Segment tip geometry of sheet intrusions:

A dynamic model for the evolving conditions of emplacement

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With thanks to

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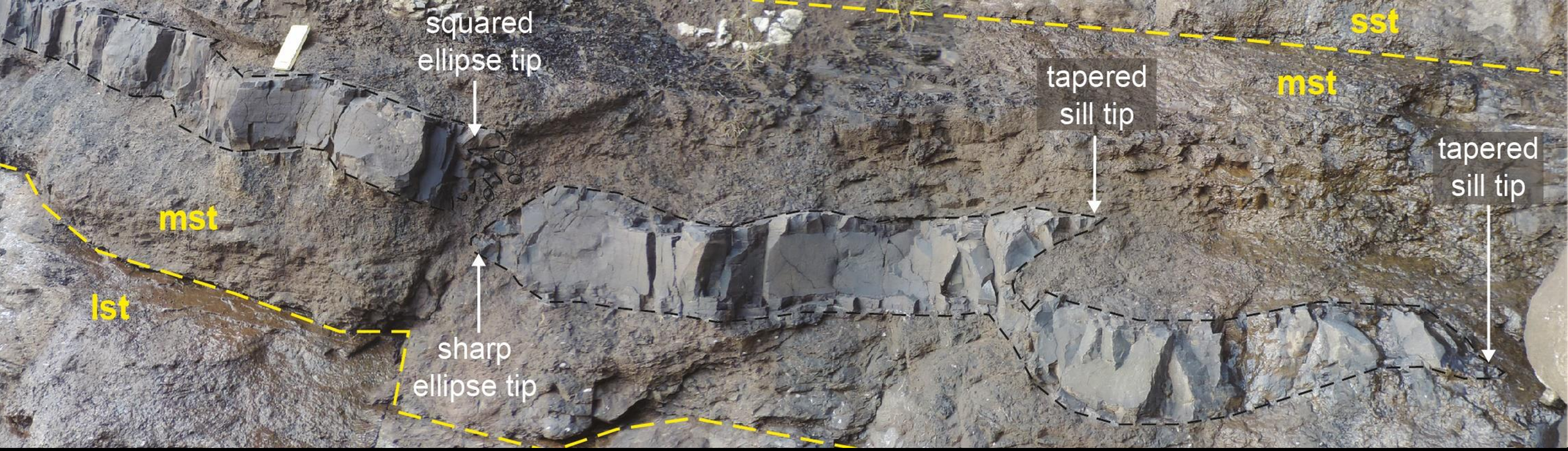

Key Points

- Multiple segment geometries & deformation styles may occur in a single intrusive complex.
- Propagation mechanism may evolve with changing conditions of emplacement.
- Segments preserved in the field may not represent the early stage of intrusion.

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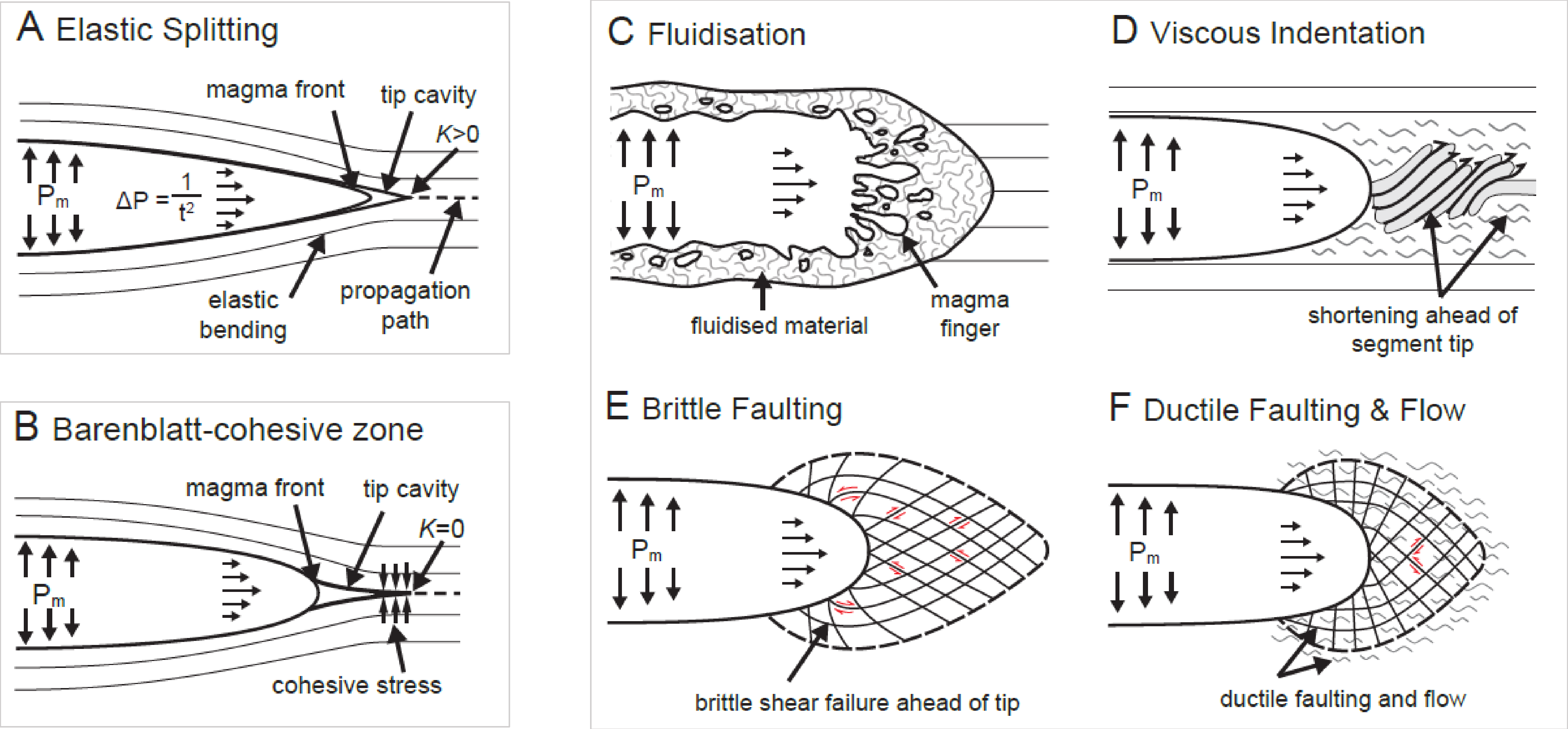
Magma Propagation Mechanisms

