The Making & Breaking of Cratons

C.M. Cooper
Washington State University

With input over the years from:

Louis Moresi - University of Melbourne
Adam Beall - Cardiff University
Meghan Miller - Australian National University
Rebecca Farrington - University of Melbourne
Adrian Lenardic - Rice University

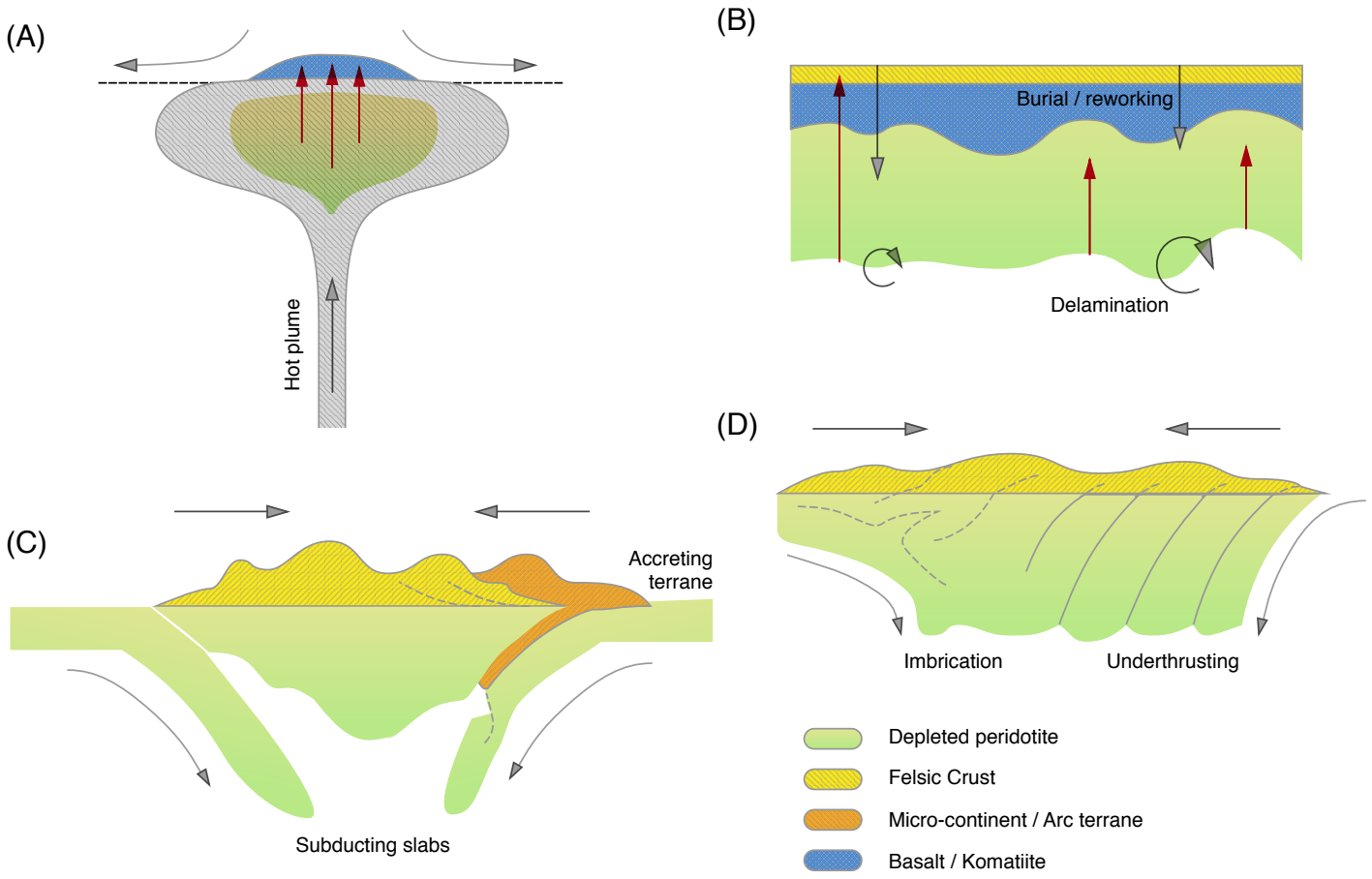
Key Points

- Understanding a craton's life history requires placing it in dynamical context.
- In other words, while composition and rheology matters, so do thickness and shape…
- …as well as timing!
- And maybe not all cratons are built to last?

