantified: fracture density across the GLFZ



We clearly see three different zones:

- Background fracturing (cooling joints) in the hanging wall and footwall
- Outer fault zone (symmetrically in hanging wall and footwall)
- Inner fault zone (corresponding to zone with hydrothermal alteration)

Fault zone architecture quantified: fracture density across the GLFZ



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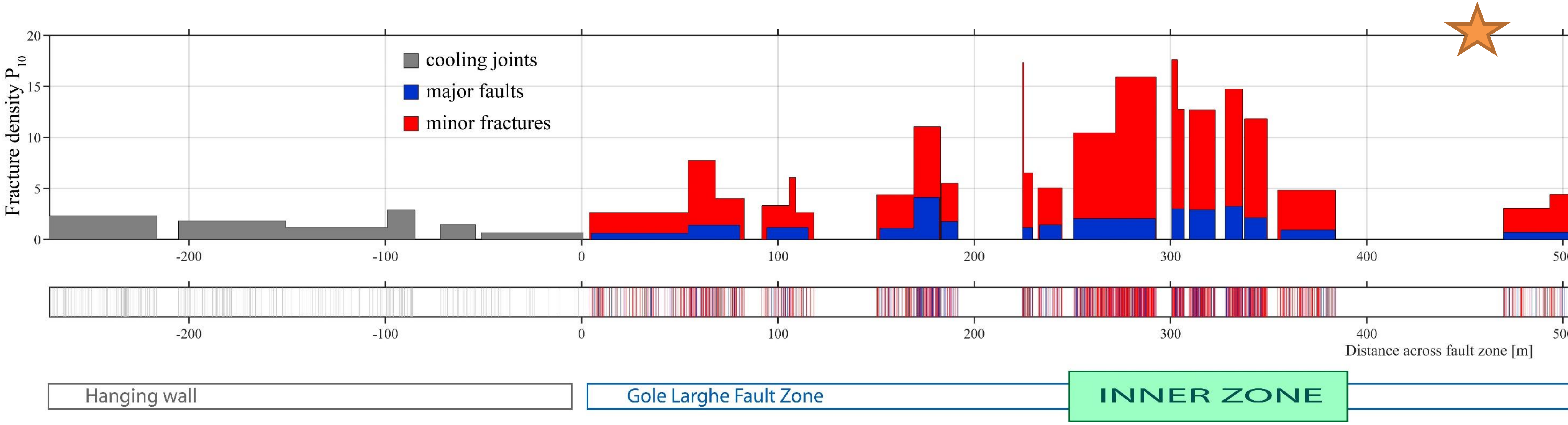
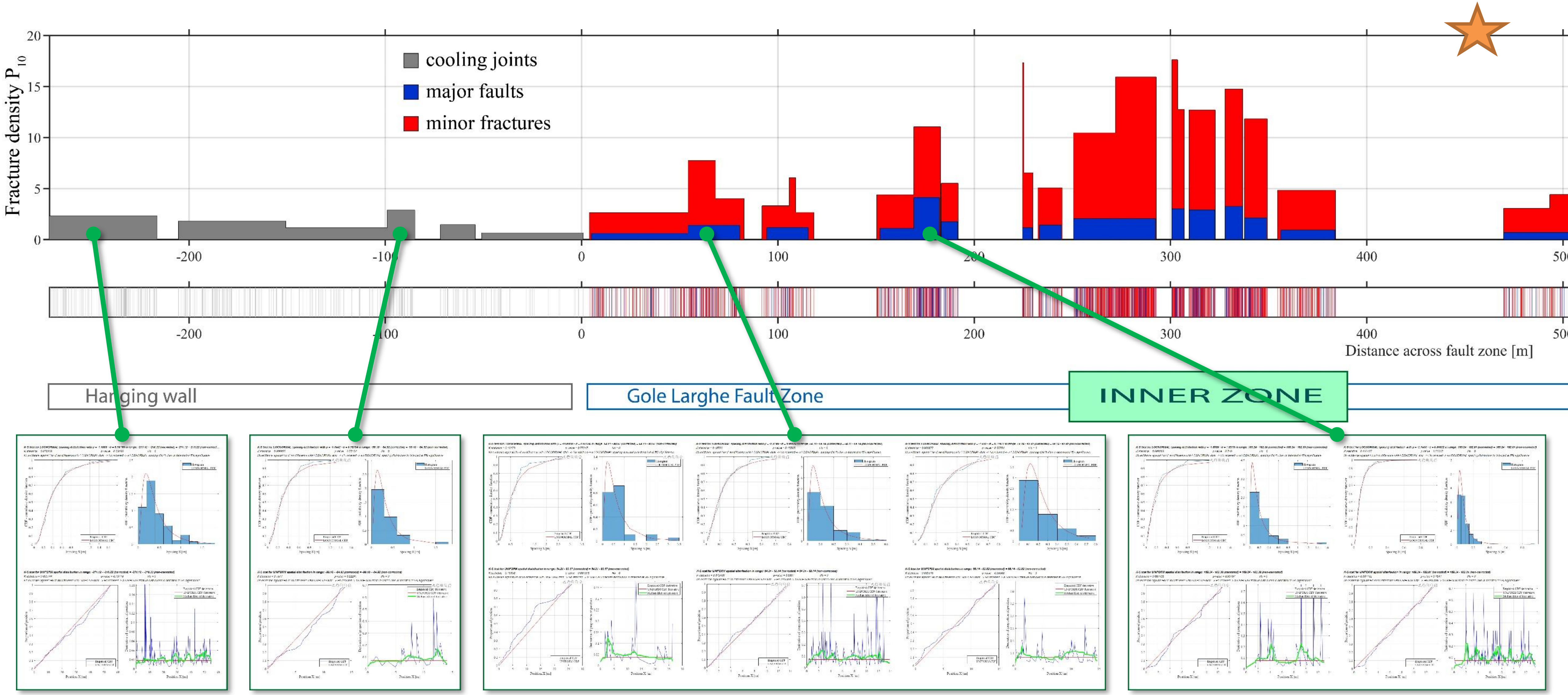


