

Inter-event strain localization modulated by background stresses across the Natron Basin, East African Rift

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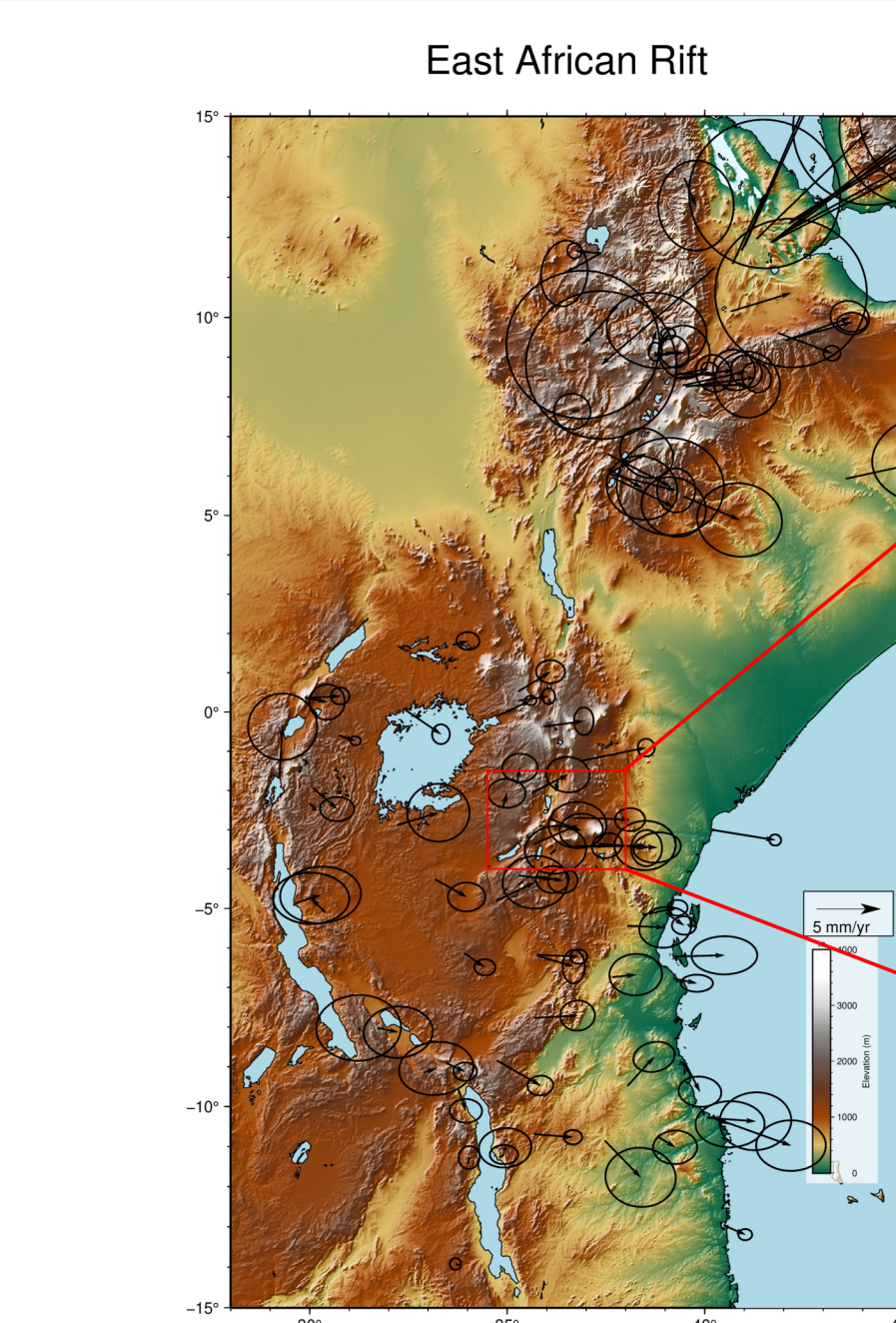
Introduction

