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Strain localization associated with brittle faulting in a natural clinoptilolite-tuff (open-pit mine Nižný Hrabovec, Slovak Republic)

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Nižný Hrabovec mine: a world-class high-qualify clinoptilolite deposit

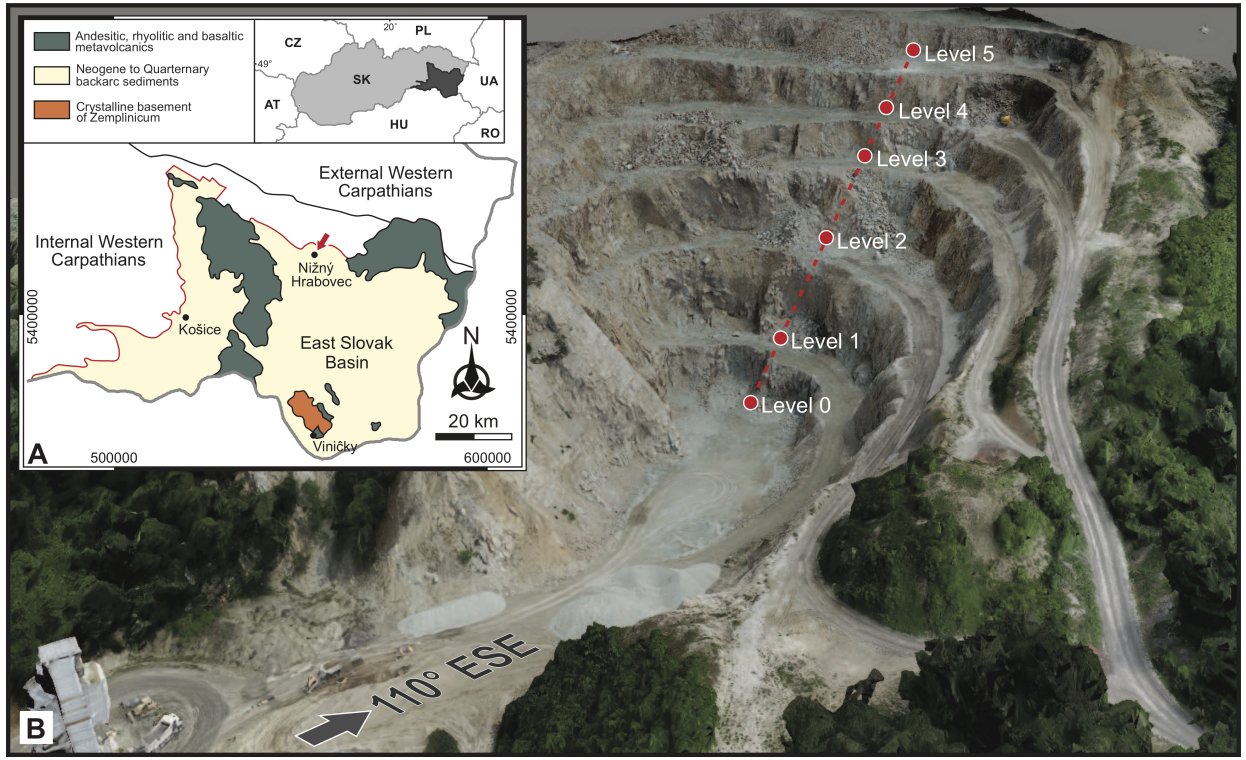

Fig 1. Overview of the Nižný Hrabovec clinoptilolite mine (from Tschegg et al., 2019)

- Nižný Hrabovec mine reserves ~150 Mt clinoptilolite tuff
- Over 170 Kt of high grade clinoptilolites are extracted annually
- Our research is motivated by the well-preserved fault localization in the clinoptilolite tuff.