Craton stability can be provided by:

- Buoyancy
- Viscosity
- Yield Strength
- Thickness
- Shape
- Proximity to weaker material
- Combination of the above

Formation Ideas

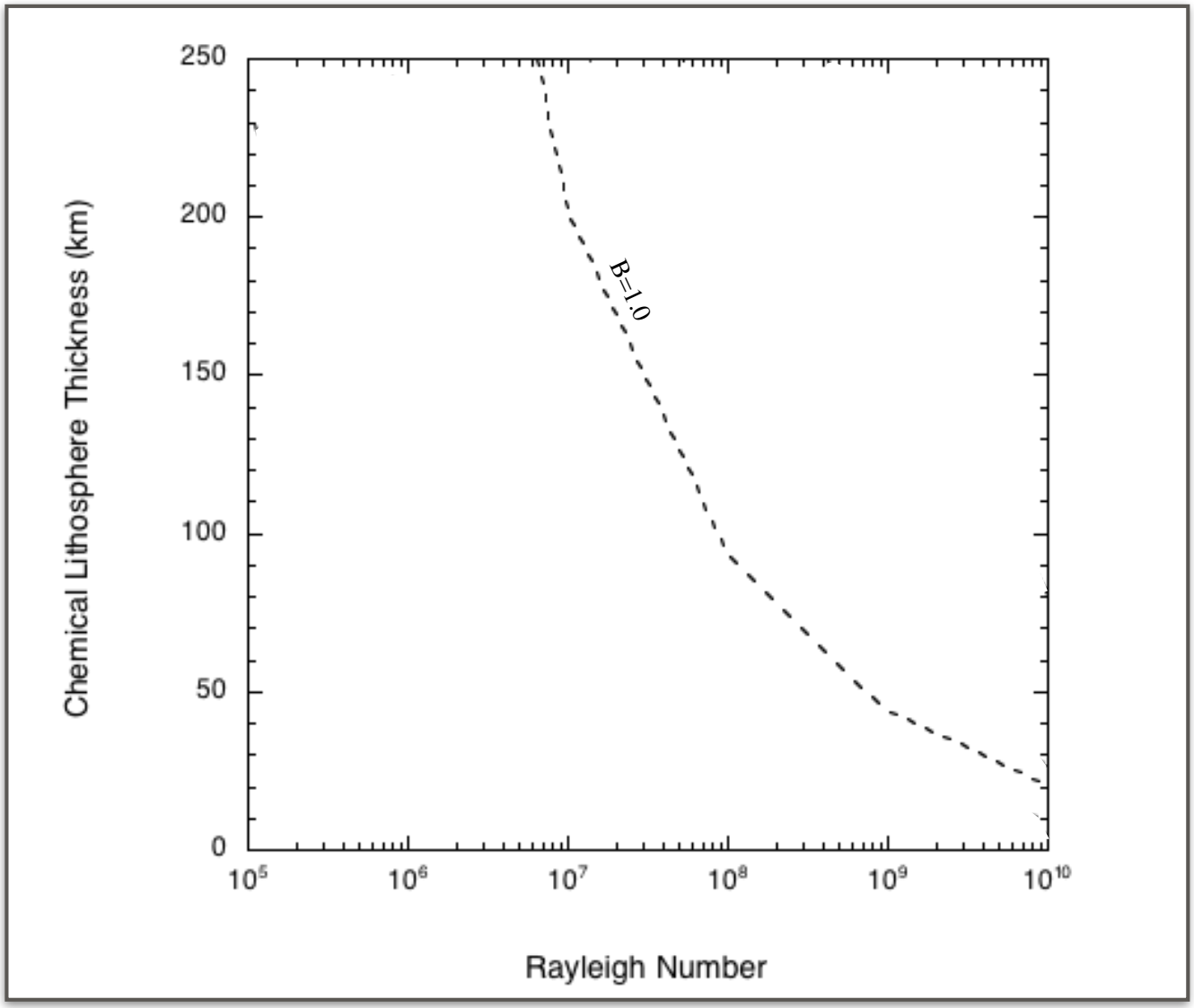


Cooper, Miller, & Moresi, 2017

Stability vs Longevity

Buoyancy Driven Stability

