The Impact of Pore Geometry and Orientation on Permeability Evolution and Compaction Band Formation in Volcanic Rocks

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- **What is the influence of pore geometry and orientation on the mechanical properties?**
- **How compaction bands are influenced by pore orientation?**
- **How this difference in geometry and orientation affect the post deformation permeability?**

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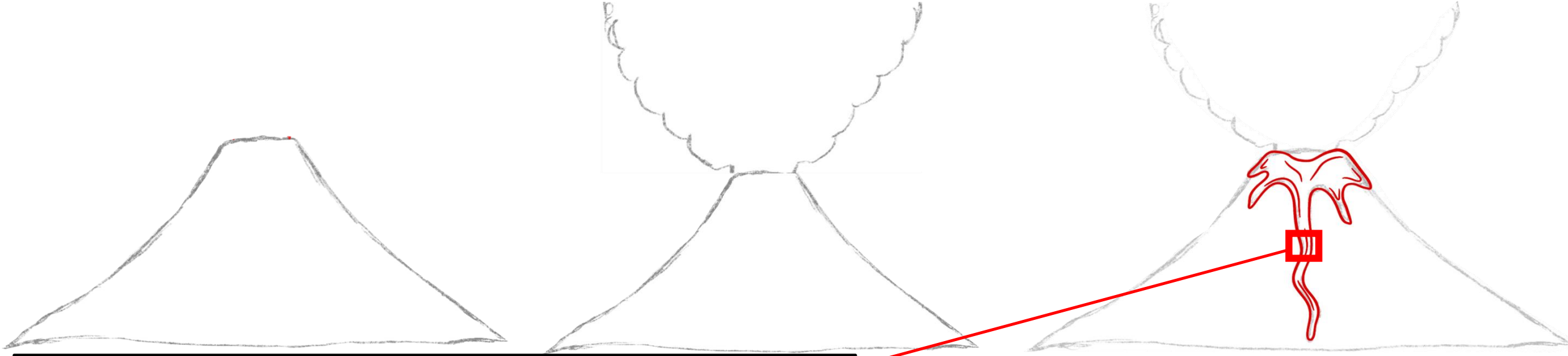
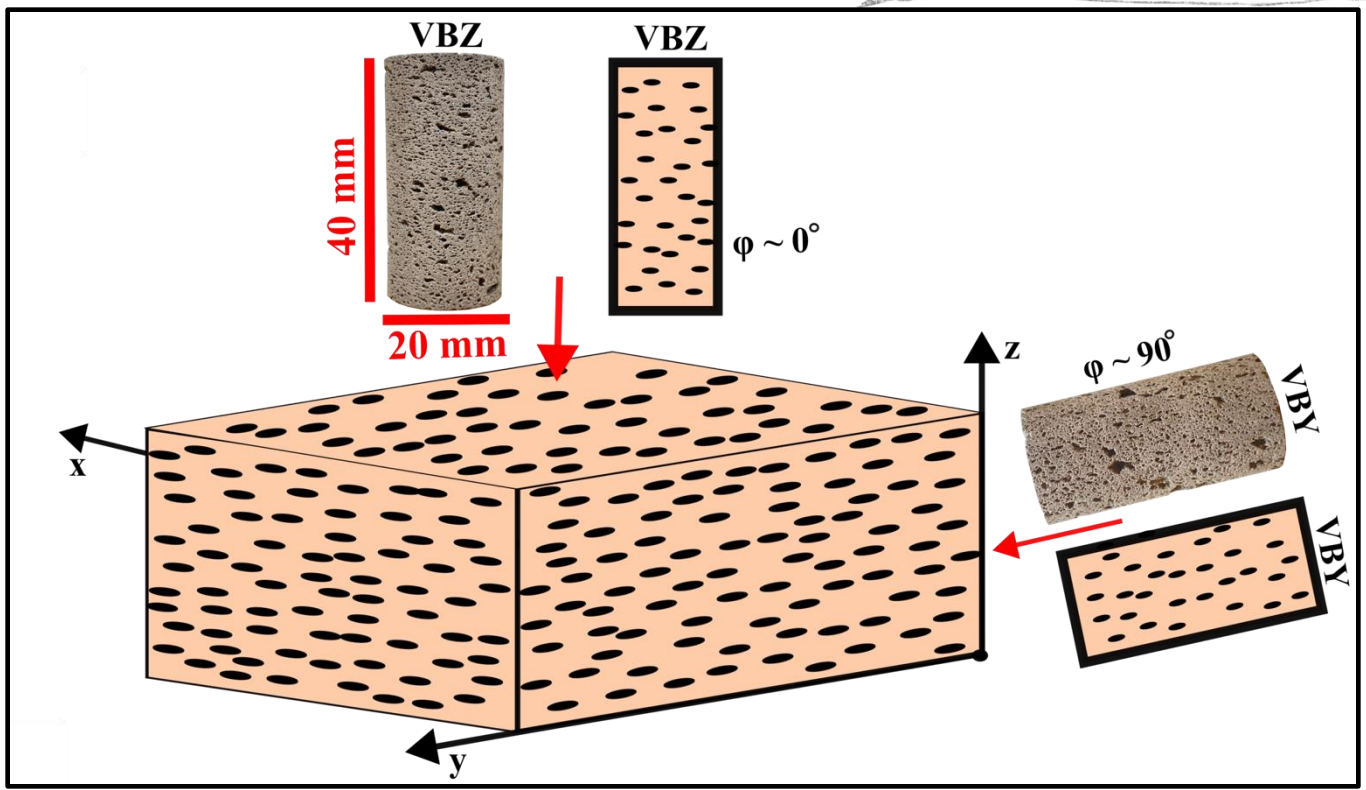
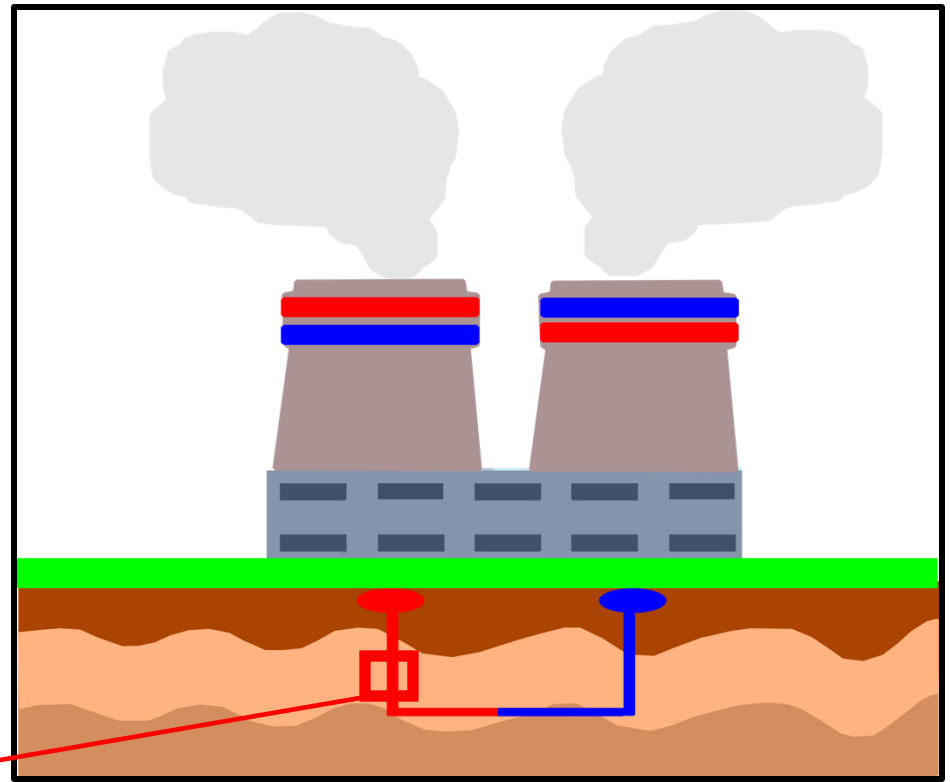
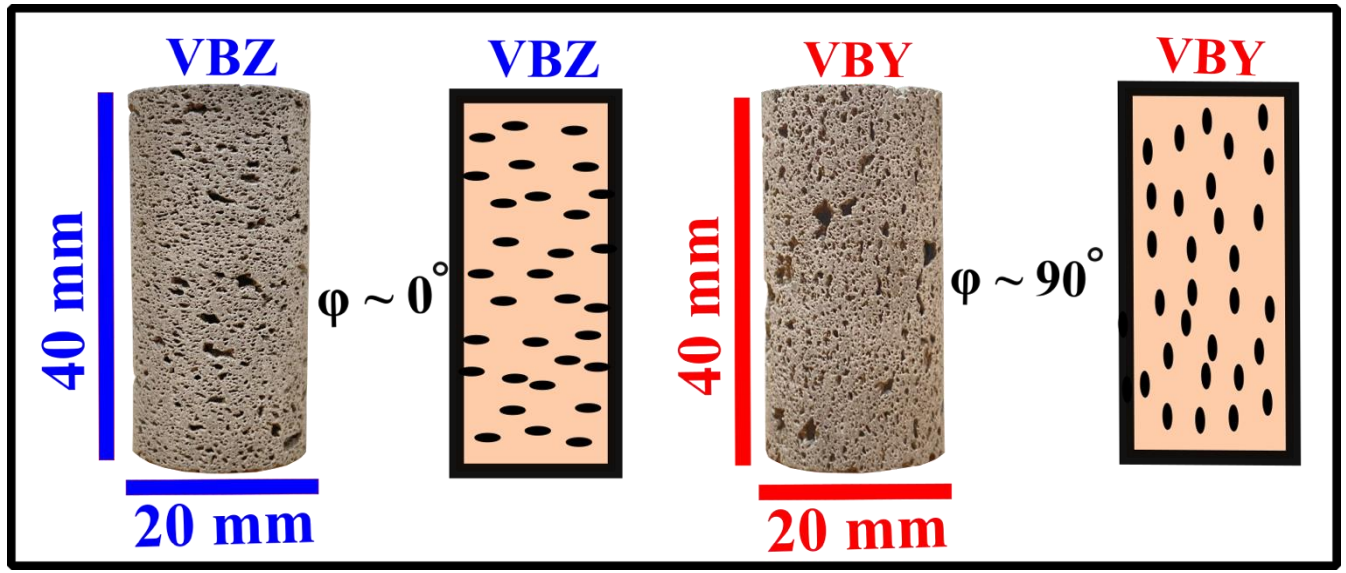
Motivation behind: A reservoir-relevant analogue