Fault localization occurs in Nižný Hrabovec mine

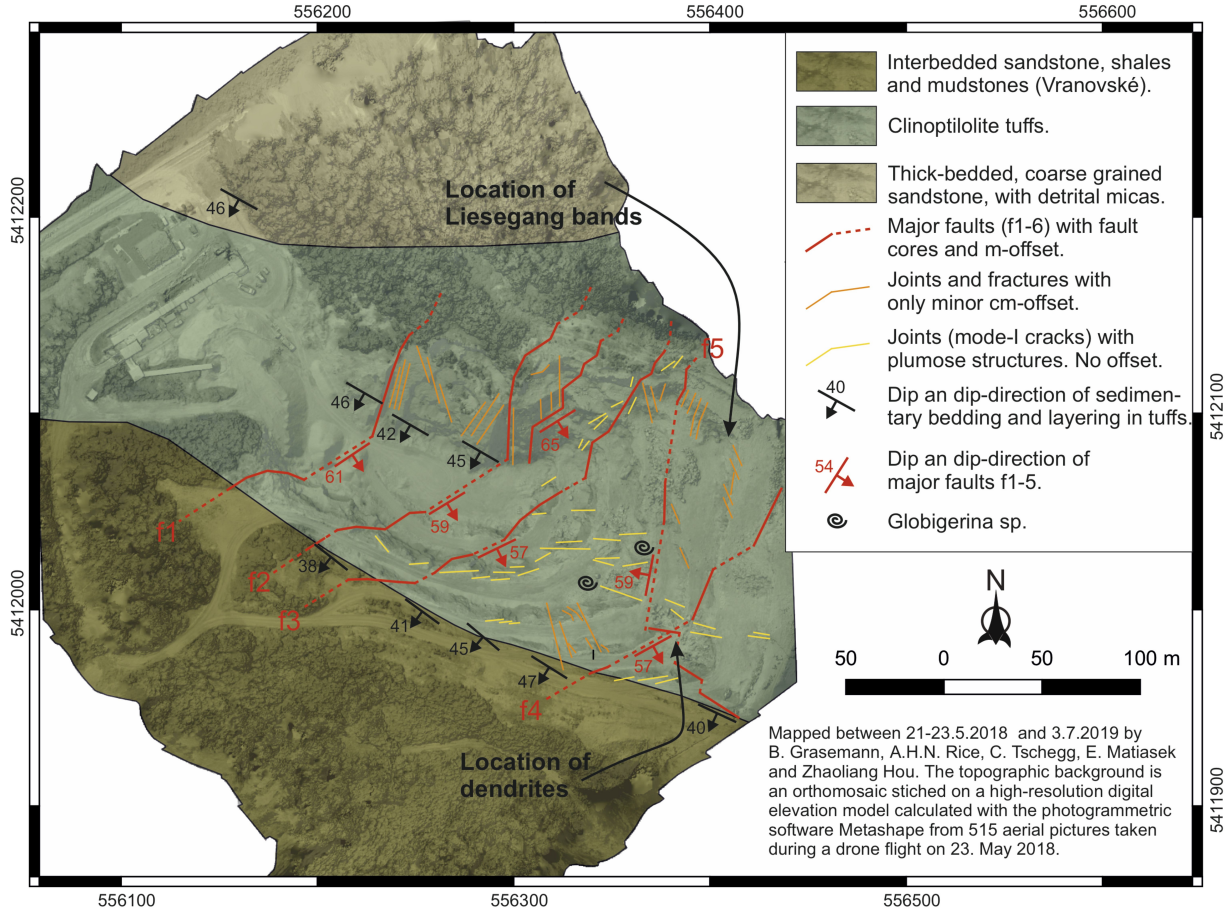

Fig 2. Geological map of the Nižný Hrabovec mine

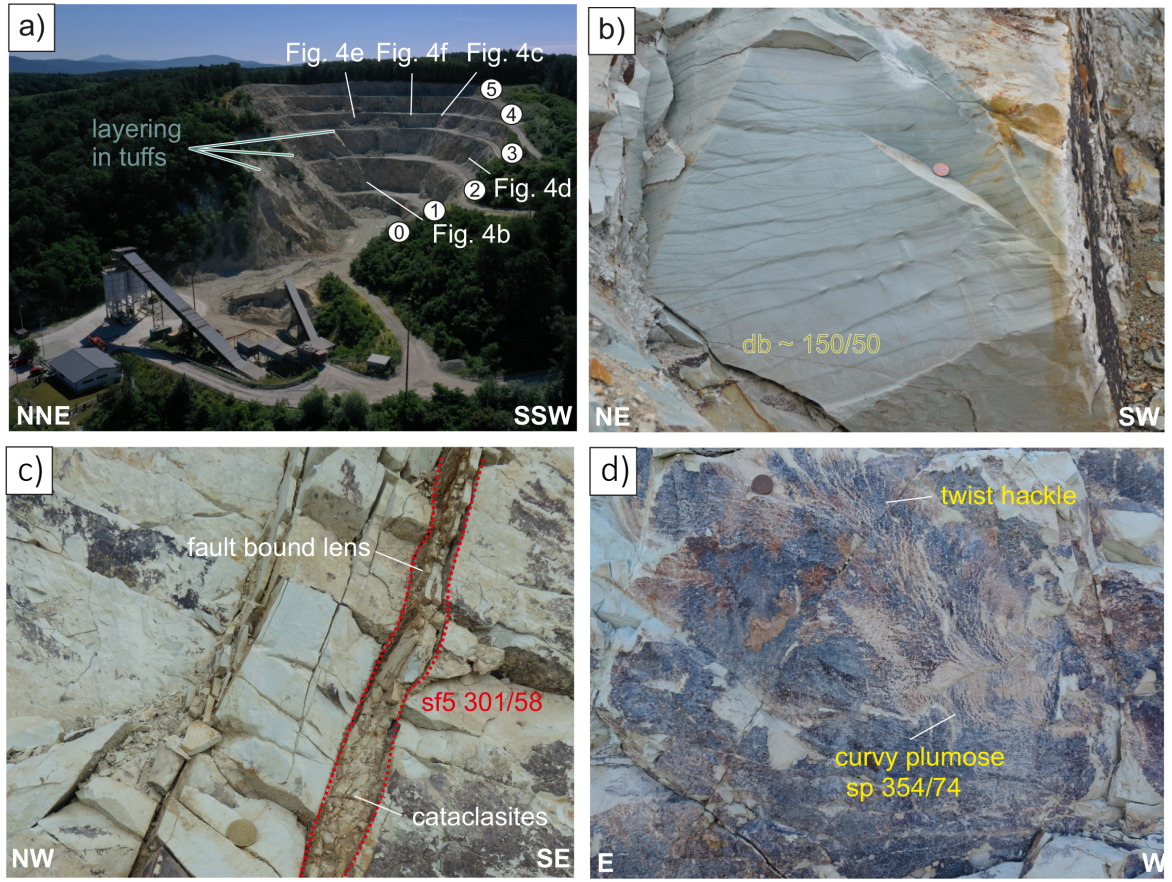

Fig 3. Field photos of clinoptilolite quarry

Aim of the research

- Investigate fault localization in the pure and homogeneous clinoptilolite-tuff

  - Understand the faulting-associated structures

  - Understand characteristics of the associated fluid-rock interacatoins during fault localization in clinoptilolites