Fracture density due to major faults is the same as that due to cooling joints, irrespective of zone (background, outer or inner fault zone).

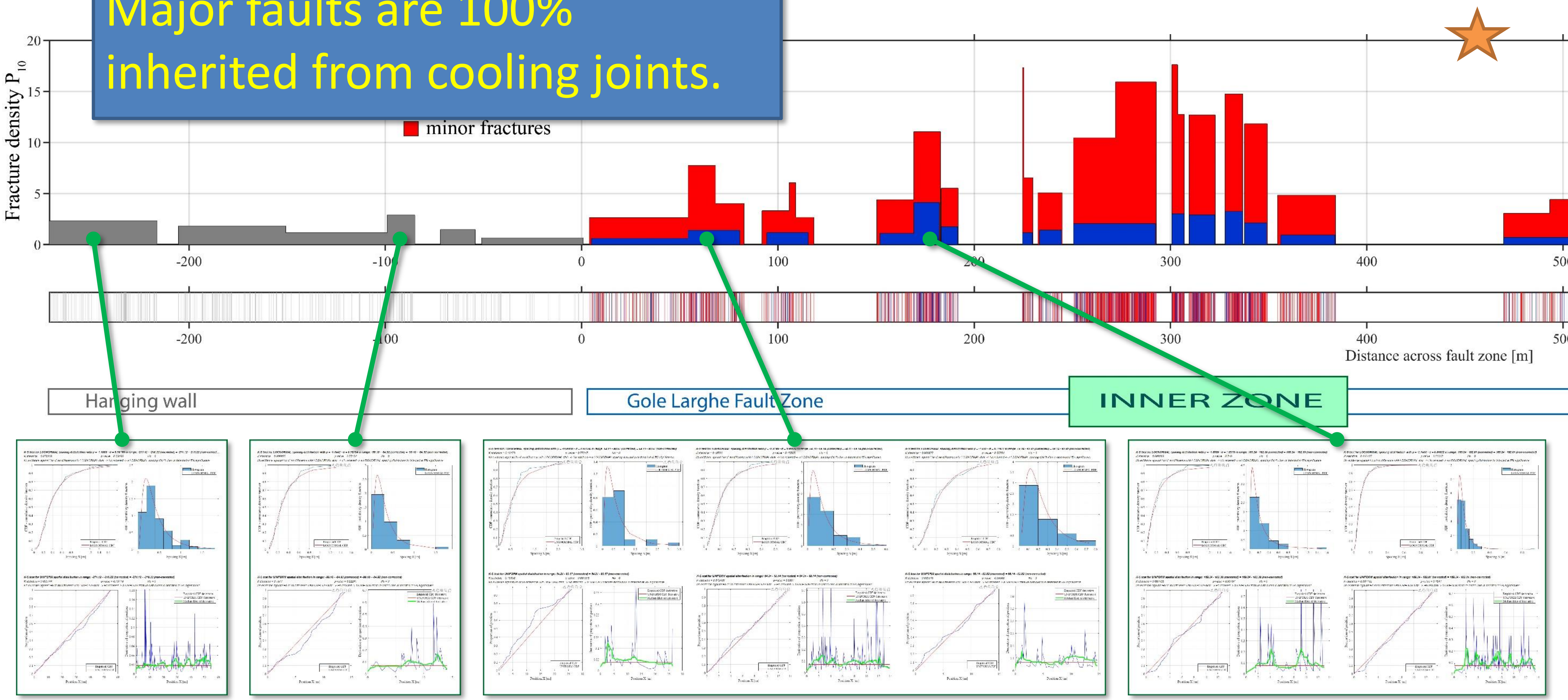
Fault zone architecture quantified: fracture density across the GLFZ



Also the spacing distributions of major faults are the same as those of cooling joints.