Elastic-Brittle
(tapered tip geometry)

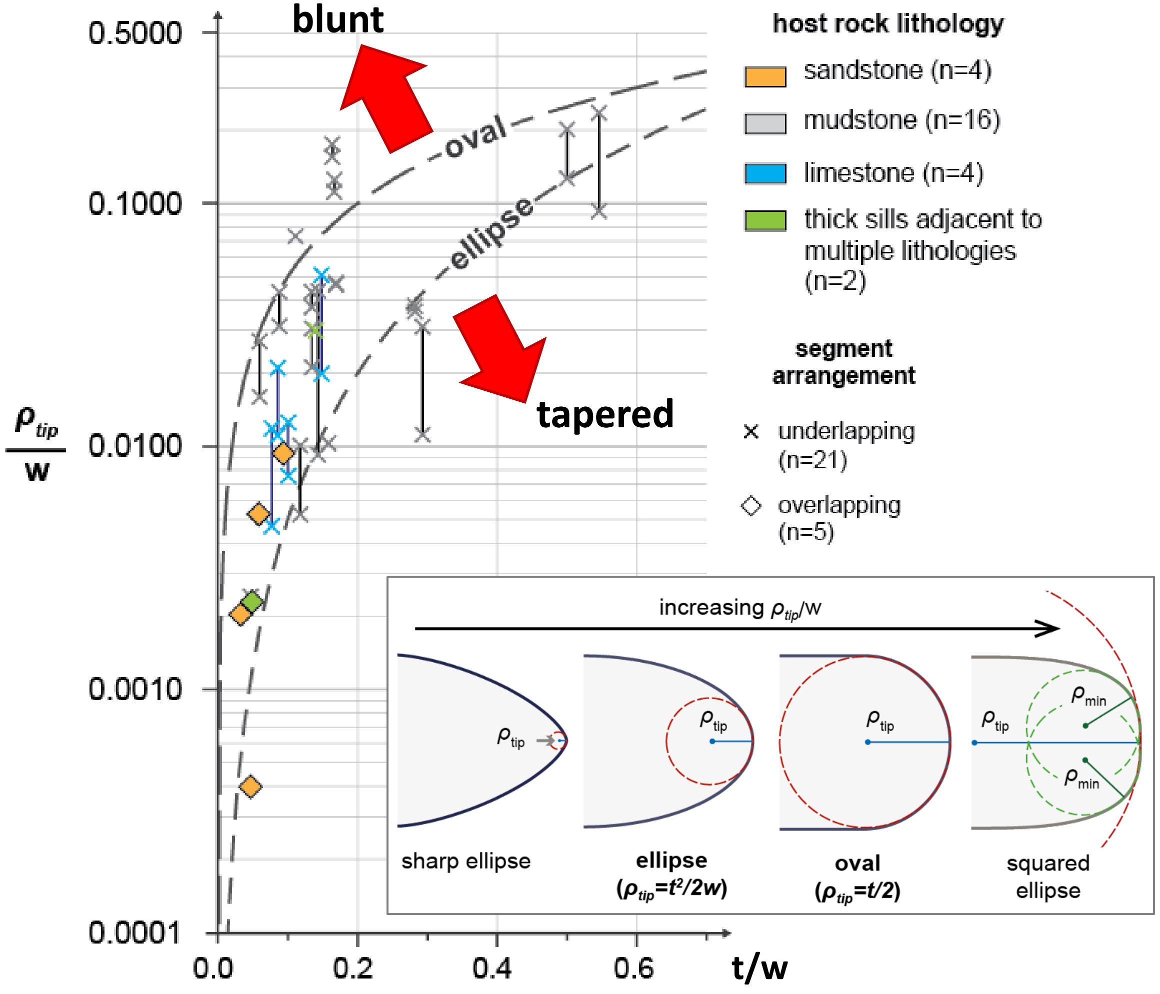
Non-Brittle
(elliptical to superelliptical tip geometry)