Polished clinopotilolitic fault surface

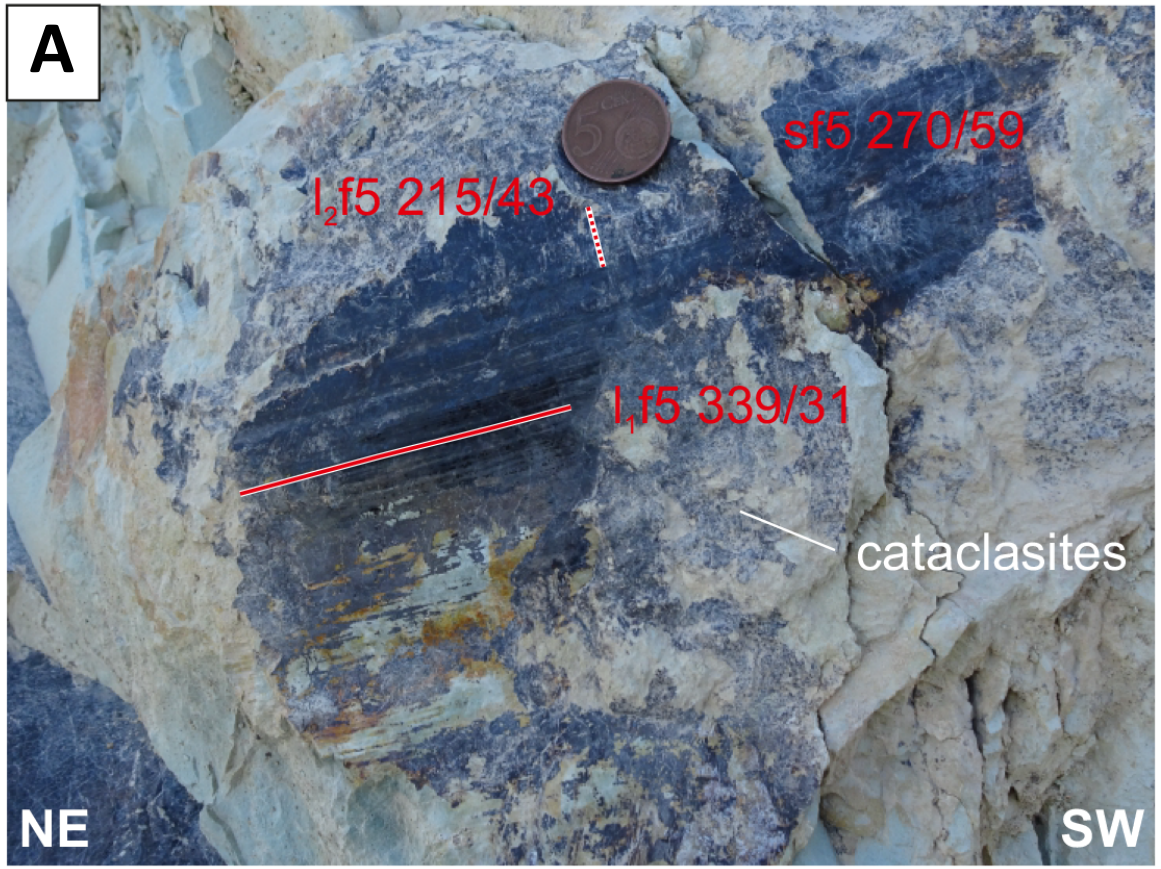

Fig 4. Fault surface are lineated, highly polished

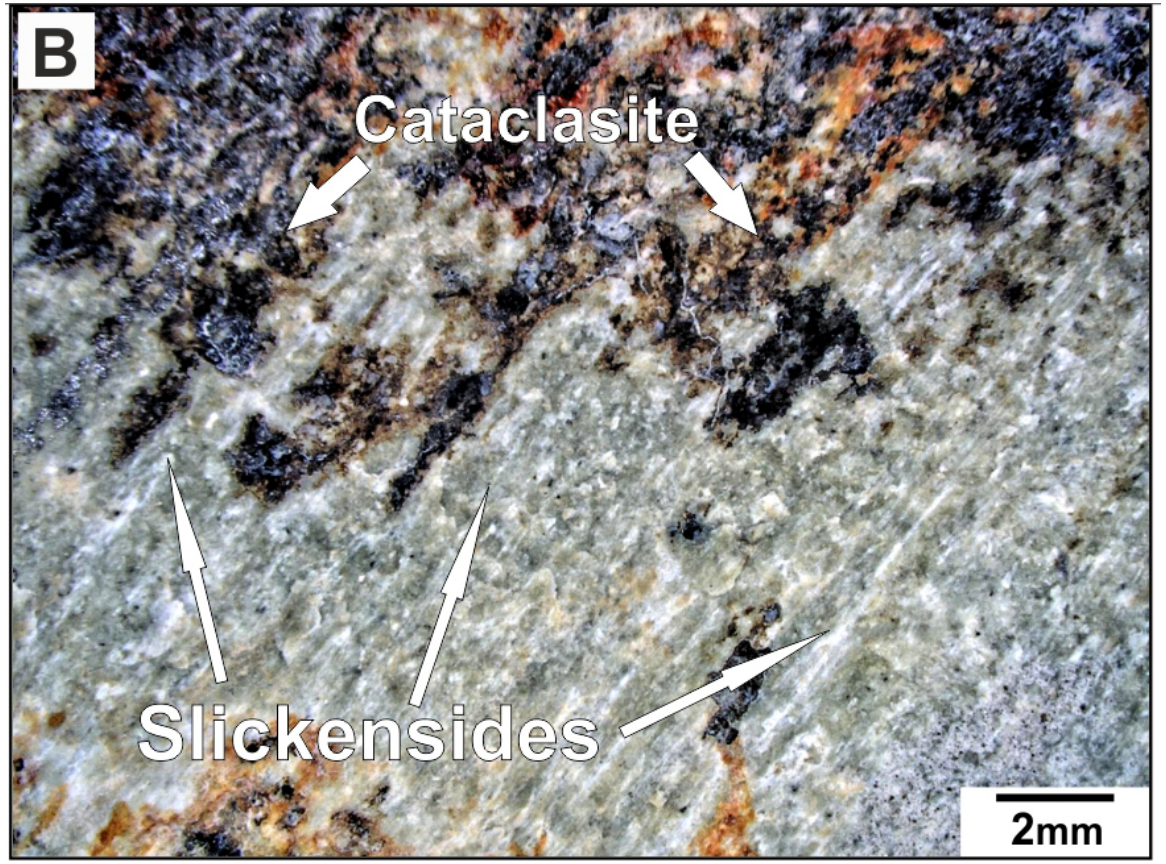

Fig 5. Fault surface is covered by a cataclasite layer