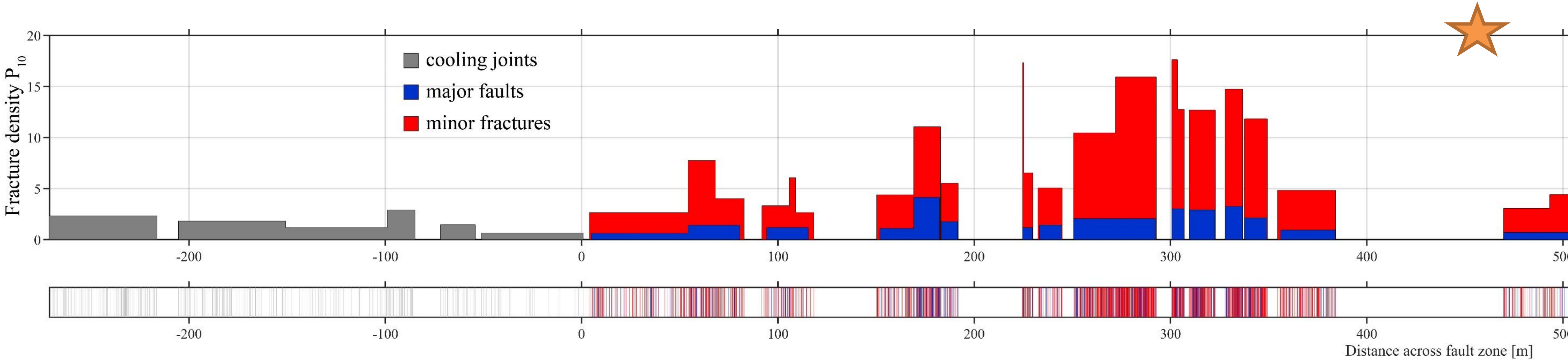
Fault zone architecture quantified: fracture density across the GLFZ

Major faults are 100% inherited from cooling joints.



Also the spacing distributions of major faults are the same as those of cooling joints.

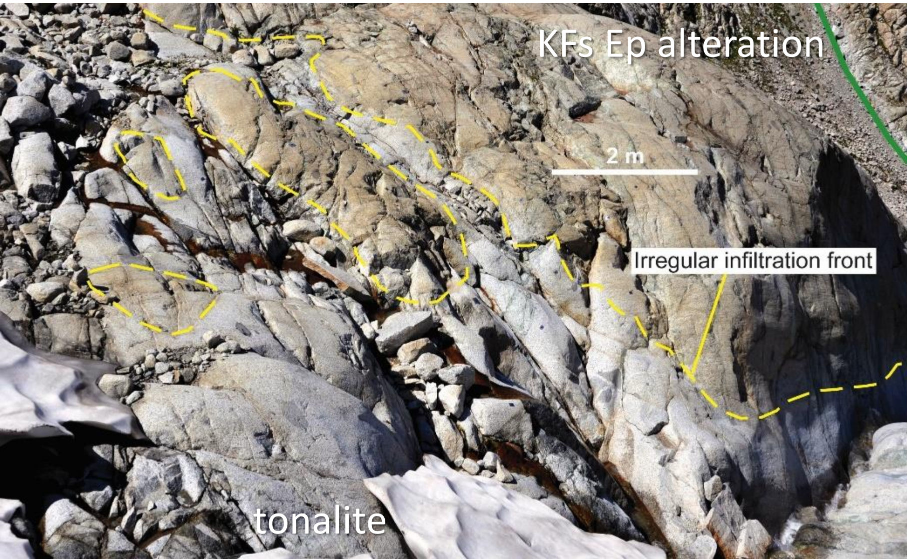
Fault zone architecture quantified: fracture density across the GLFZ