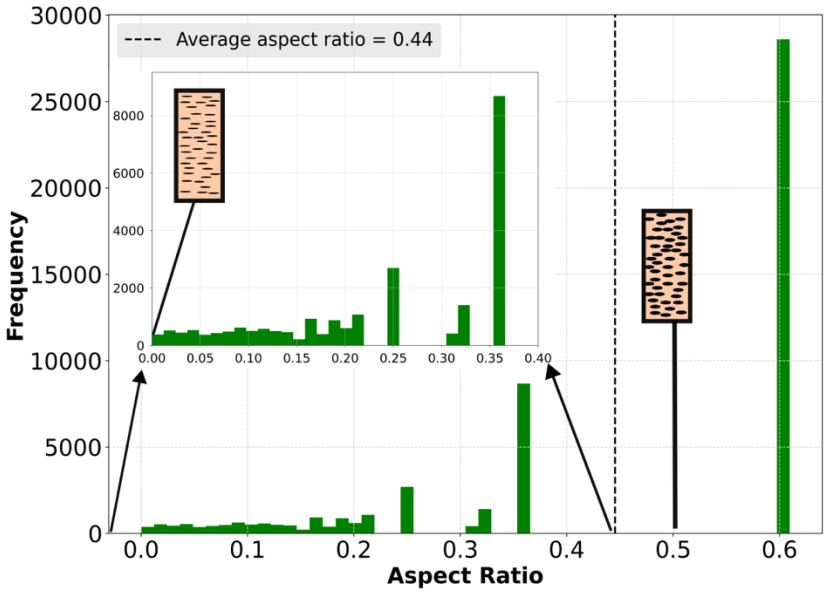


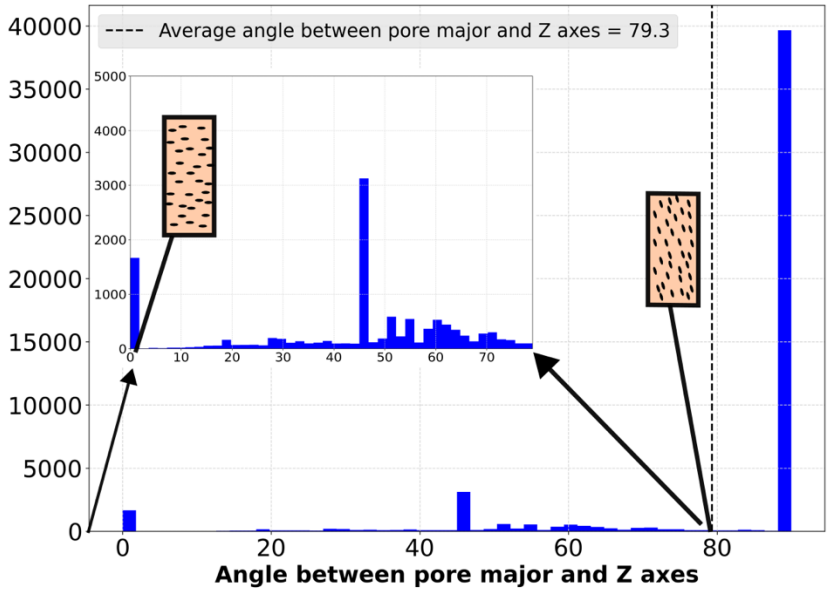


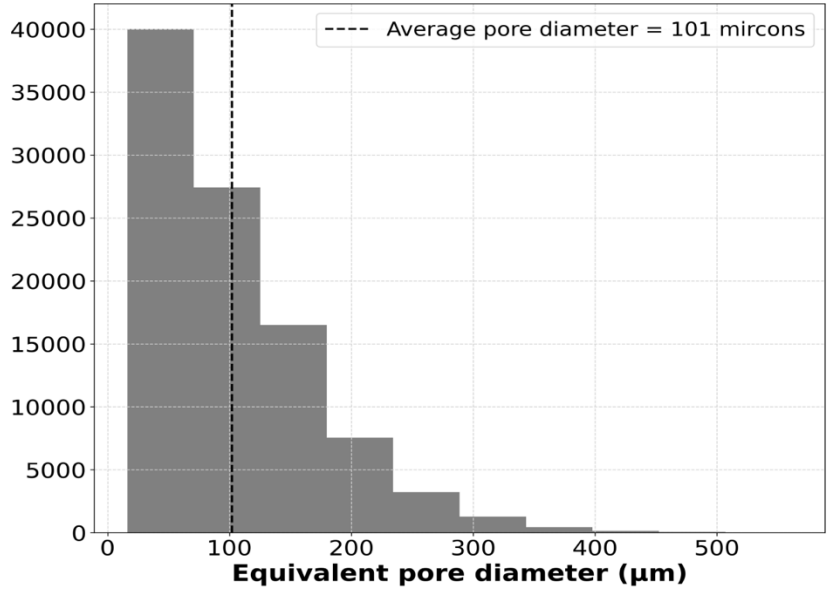
Material characterization



Φ_{VBY}=23-27%
Φ_{VBZ}=24-27%
k_{VBY}~1.5-3.2 x $10^{-14}m^2$
k_{VBZ}~1.8-4.7 x $10^{-15}m^2$