Microstructures of clinoptilolitic fault surface

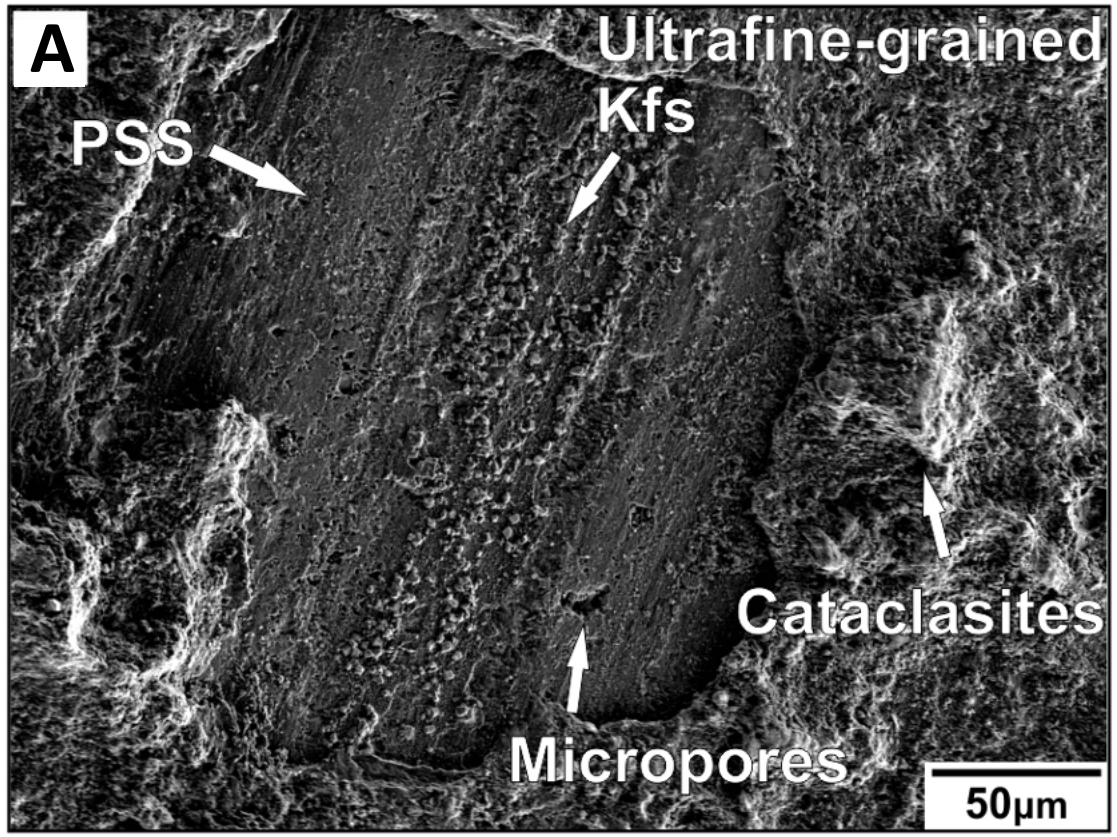

Fig 6. Fault surface (SEM-SE)

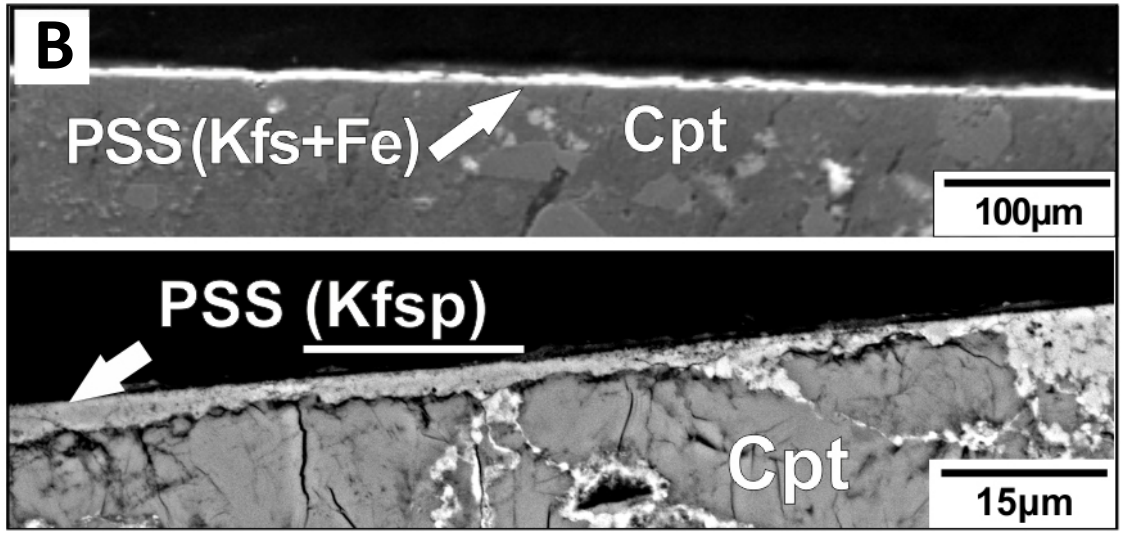

Fig 7. Fault surface (SEM-BSE)