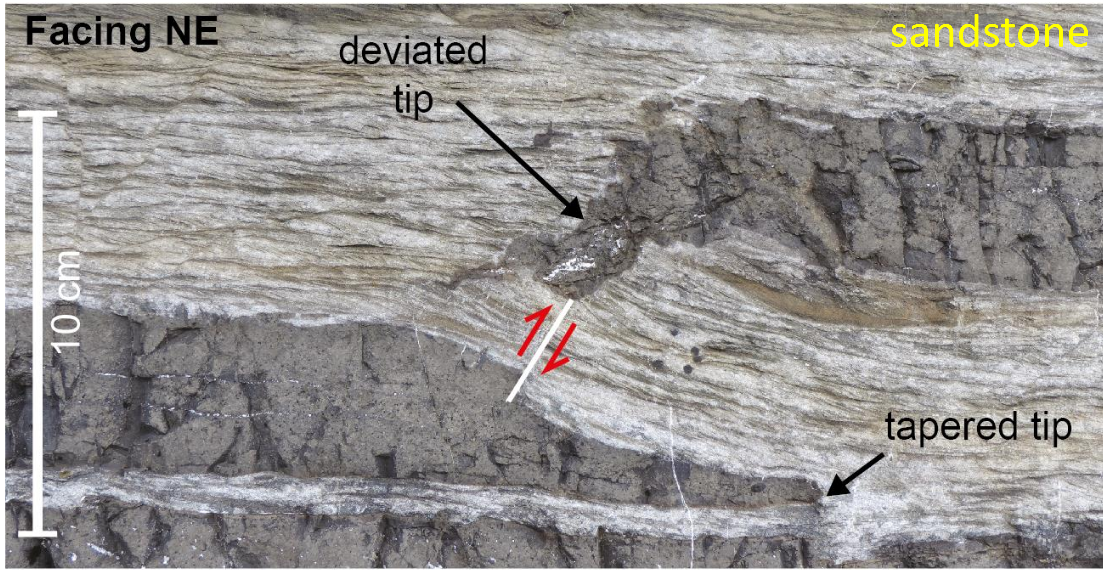


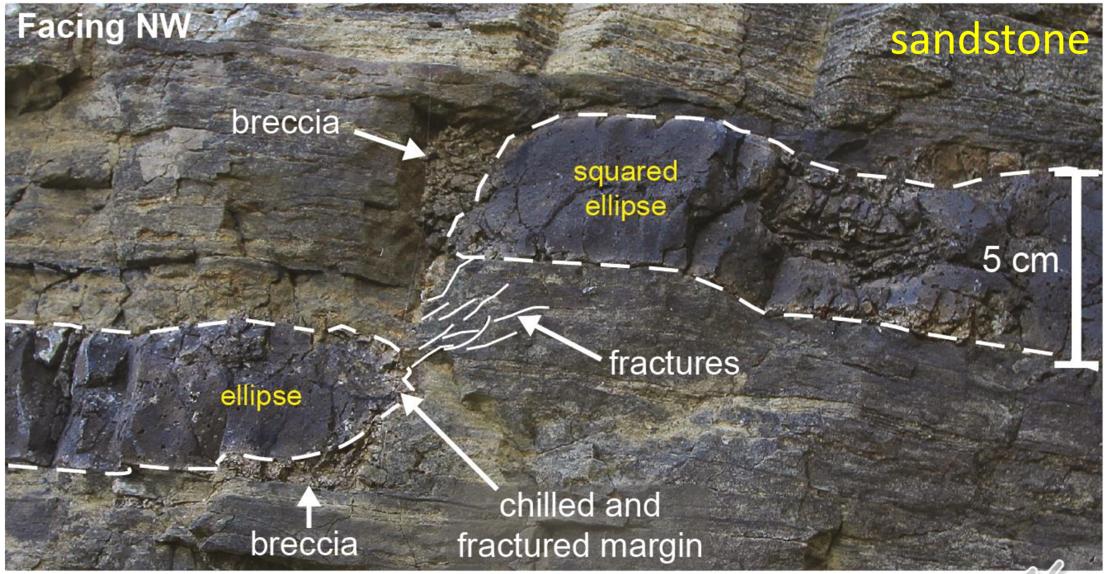
*(**A,E,F**) Pollard et al., 1973. (**B**) Rubin, 1993.*
*(**C**) Schofield et al., 2012. (**D**) Spacapan et al., 2017.*

Segment Geometry

Little Minch Sill Complex (Neist Point, Isle of Skye): Basaltic intrusions in layered sandstones, siltstones, mudstones, and limestone