Chemical Buoyancy > Thermal Buoyancy



$$Bd > \omega_2 Ra^{-1/3}$$

$$B = \frac{\Delta\rho_{cbl}}{\rho_m \Delta T \alpha}$$

Above the curve = stability
Below the curve = deformation

Cooper et al., 2006

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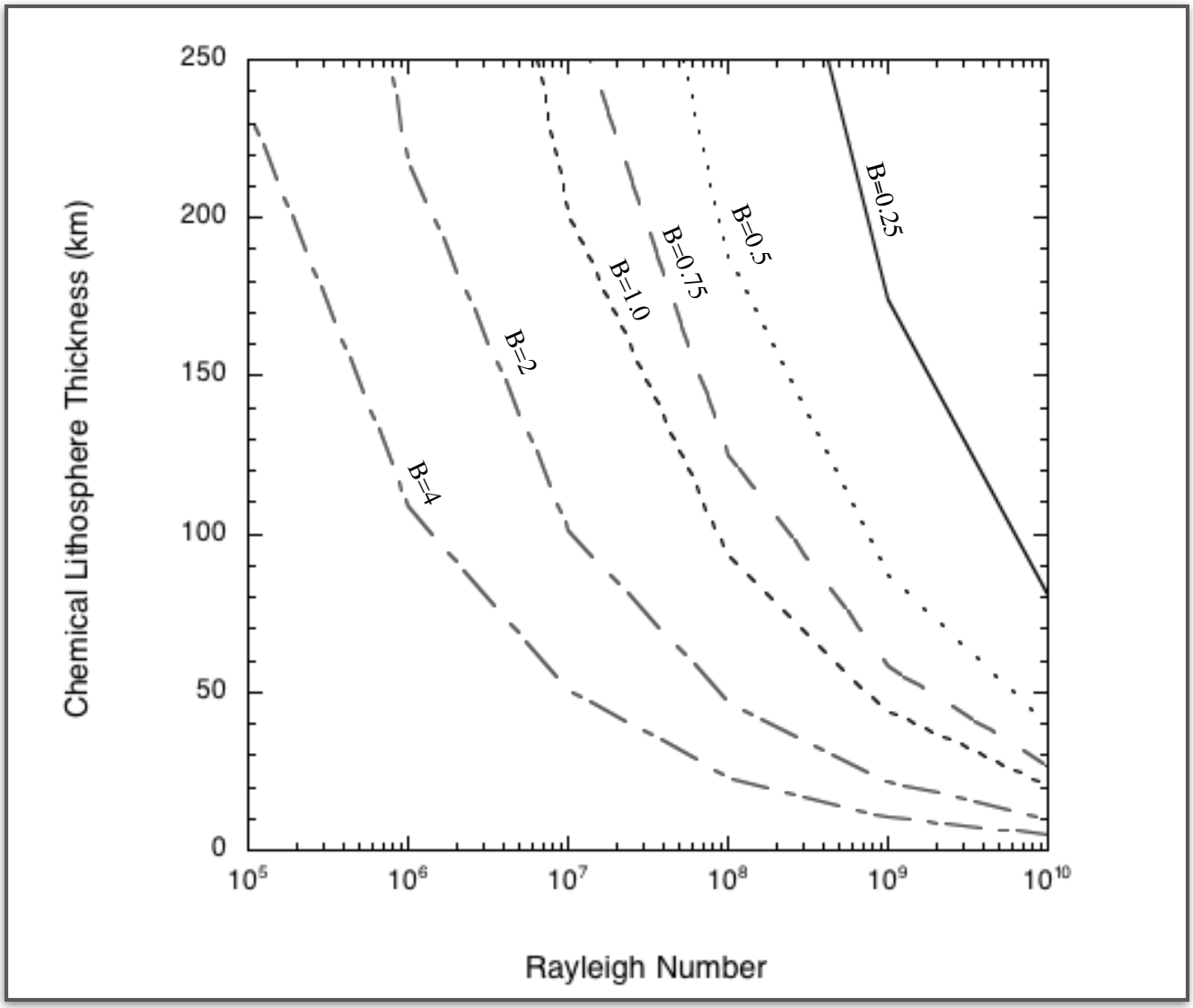