Microstructures of undeformed clinoptilolite tuff

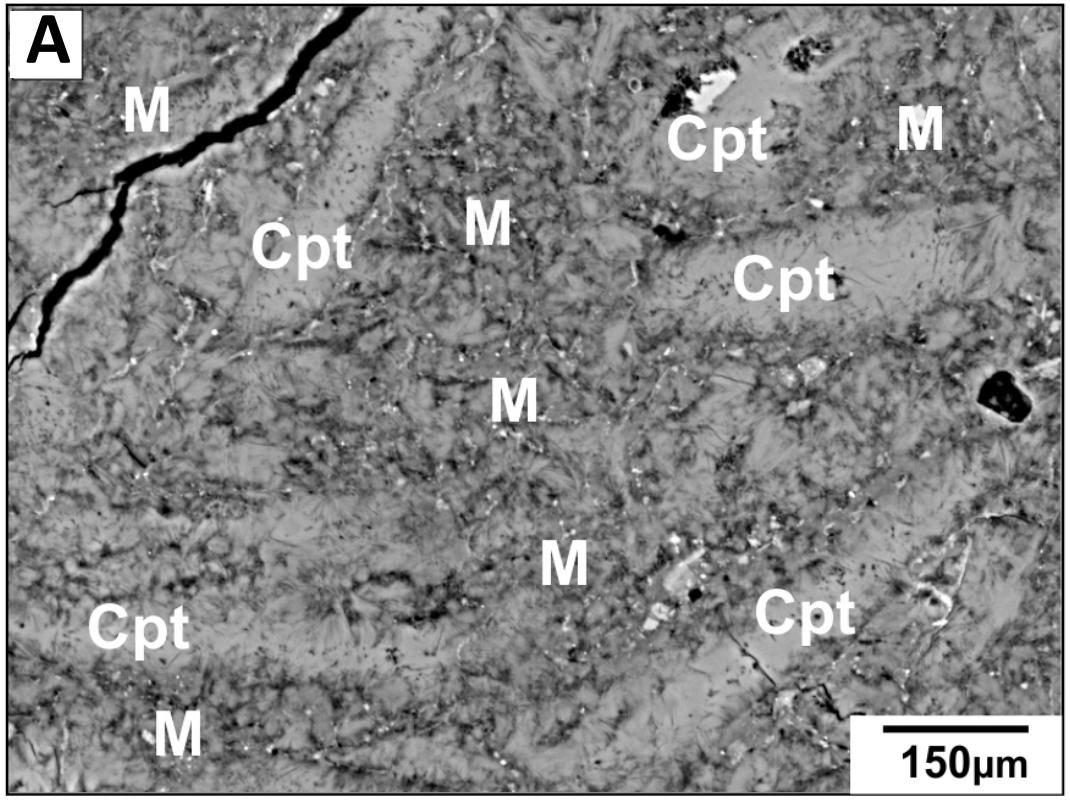

Fig 8. Idiomorphic clinoptilolite grains and ultrafine clinoptilolite matrix

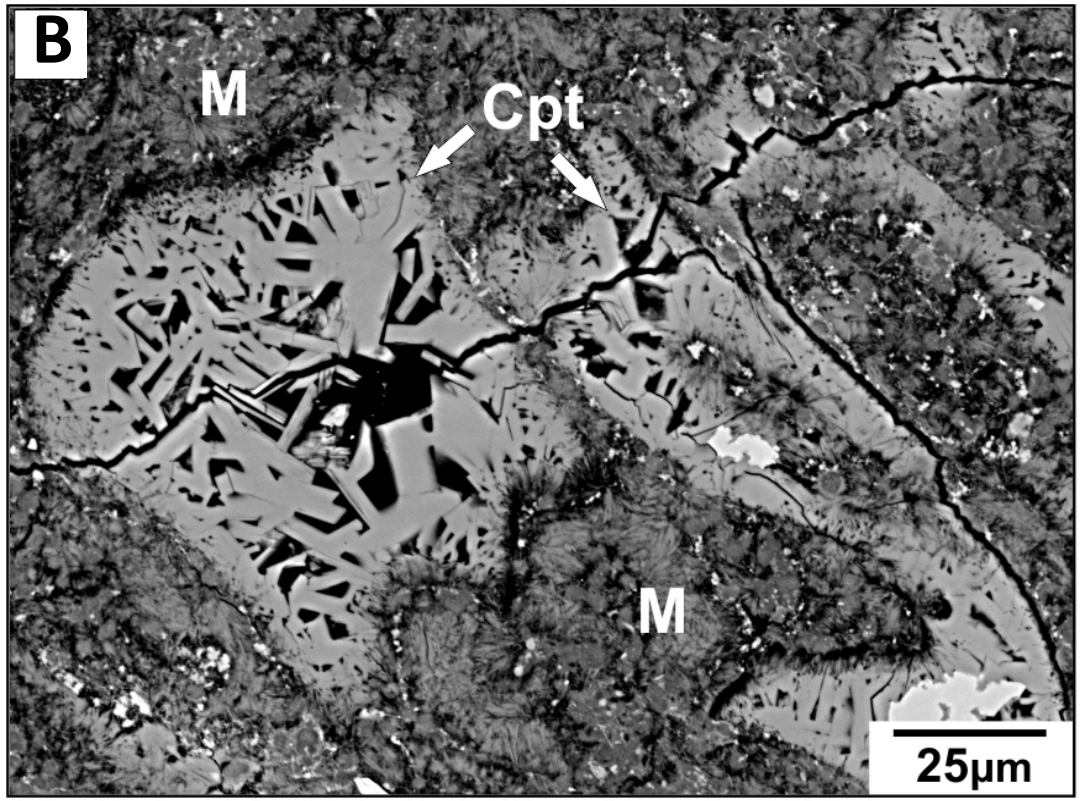

Fig 9. Coarse clinoptilolites infilling voids

Microstructures of the principle slip surface (PSS)