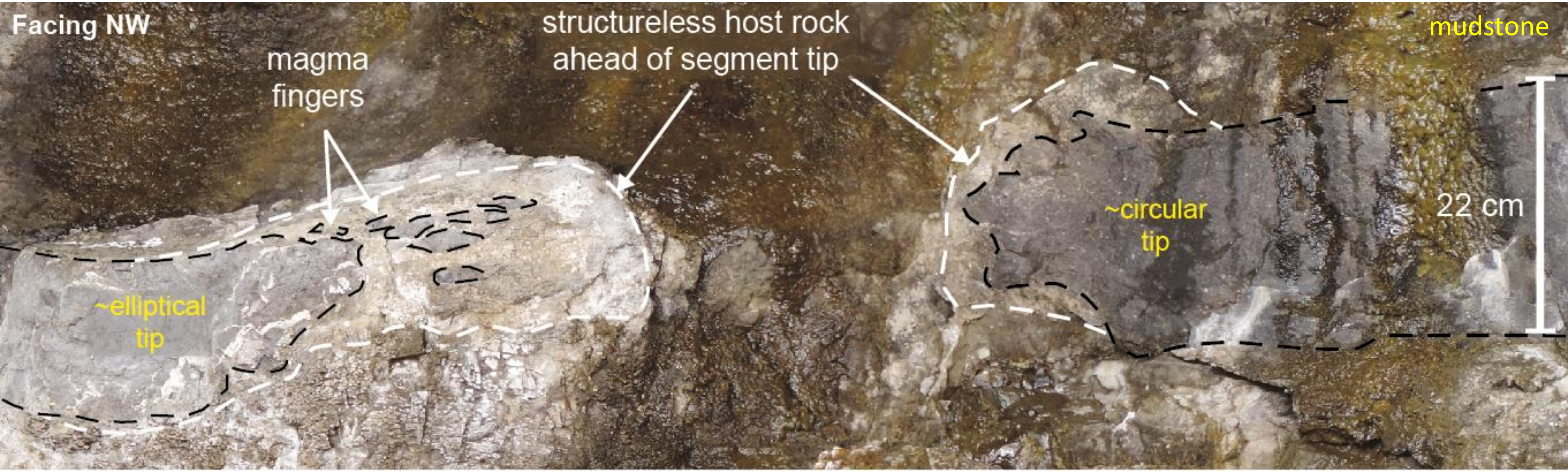




Host Rock Deformation

Observation: Local loss of sedimentary structures ahead of sill tip with magma fingers

