

Impact of shear zone distribution in the middle to lower crust

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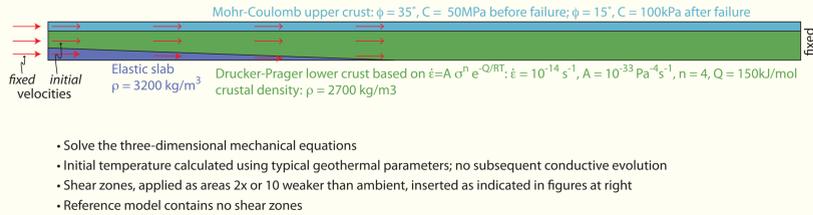


Rationale and question

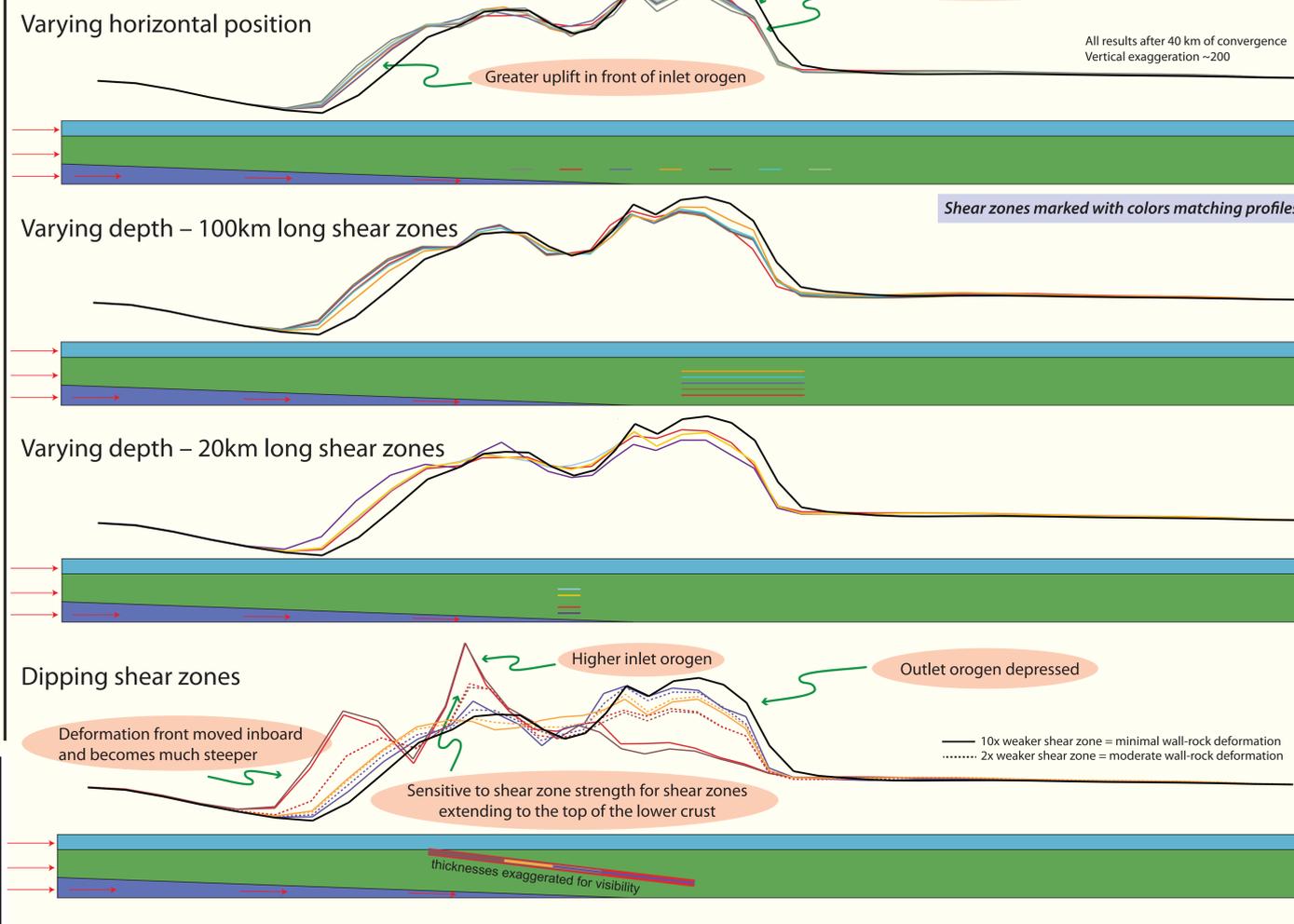
Deformation localization occurs at all scales of the Earth. Localization implies weakening, and takes the form of shear zones in the middle and lower crust. But how much do these shear zones affect what we see at the surface of an orogen?