- Plate separation at continental rifts is accommodated by tectonic and magmatic processes.
- On short time scales, rifting manifests as discrete events of fault slip and magmatic intrusion.
- Such events relieve extensional stresses built-up at the axis over 10's to 100's years.
- Here, we focus on the **inter-event localization of deformation** in the Natron Basin

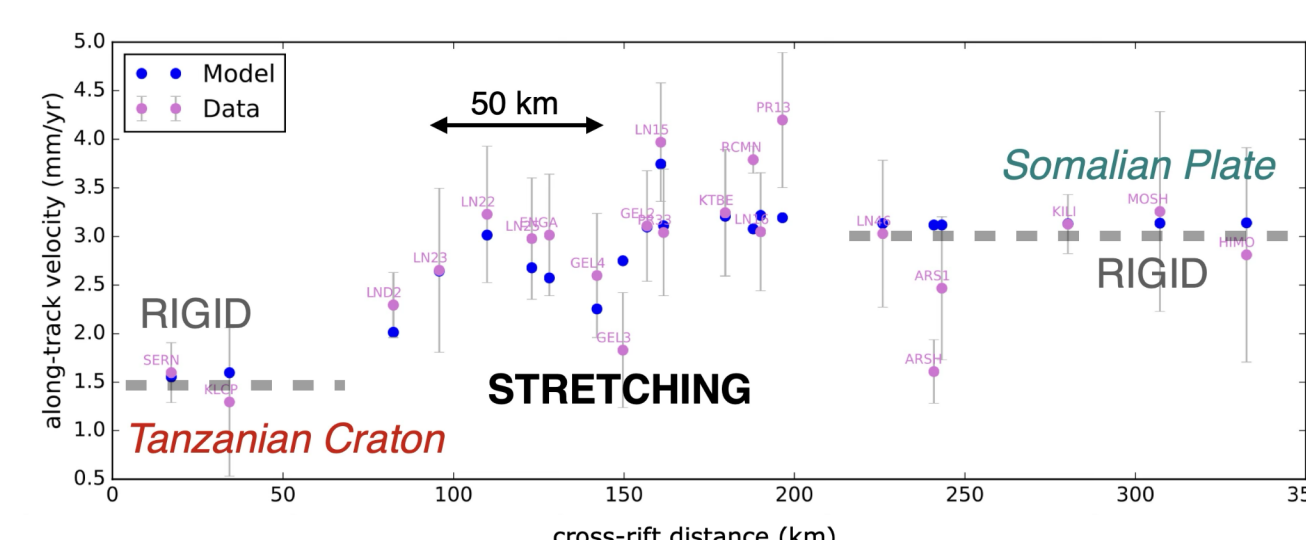
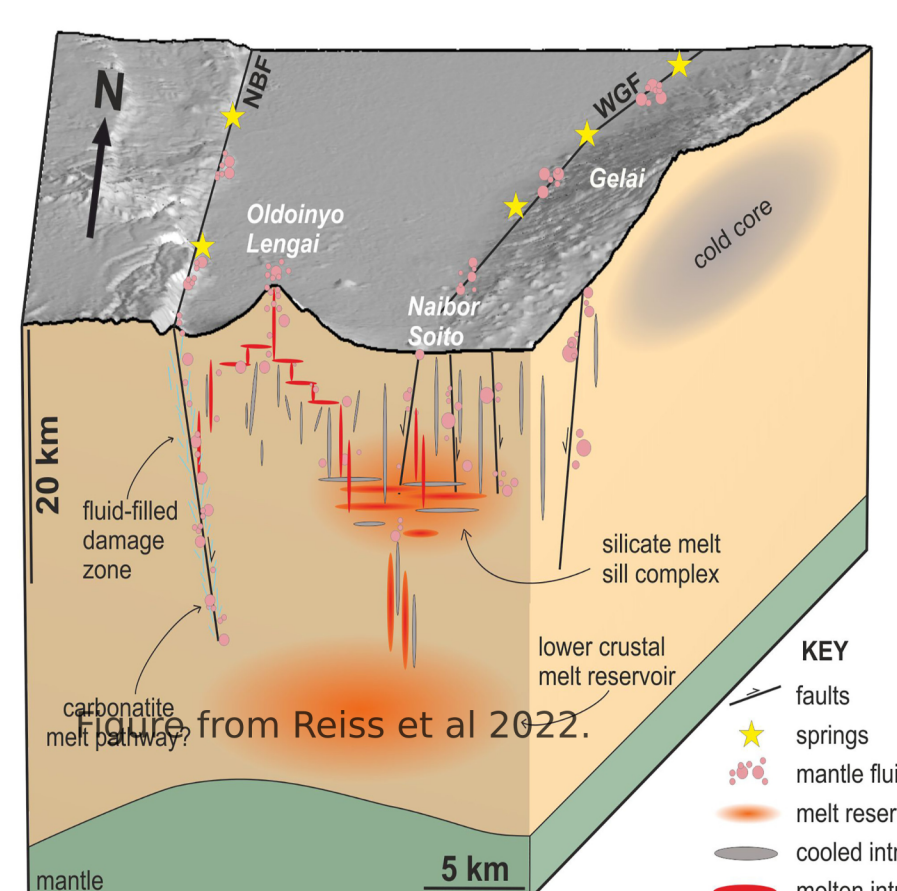
Key Question:

Does long-term (finite) deformation influence short-term stress build-up?

Study Area: Natron Basin



- Part of the eastern branch of the East African Rift
- Experienced a major tectono-magmatic event in 2007. (Calais et al 2008)

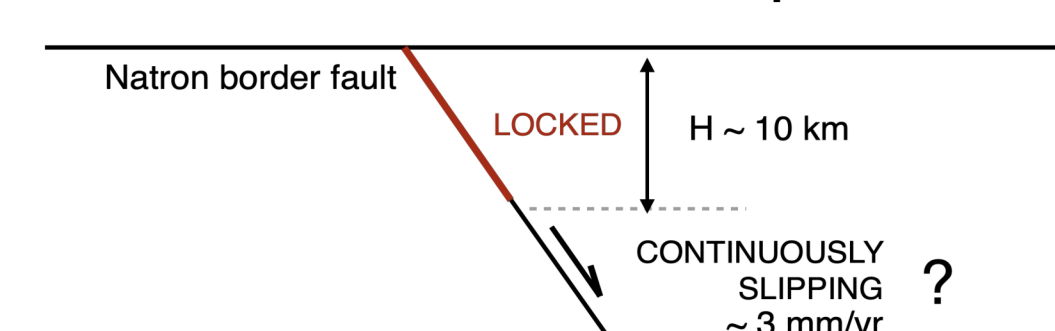


GNSS horizontal velocity profile across the rift reveals a gradual transition zone between the **Tanzanian craton** and the **Somalian plate**, with ~2 mm/year of extension distributed over a ~100 km stretching zone.

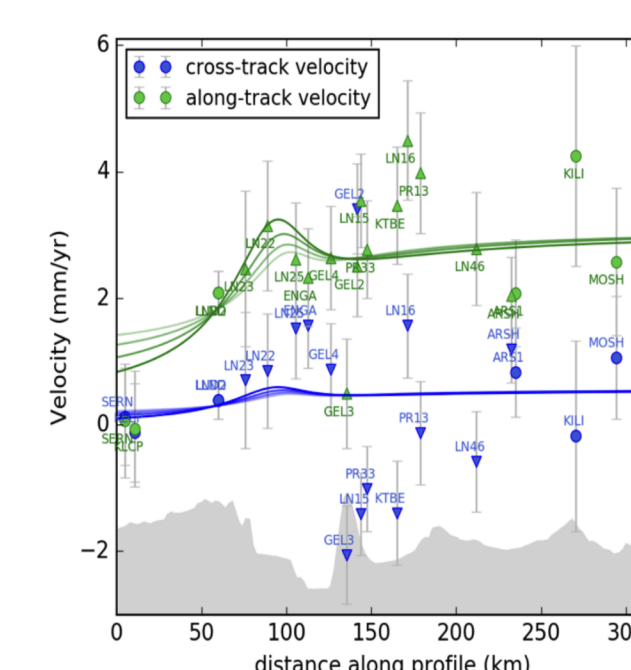
So, what controls the width of this inter-event stretching zone?