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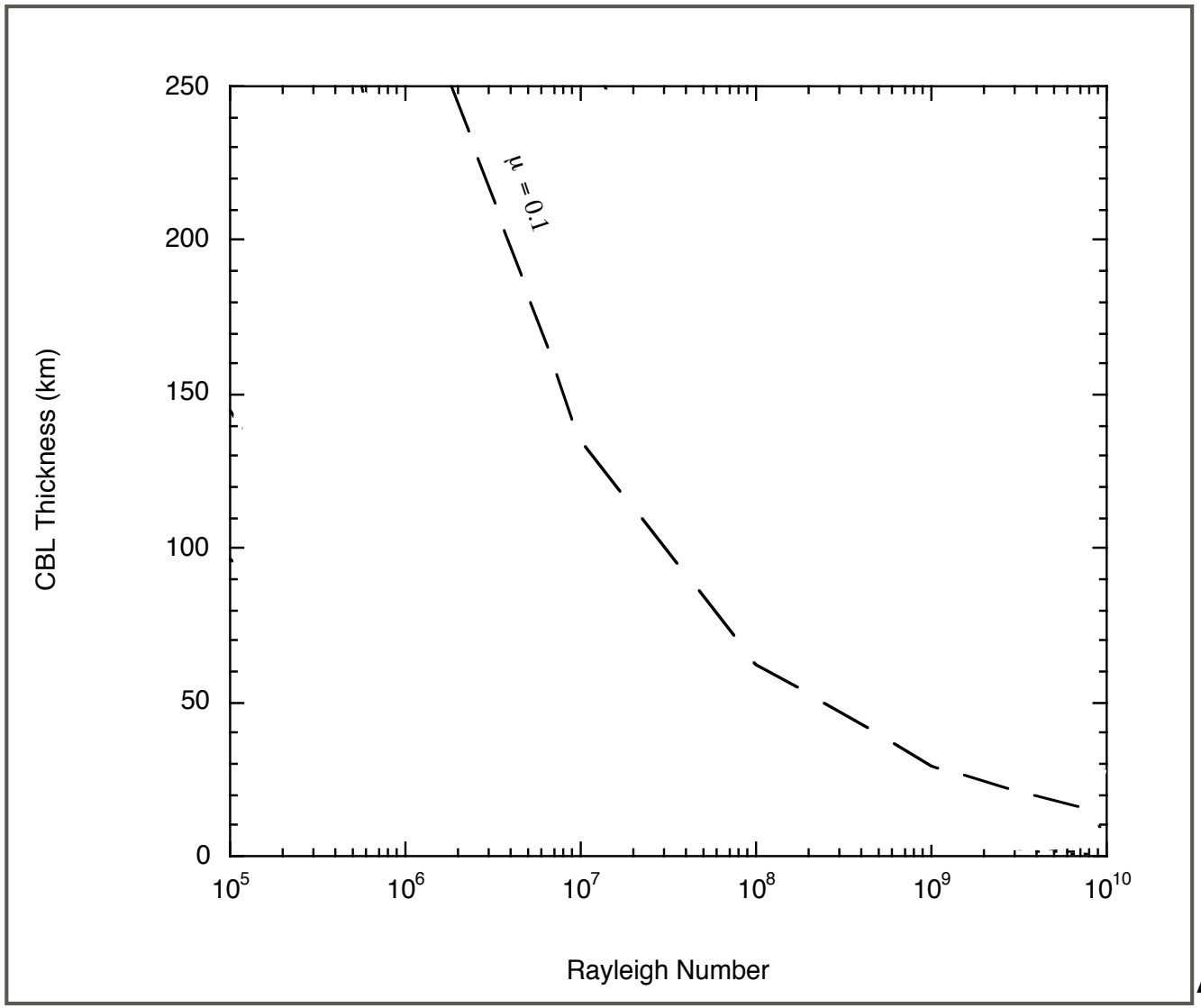
Yield Strength Driven Stability