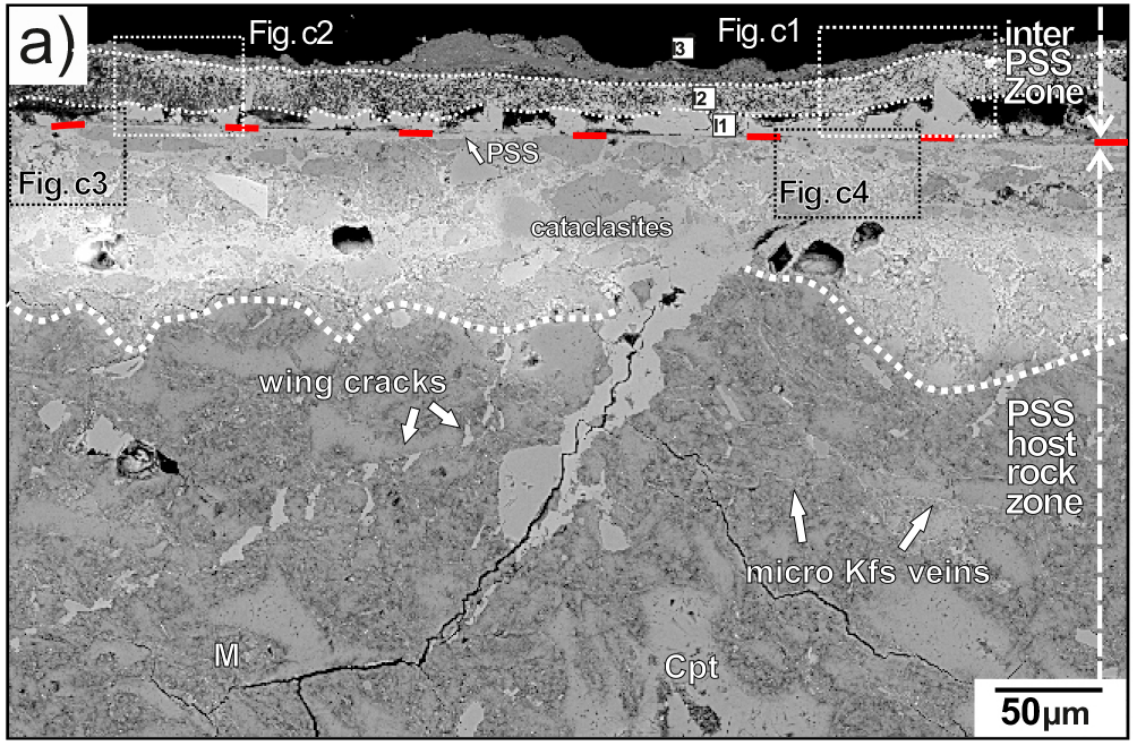

Fig 10. Clinoptilolite PSS consists of an inter-PSS zone and a PSS-host-rock zone