Interpretation: Local fluidization & viscous fingering



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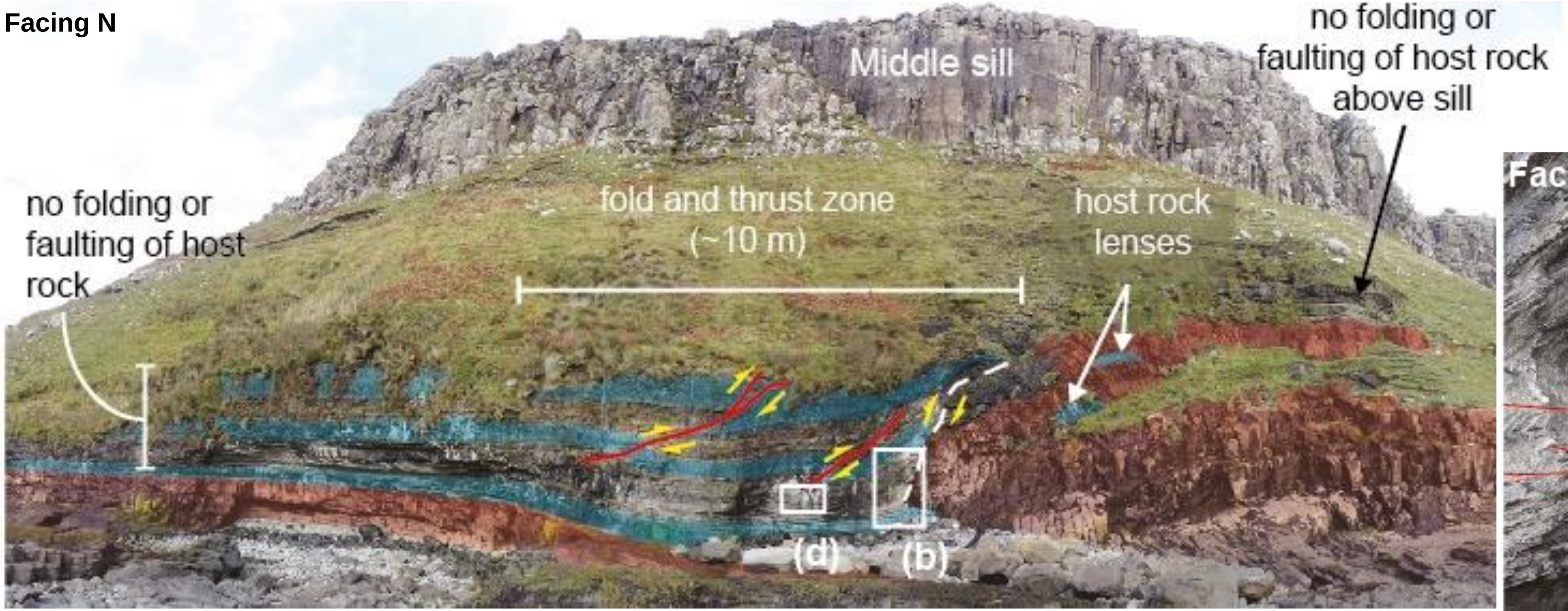
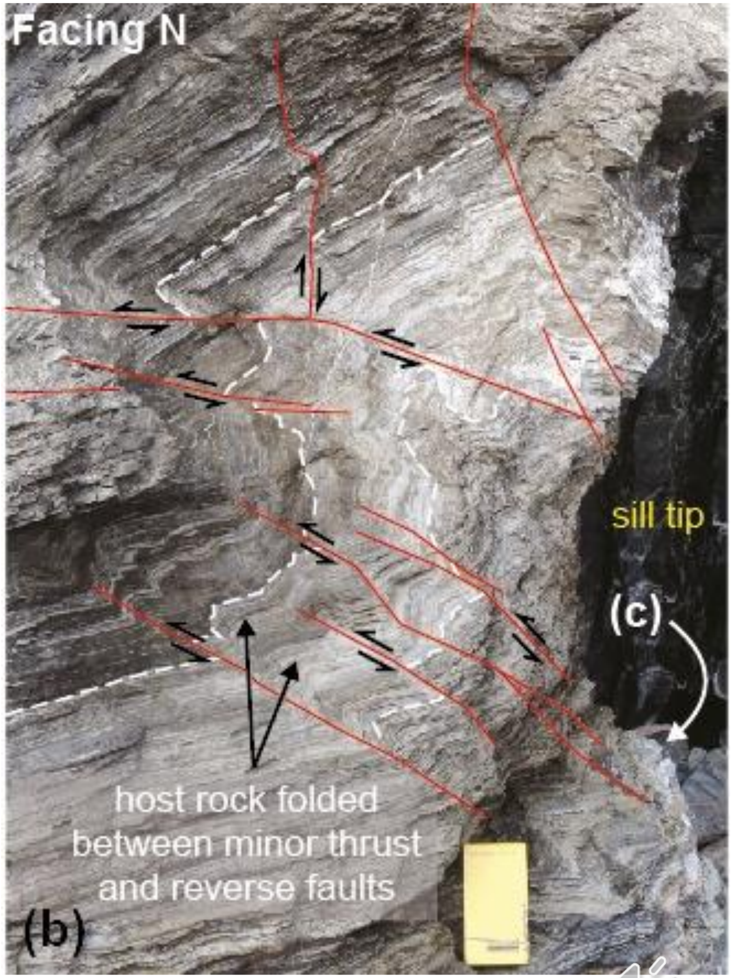
Host Rock Deformation