Yield Stress > Convective Stresses



$$d\mu > \omega_1 Ra^{-1/3}$$

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Cooper et al., 2006

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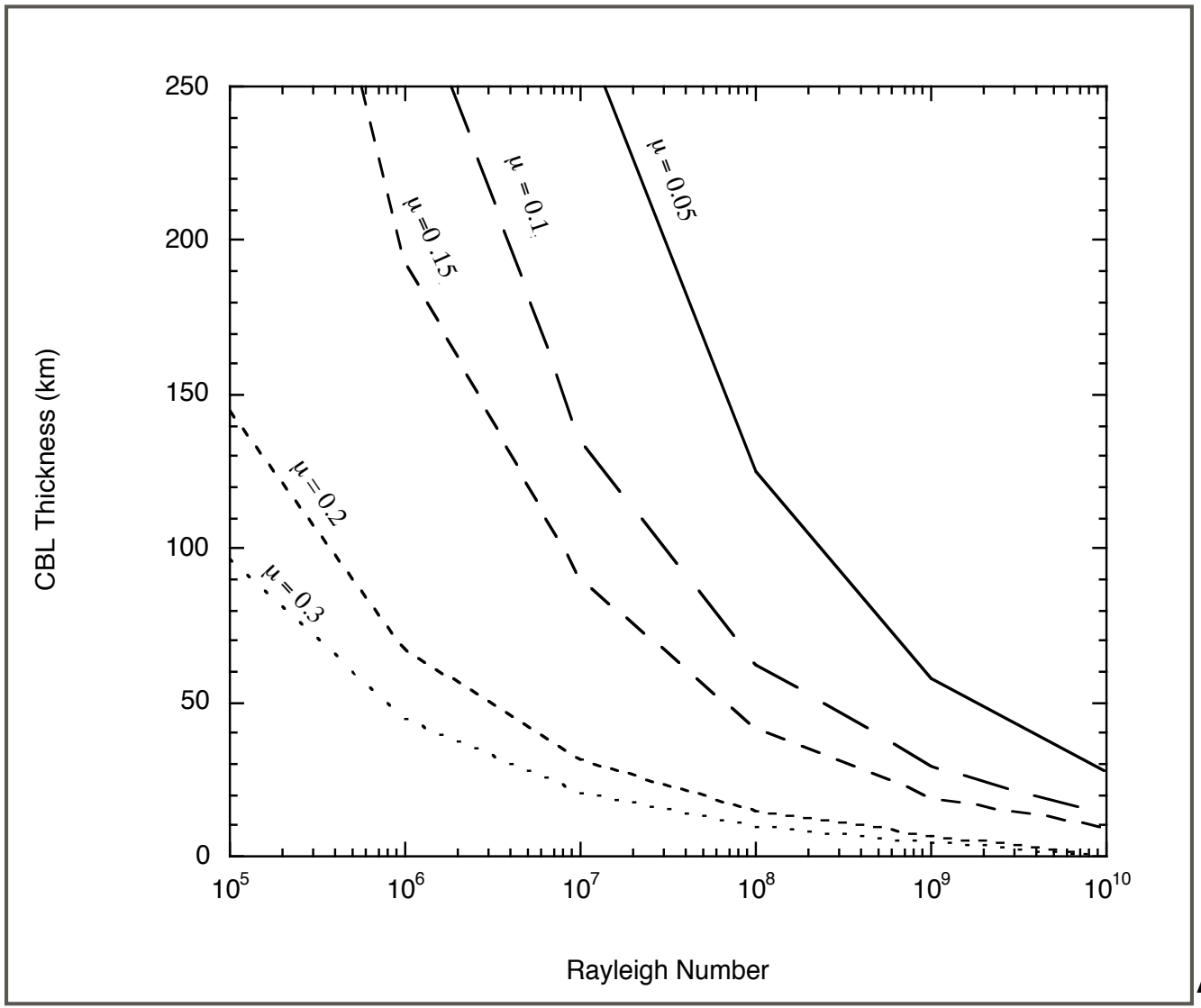
Yield Stress > Convective Stresses