Stretching Zone: Prior Models

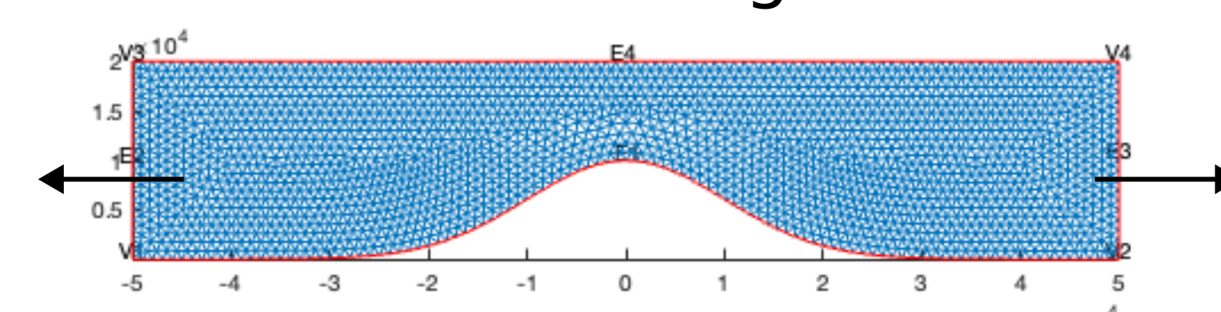
Dislocation (back-slip) Model



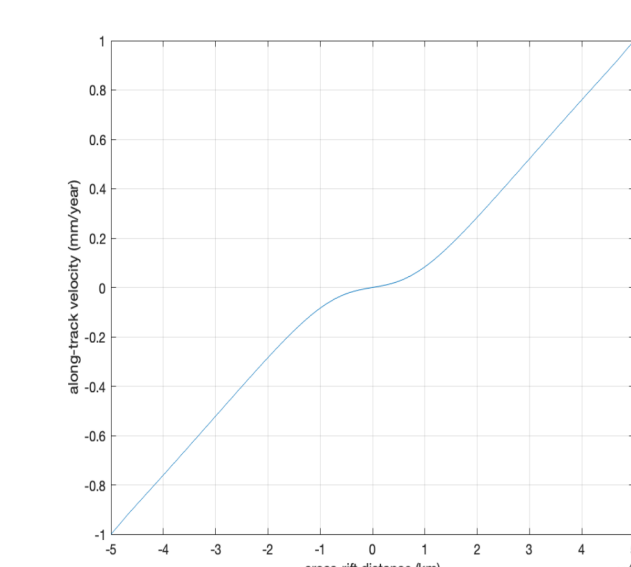
Requires localized shear zone deep within the lower crust. Inconsistent with weak, magma-rich lower crust?



Elastic Necking model



Produces no stretching at the axis. Strain localization would require weaker elastic moduli at the axis



From Long- to Short-term Rifting



Modelling Approach

- 2D Thermo-mechanical model to stretch a elasto-visco-plastic layer.
- Form a major border fault that continuously slips for 5Myrs.
- Artificially lock the fault by instantaneously strengthening it, while drastically reducing the time step in our simulations to 1 month.