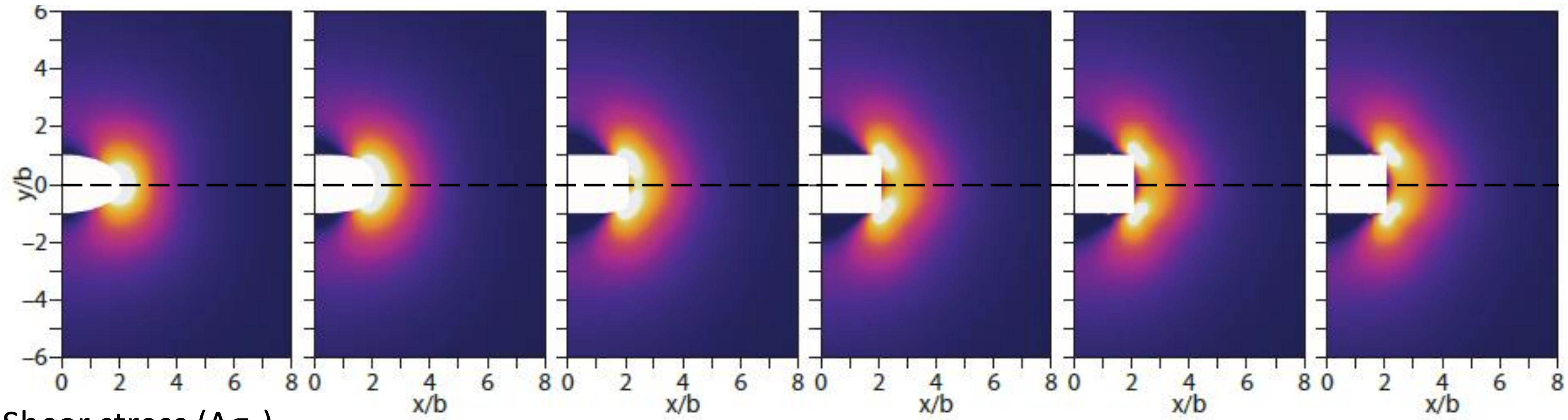


Observation: Local folding and thrusting ahead of sill tip

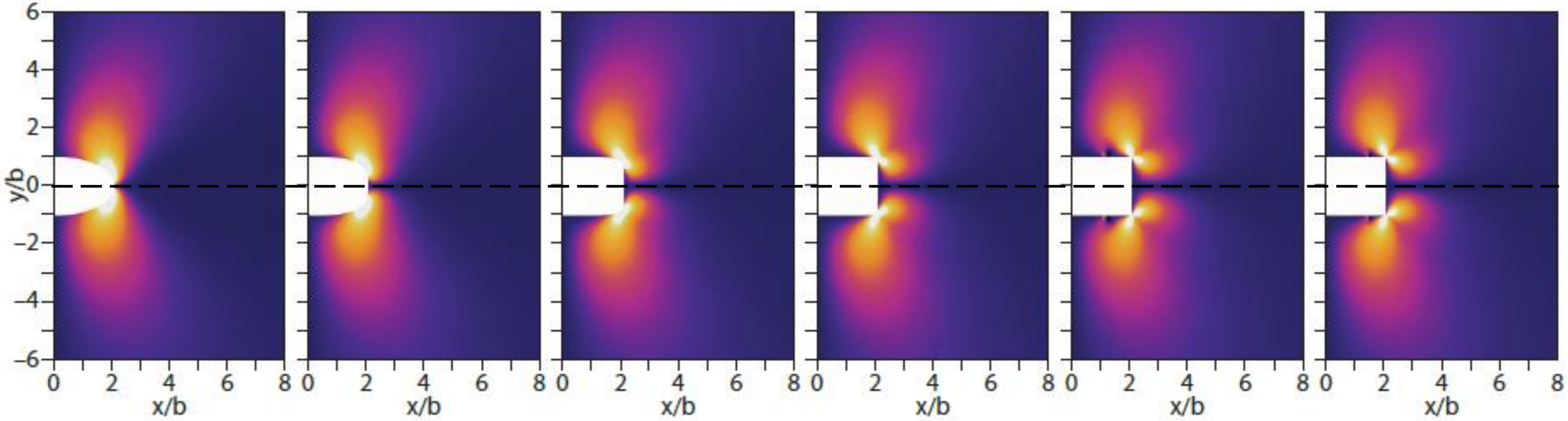
Interpretation: viscous indentation

FE models: Effect of tip geometry on stress perturbation

A) Tensile stress ($\Delta\sigma_1$)

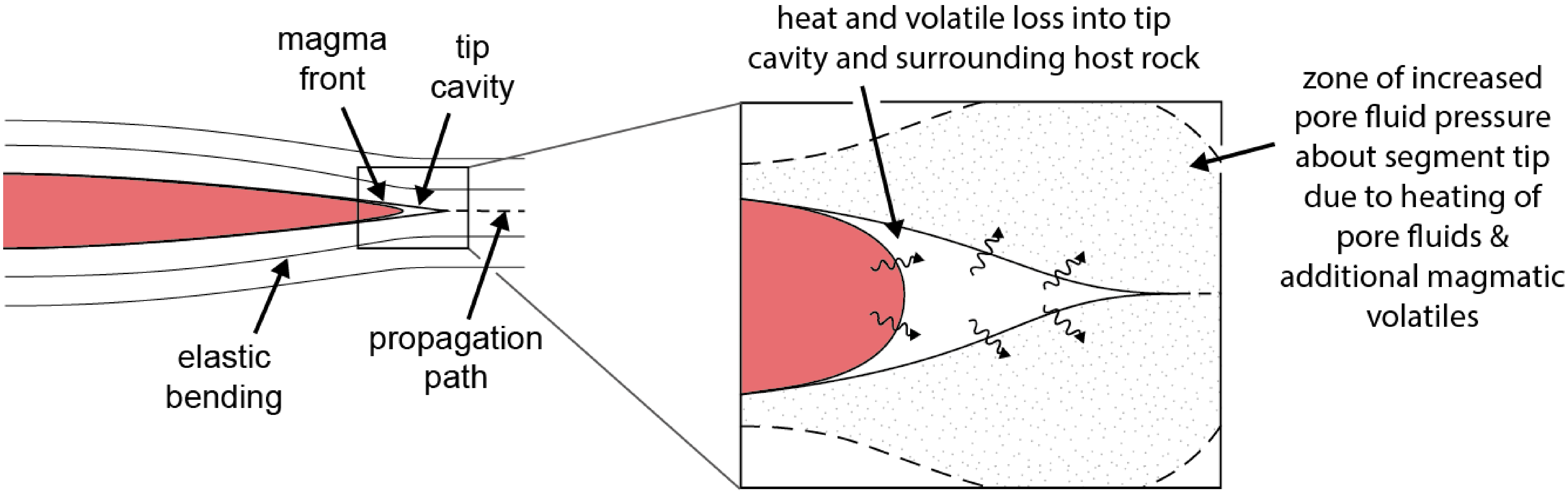


B) Shear stress ($\Delta\sigma_1$)