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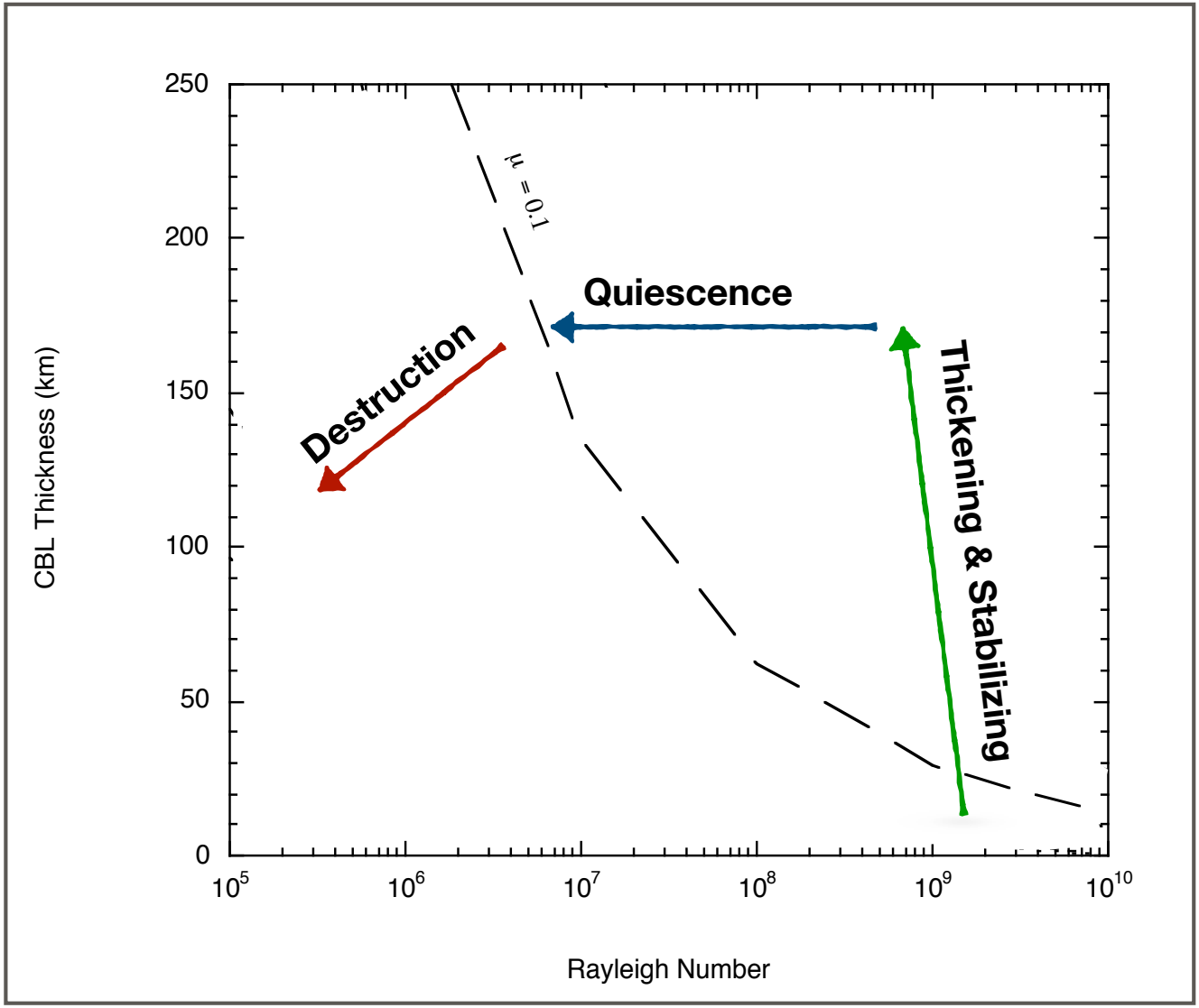