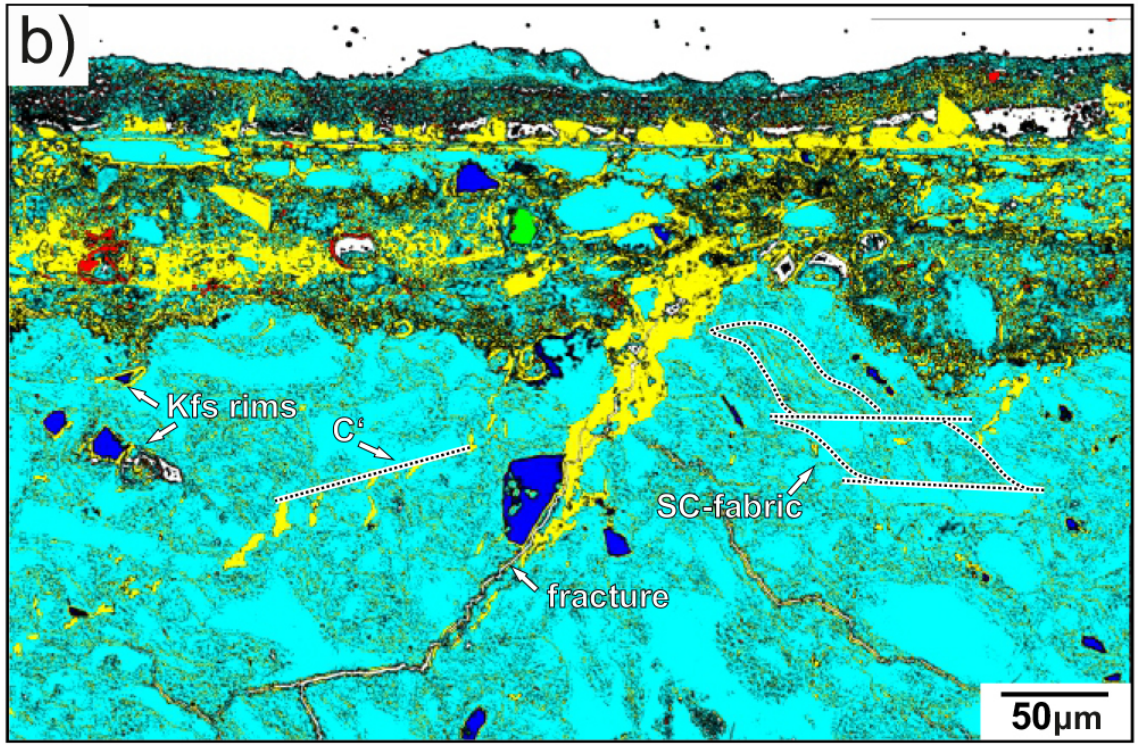

Fig 11. Associated mineral compositions in the PSS

Detail microstructures of the principle slip surface zone

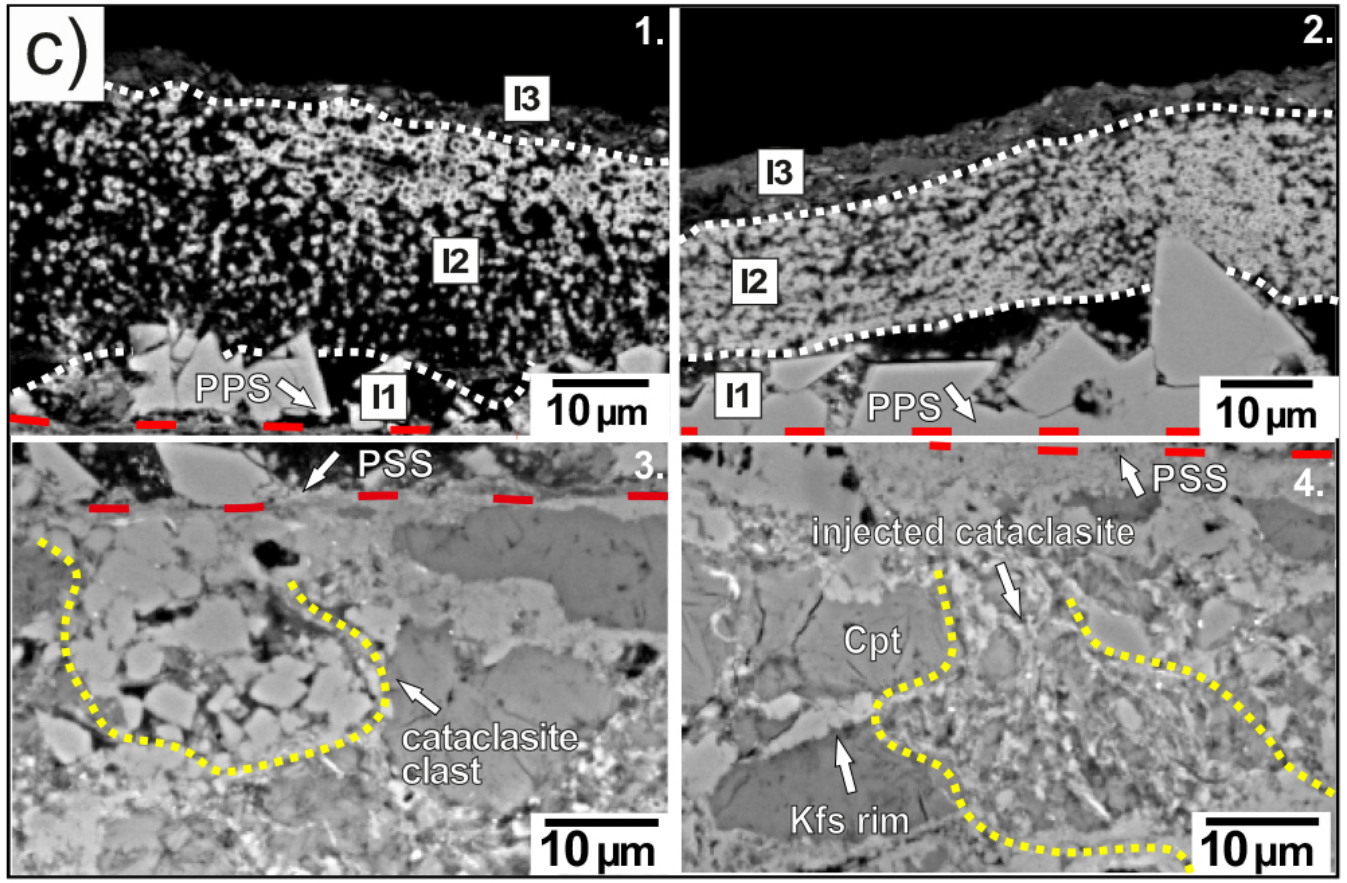

Fig 12. Detail microstructures around PSS

- 1&2: Inter-PSS zone is subdivided into three sublayers accroding to their microstrucres
- 3: Fine grain cataclasites below the PSS
- 4: K-feldspar injectes into the fine grain cataclasite, generating Kfsp networks