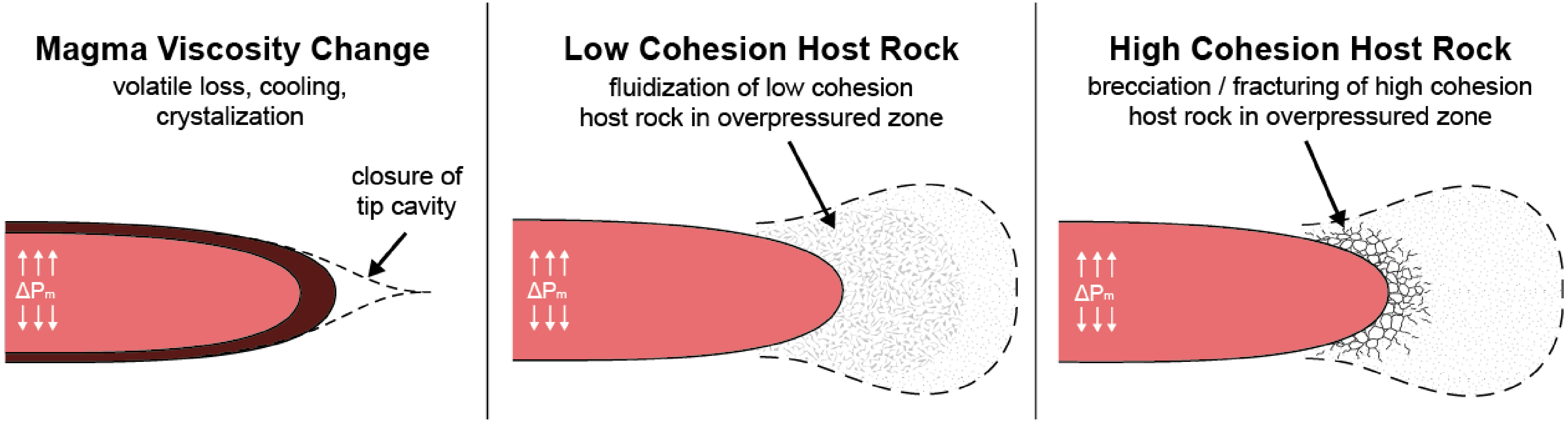
Multi-phase emplacement model

Phase I

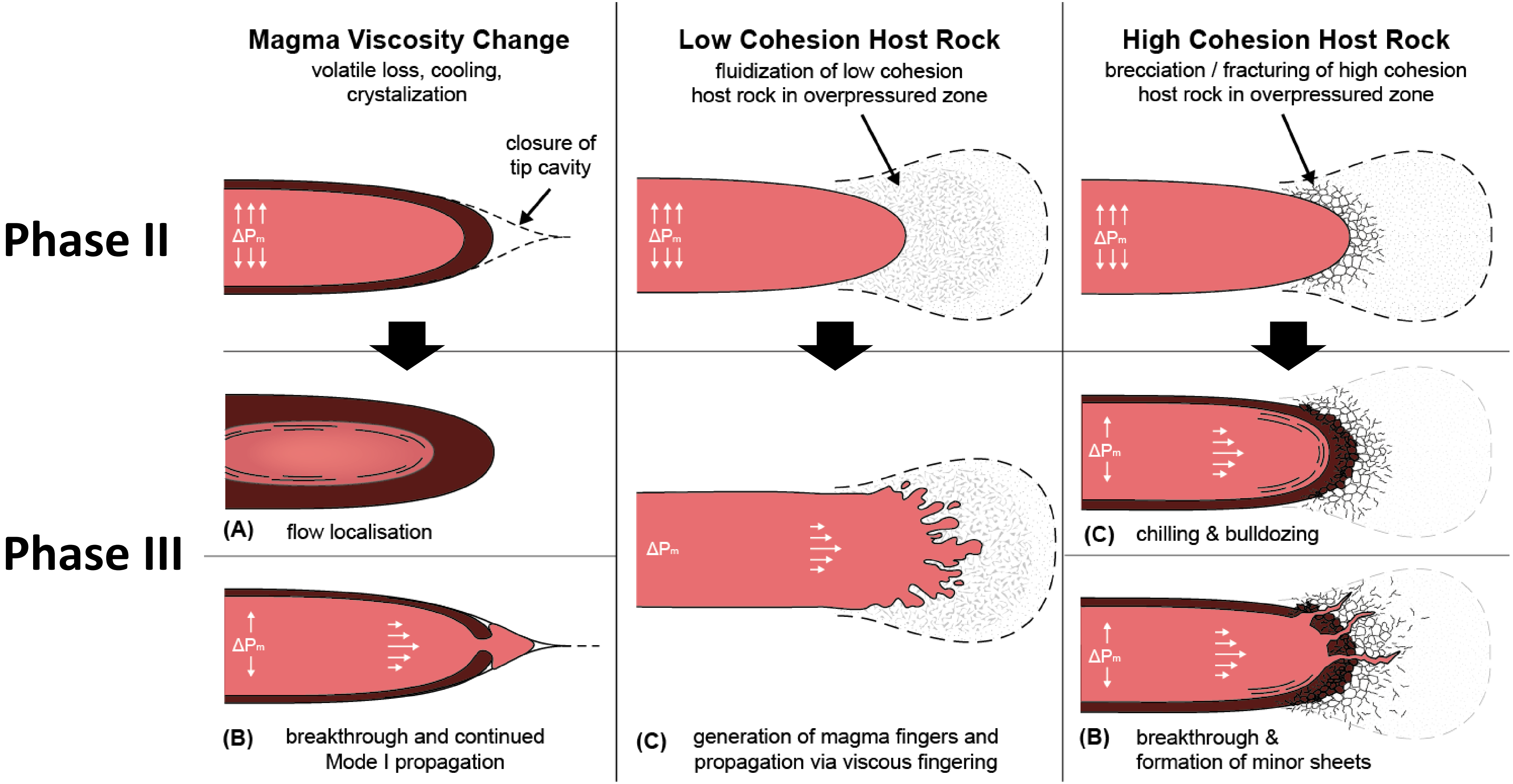


Multi-phase emplacement model

Phase II



Multi-phase emplacement model



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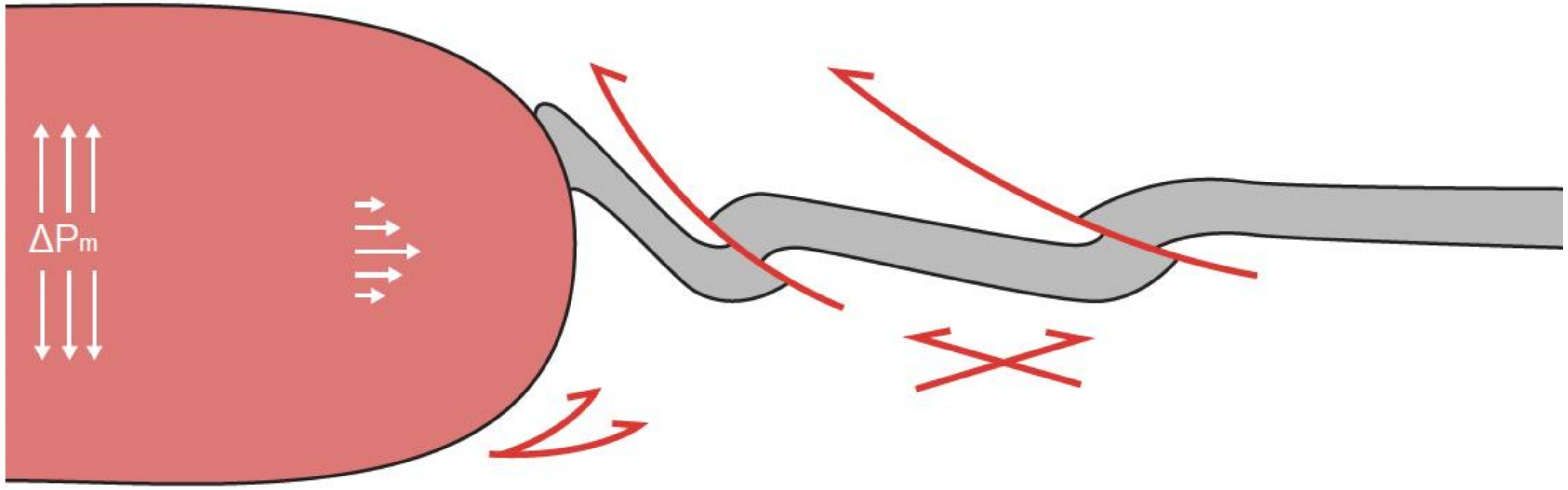
Multi-phase emplacement model

Phase III

Interbedded Host Rock

Inflation such that sill thickness >> bed thickness

renewed propagation via viscous indentation



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Summary

- Multiple segment geometries & deformation styles may occur in a single intrusive complex.
- Propagation mechanism may evolve with changing conditions of emplacement.
- Segments preserved in the field may not represent the early stage of intrusion.

Thank You!

Please email any questions to:

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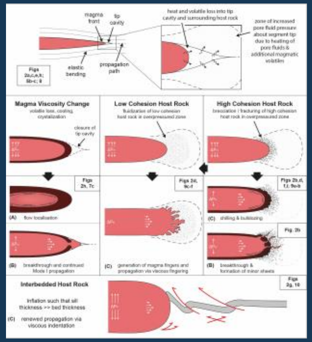
And if you want to know more…

Stephens, T.L, Walker, R.J, Healy, D. and Bubeck, A. (2021) "**Segment tip geometry of sheet intrusions, II: Field observations of tip geometries and a model for evolving emplacement mechanisms**", *Volcanica*, 4(2), pp. 203–225. doi: 10.30909/vol.04.02.203225.



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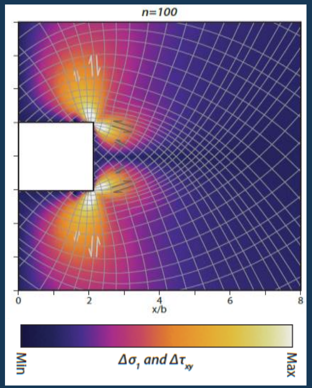

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