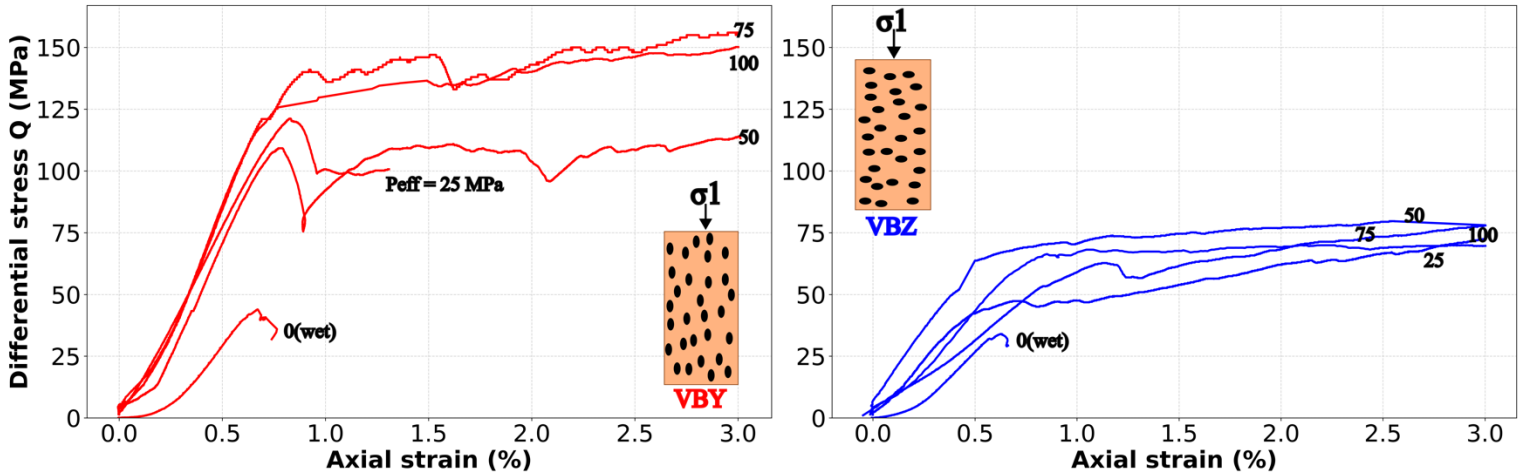




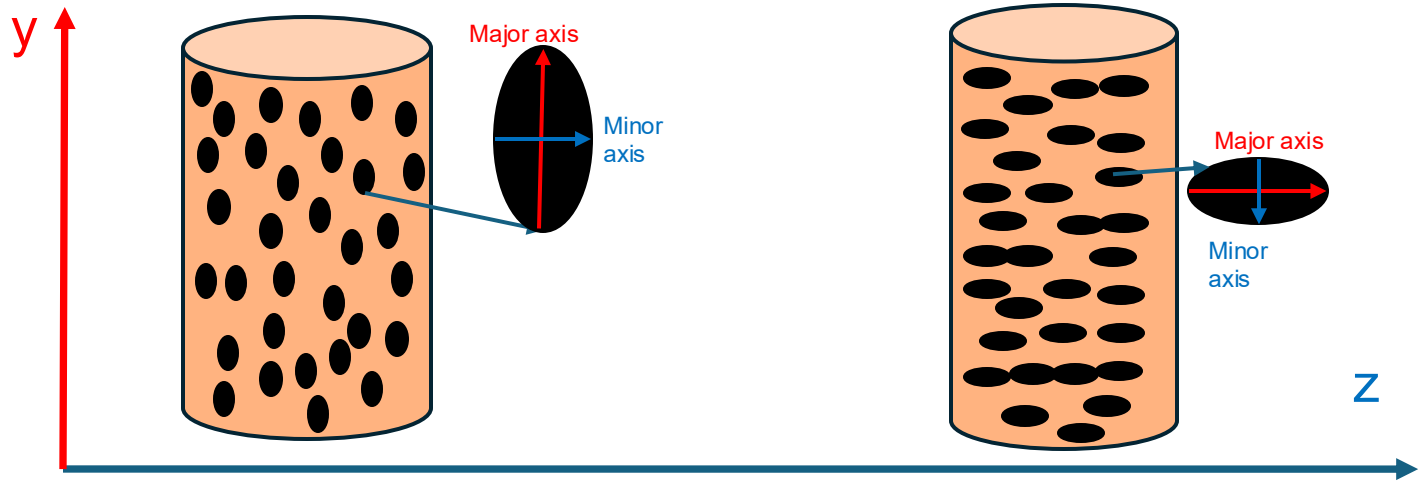


What is the influence of pore geometry and orientation on the mechanical properties?

- Under triaxial compression, for a given effective pressure, VBY samples achieve the stress required for inelastic behaviour (C*) at 2-3 times higher differential stress than VBZ samples.