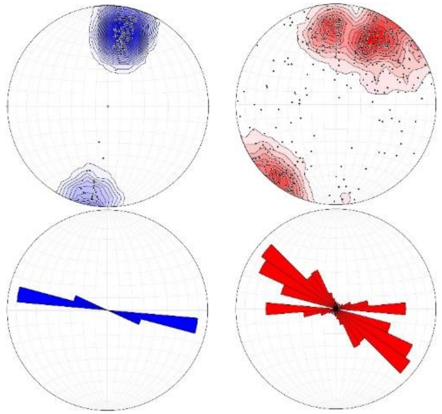
Hanging wall

Gole Larghe Fault Zone

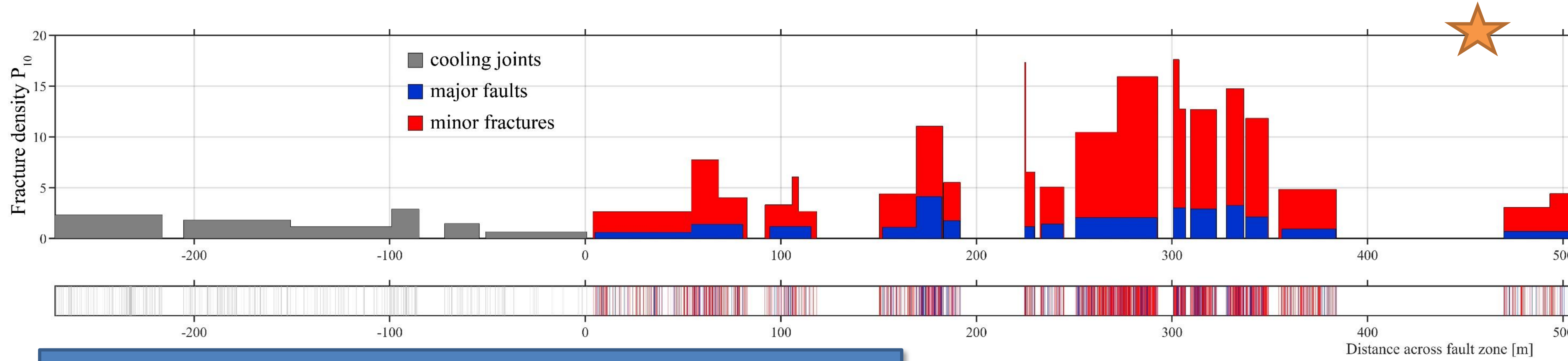
INNER ZONE



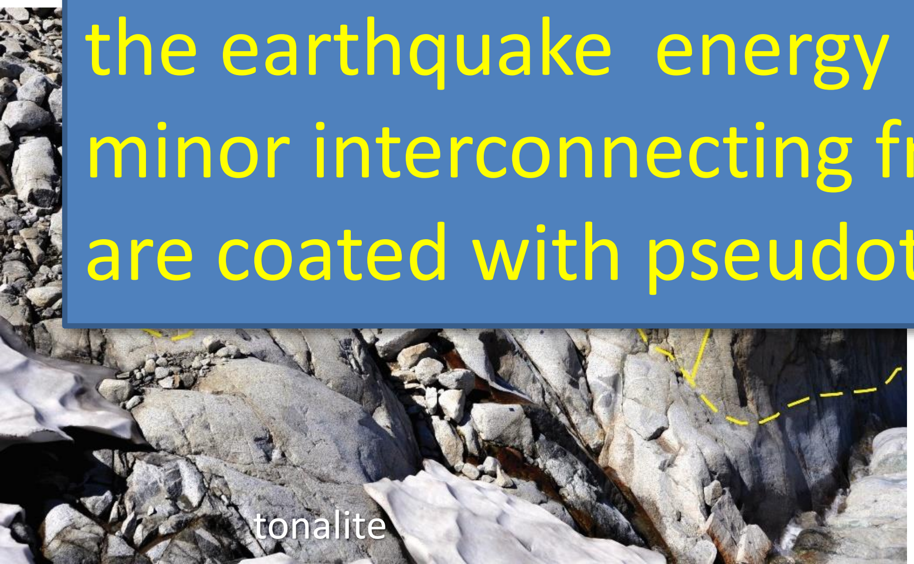
Fracture density increases in the fault zone and particularly in the inner zone due to minor fractures with highly variable orientation. This results in increased hydraulic connectivity and hydrothermal fluid flow in the inner zone.



Fault zone architecture quantified: fracture density across the GLFZ



The only fractures to be considered in the earthquake energy budget are the minor interconnecting fractures that are coated with pseudotachylytes.



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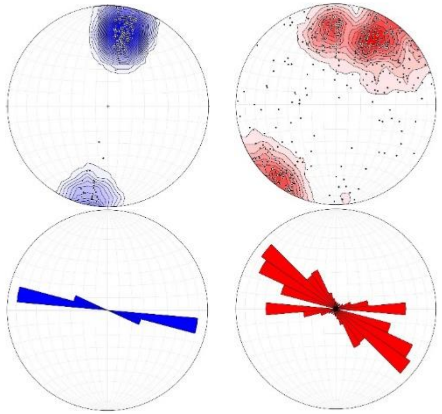

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