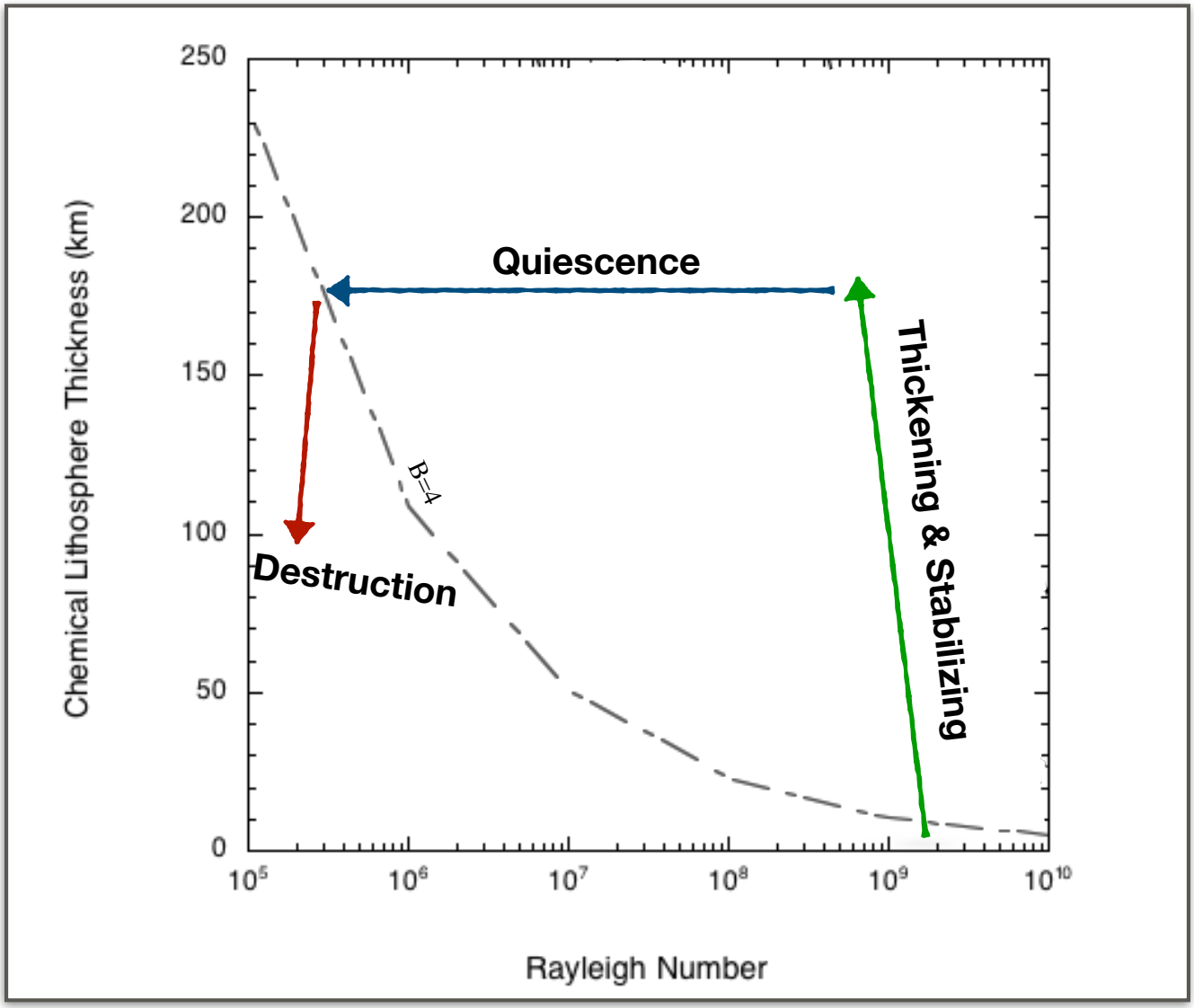
Cooper et al., 2006