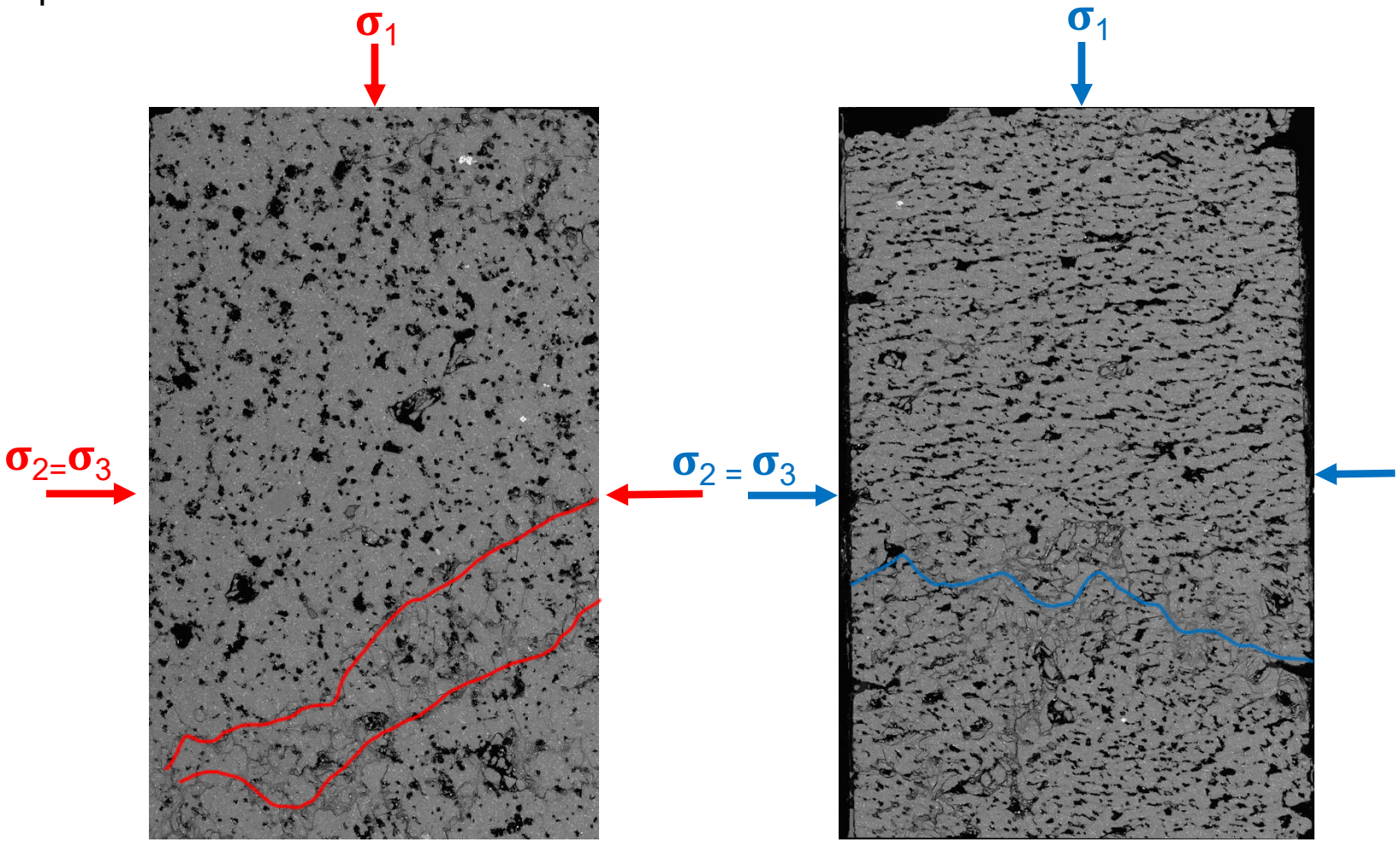
- For triaxial compression tests, the post-yielding behavior of both VBY and VBZ shows hardening and bigger stress drops in VBY samples, which are often attributed to compaction localisation.



How compaction bands are influenced by pore orientation?

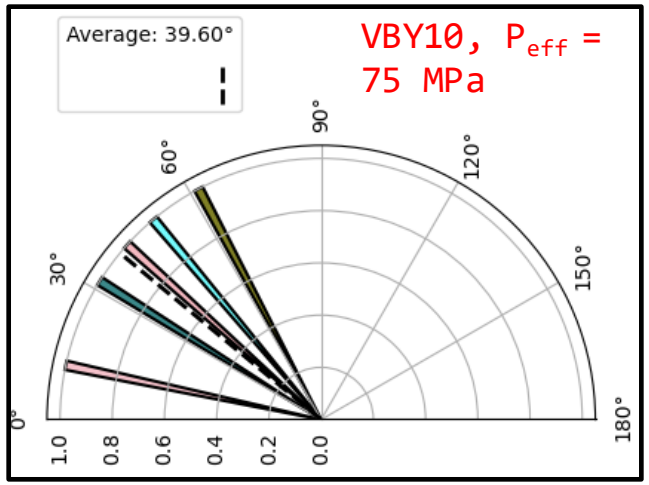
- For both types of pore distributions, samples deformed triaxially undergo compaction localization with evident development of the compaction bands.