Horizontal stress during inter-event rifting

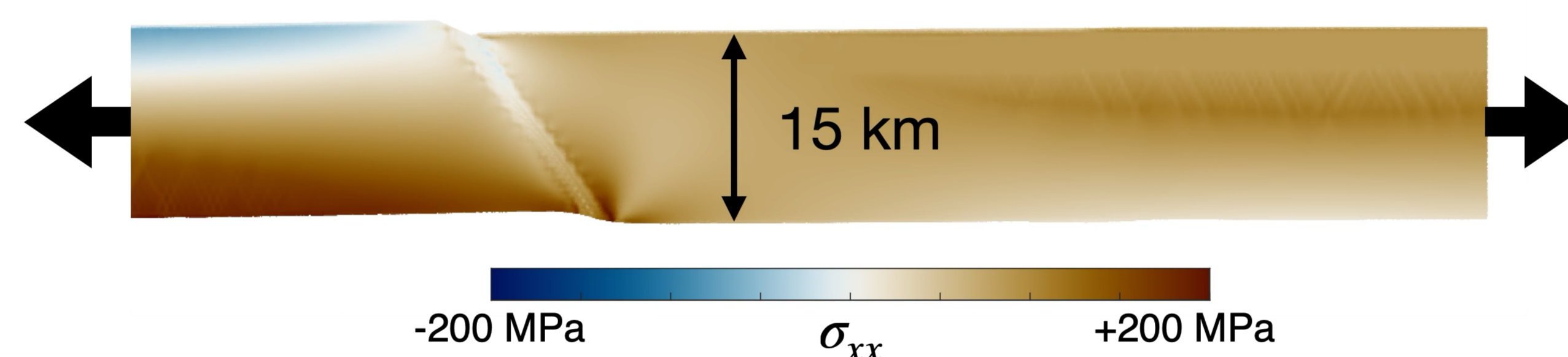
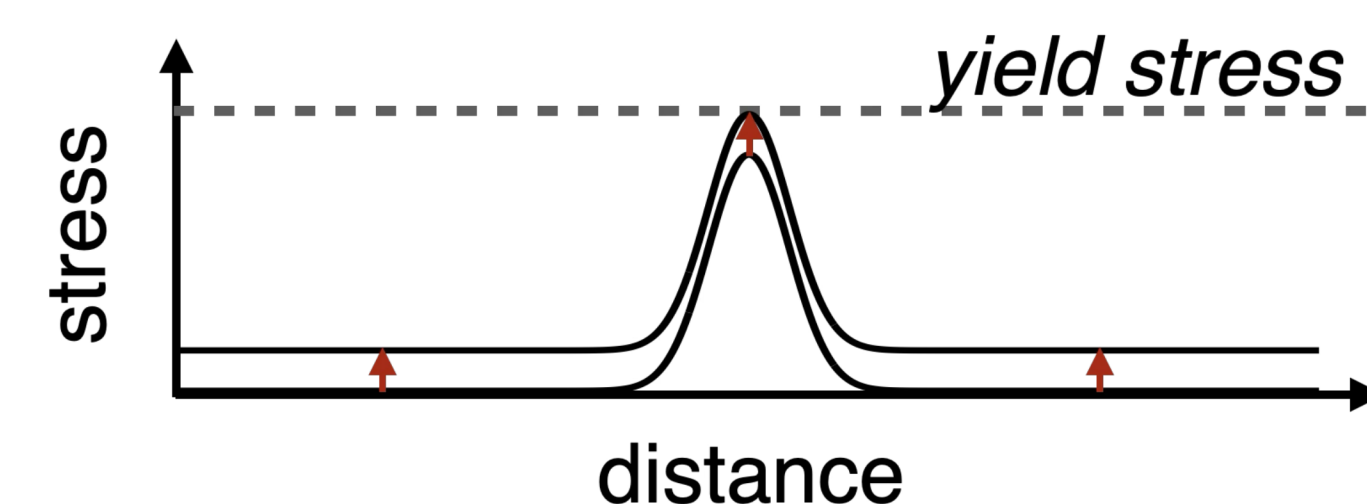
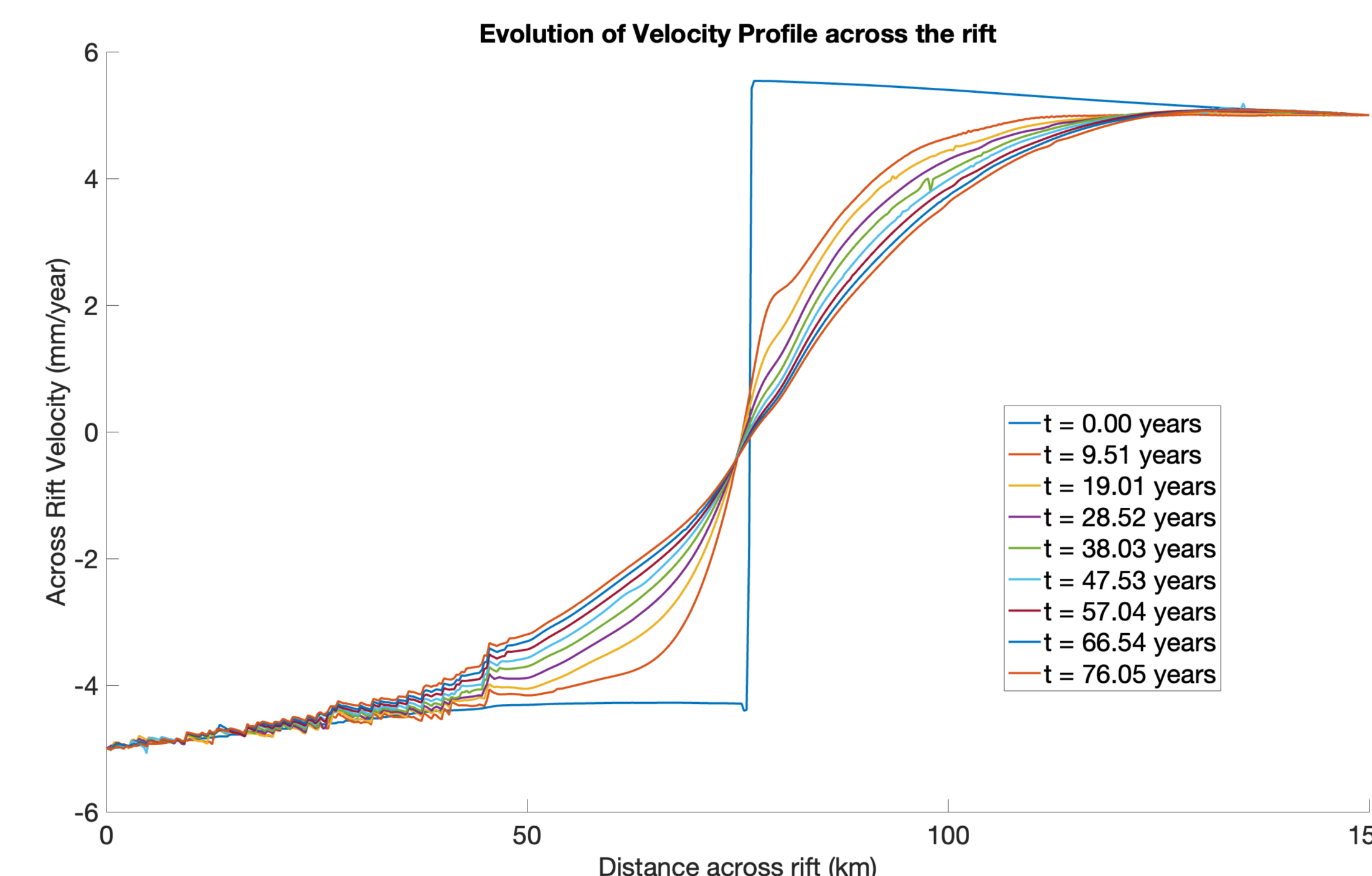


Plate divergence elastically raises ambient stress to yield point, localizing inter-event strain.



Velocity Profile Across Locked Fault



Next Steps:

- Usage of pseudo-transient numerical methods, where fundamental conservation equations are formulated in terms of strain increments rather than strain rate.
- Analyze the impact of the brittle layer thickness in the width of the stretching zone.

Take Home Messages

- The **width of the stretching zone** in the Natron Basin can be explained by the accumulation of heterogeneous **stresses due to past deformation**, particularly fault block bending, rather than by continuous slip on deep faults.
- A 2D thermo-mechanical model shows that even in the absence of deep fault slip, **localized deformation occurs due to pre-existing stress fields**, producing a sigmoidal velocity profile.
- This modeling challenges classic elastic back-slip interpretations and suggests that **long-term stress accumulation significantly controls short-term deformation** in magma-influenced continental rifts like the

Acknowledgement

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