Other typical structures associated with PSS

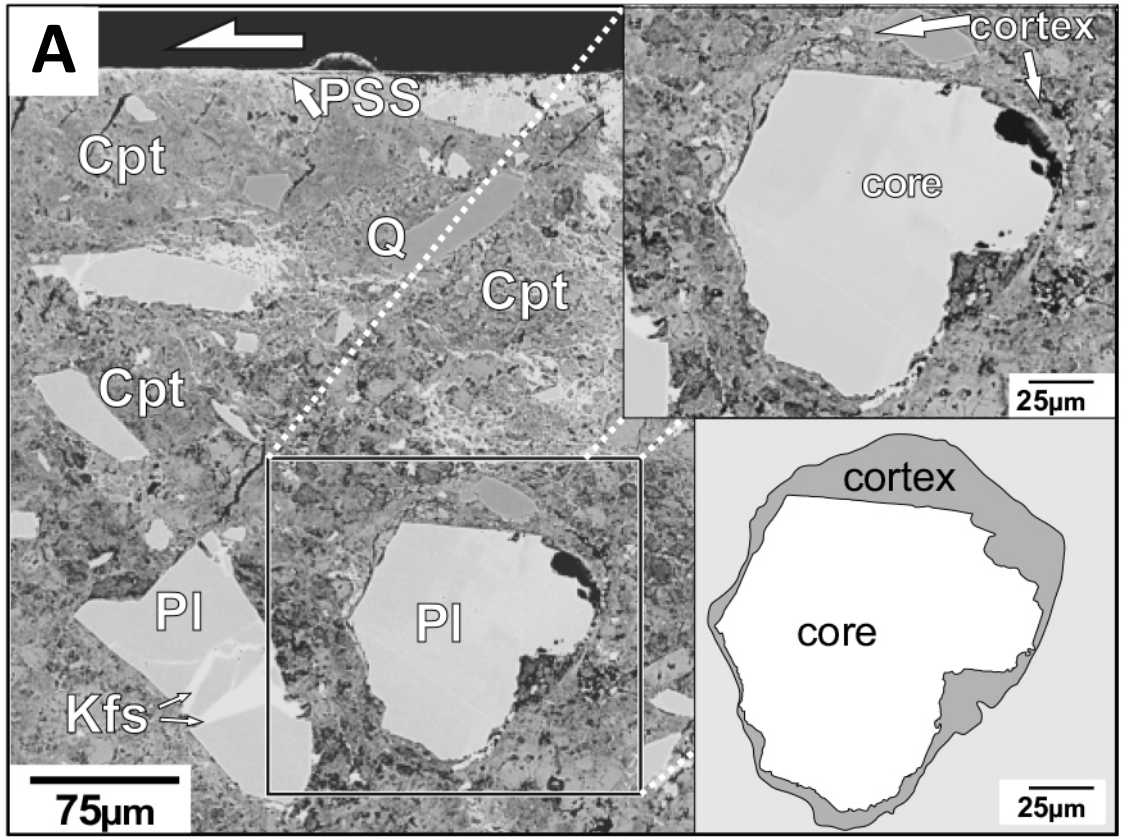

Fig 13. Cortex-grains in the PSS-host-rock zone close to the PSS

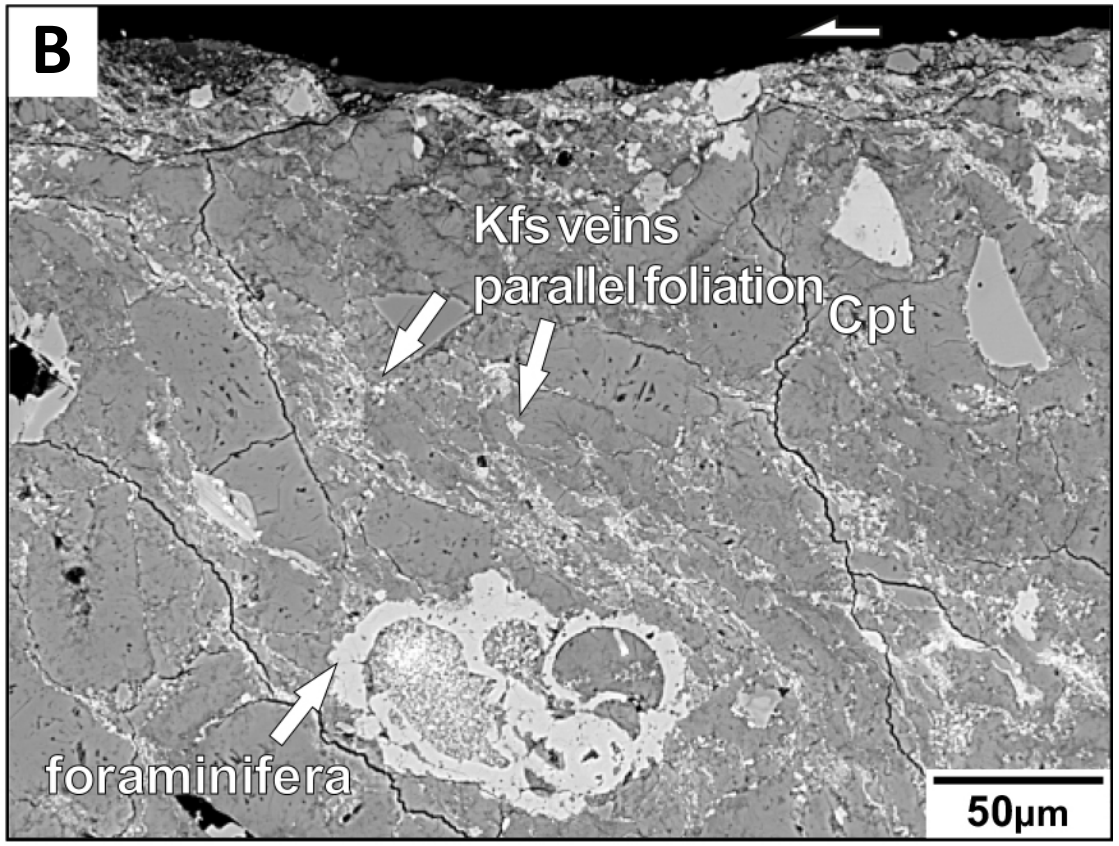

Fig 13. Foliated cataclasites with K-feldspar veins; Long axis of the foraminifera parallel to the foliation

Take home message:

➢ We present for the first-time fault localization in clinoptilolites (Zeolites).

- Fault in clinoptilolites are extremely localized.
- Clinoptilolite principal slip surface (PSS) consists of an inter-PSS zone and a PSS-host-rock zone, which indicate velocity hardening and velocity weakening.
- Polished slickenside, injection of fluided cataclasites, cortex grain structures along PSS may indicate seismic slip .