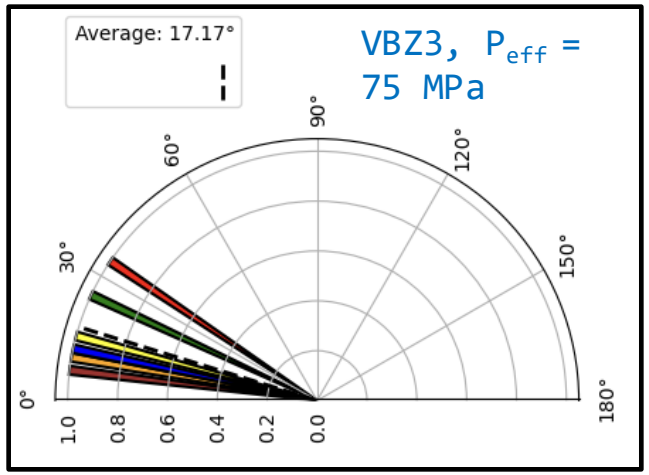
- In VBY samples these bands are localized in an angle of ~ 35º-40º while VBZ samples localized these features almost subperpendicular with respect to the loading direction.



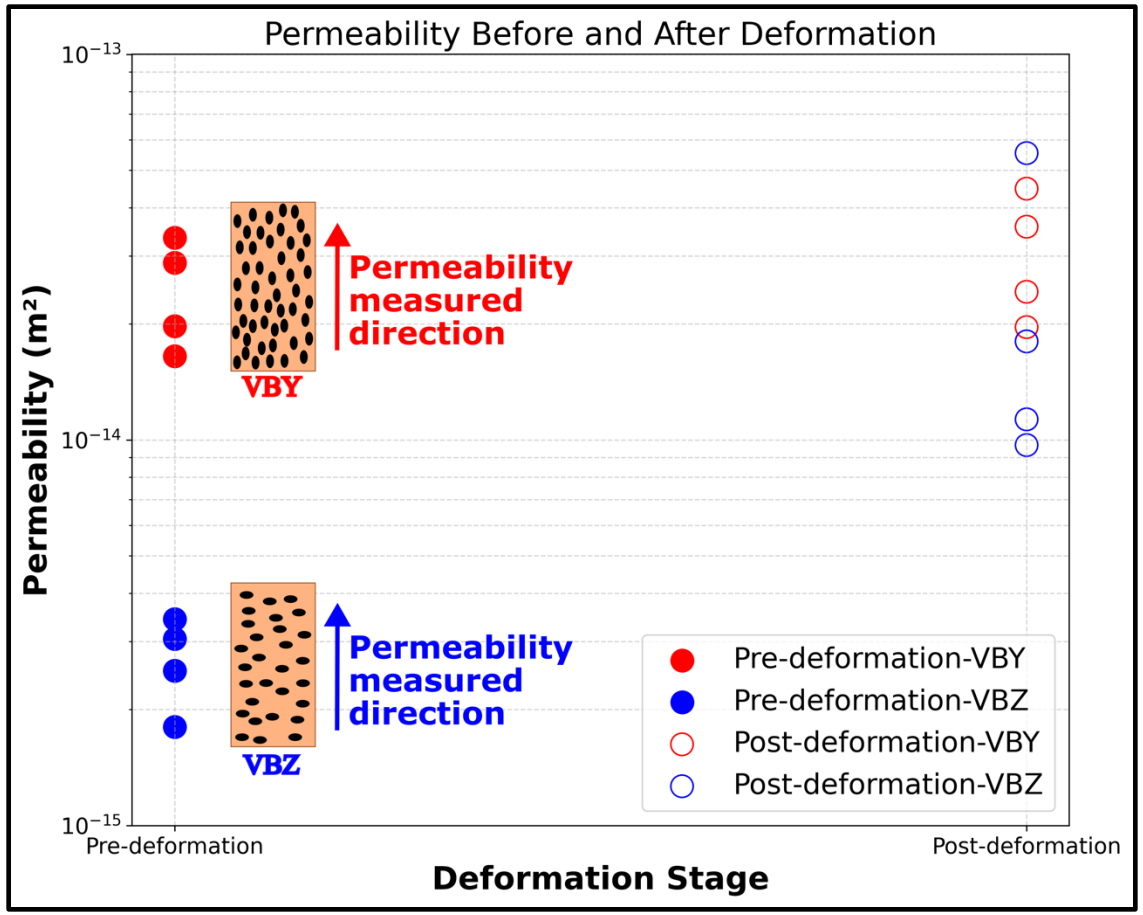
VBY10, Peff= 75 MPa

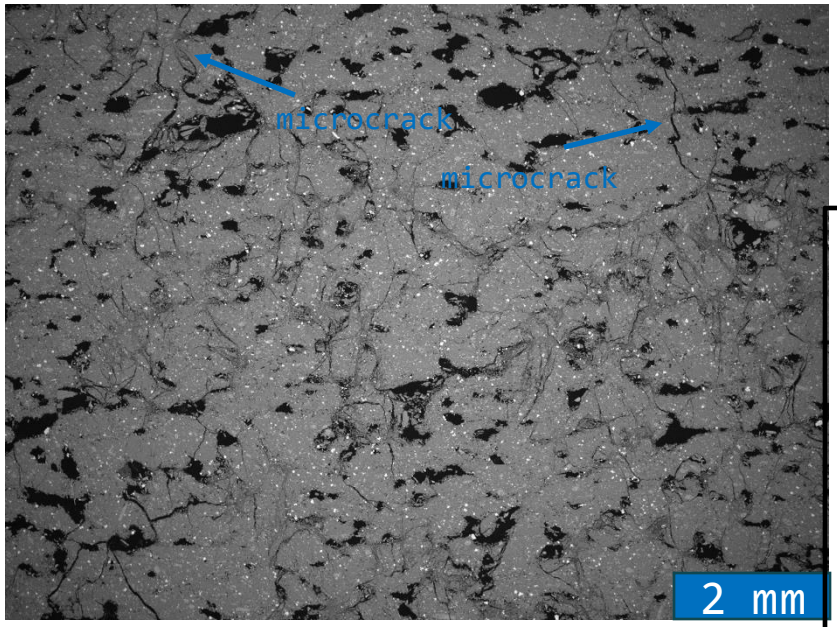
VBZ3, Peff= 75 MPa

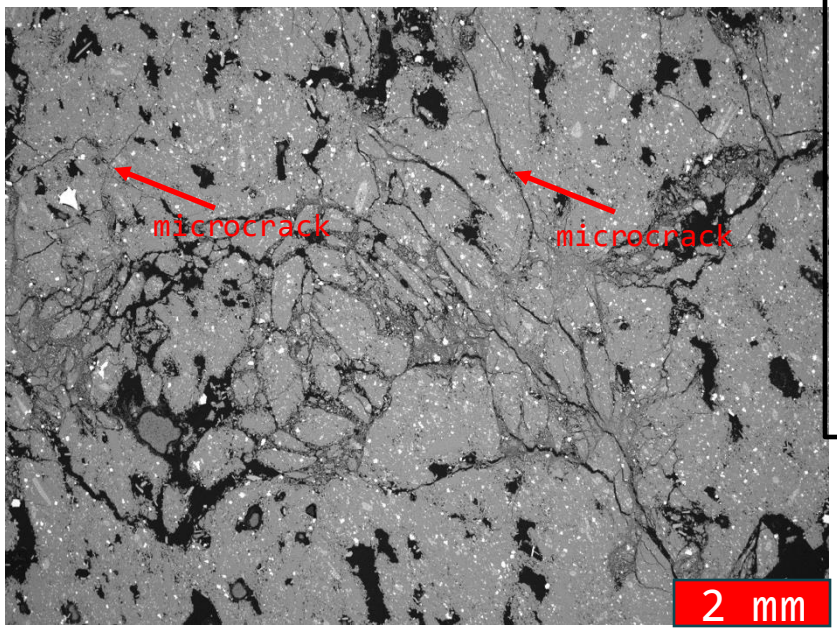




How this difference in geometry and orientation affects the post deformation permeability?







- We observe increase in most of post deformation permeability values which are due to the newly developed axial microcracks in both samples.
- The increase is higher and more visible in VBZ samples ~ almost an order of magnitude.

Concluding remarks

- To our knowledge, this is the first study to triaxially deform lavas with different pore orientations and assess their transition from elastic to inelastic deformation.
- We find that porous lavas with pores aligned parallel to the loading direction achieve the stress required for inelastic behaviour (C*) at 2–3 times higher stresses than those with perpendicularly oriented pores.
- Pore orientation also controls the geometry of compaction bands: VBY samples develop tilted compaction bands at angles of ~35°–40°, whereas VBZ samples form bands that are nearly perpendicular to the loading direction.
- All deformed samples exhibit increased post-deformation permeability, attributed to the formation of new axial microcracks.

Thank you for your attention !

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