Our guiding question: What scale, position, and magnitude of weakened zones can affect orogen topography? (And in what patterns?)

The numerical model



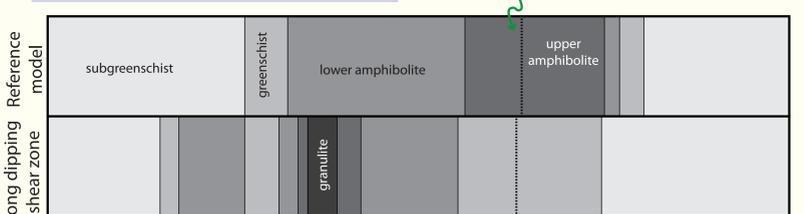
Results



Examples of internal fields



Hypothetical metamorphic facies distributions after moderate exhumation



Unanswered question #1: Do most km-scale shear zones affect orogen-scale kinematics?

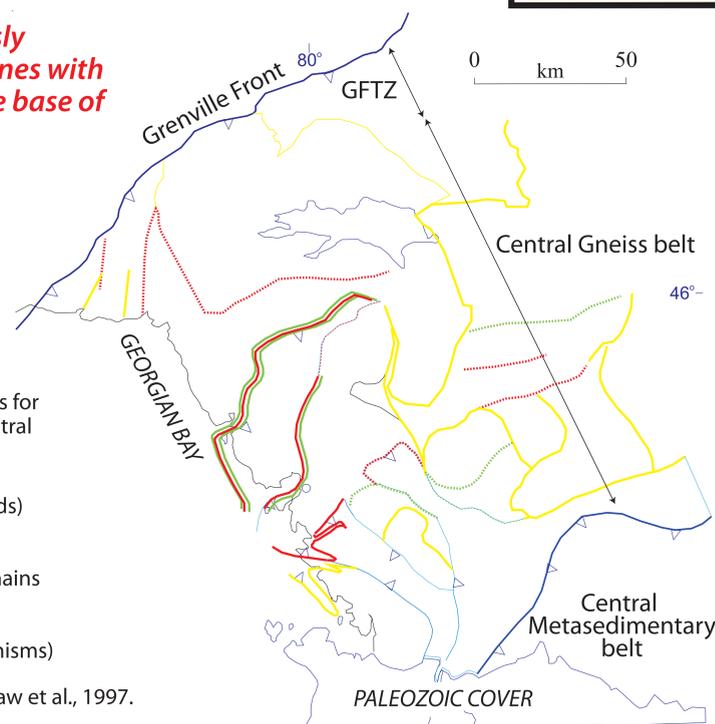
How contemporaneously connected are shear zones with each other and with the base of the upper crust?



Inferred weakening mechanisms for km-scale shear zones in the Central Gneiss belt and Grenville Front Tectonic Zone (GFTZ)

- metamorphism (incl. fluids)
- textural change
- uncertain
- borders of anatectic domains
- dashed=tentative (none with other mechanisms)

Map after Easton, 1992; Culshaw et al., 1997.



Unanswered question #2: What are the dominant causes of km-scale weak zone development? Are they the same in different tectonic settings?

Some candidates

Thermal (advection or shear heating)

Textural change

Hydration

Mineralogical change

Melt

Stress perturbation

An example of hydration-induced reaction causing km-scale weakening



Take-home points

- Even 20 km long shear zones can affect orogen topography.
- With a shear zone present, deformation shifts towards the underlying plate.
- Orogen-scale effects are relatively insensitive to shear zone position unless shear zone connects to upper crust (and thereby to the surface).

Acknowledgments and References

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Culshaw, N.G., Jamieson, R.A., Ketchum, J.W.F., Wodicka, N., Corrigan, D., Reynolds, P.H., 1997. Transect across the northwestern Grenville orogen, Georgian Bay, Ontario: Polystage convergence and extension in the lower orogenic crust. *Tectonics*, 16, 966-982.

Easton, R.M., 1992. The Grenville Province and the Proterozoic History of Central and Southern Ontario. In: Thurston, P.C., Williams, H.R., Sutcliffe, R.H., and Stott, G.M. (Ed.). *Geology of Ontario, Special Volume 4 Part 2*, Ontario Geological Survey, p. 715-906.