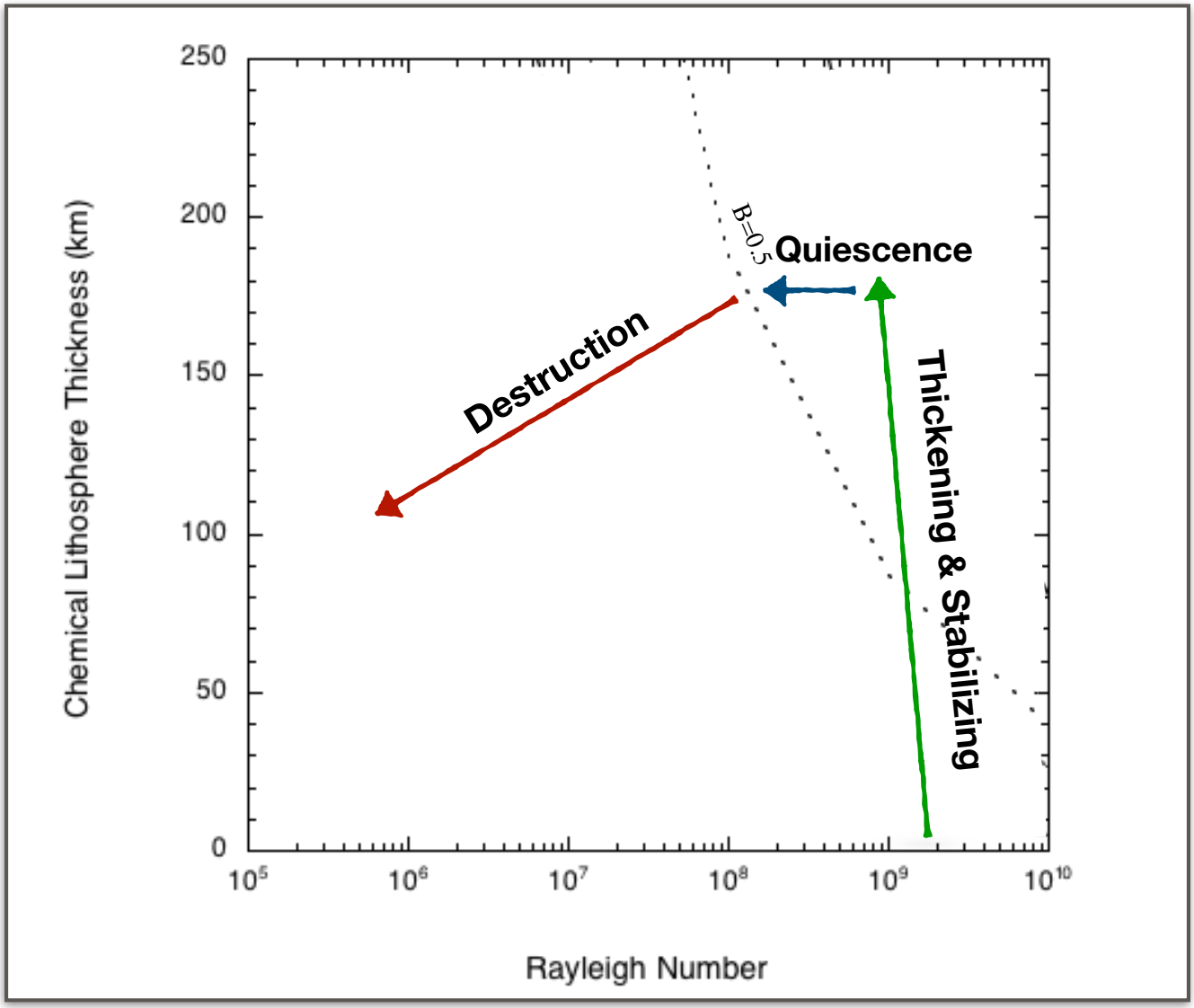
For a specific composition & rheology



For stronger, more buoyant material



For weaker & denser material (potentially modified?)

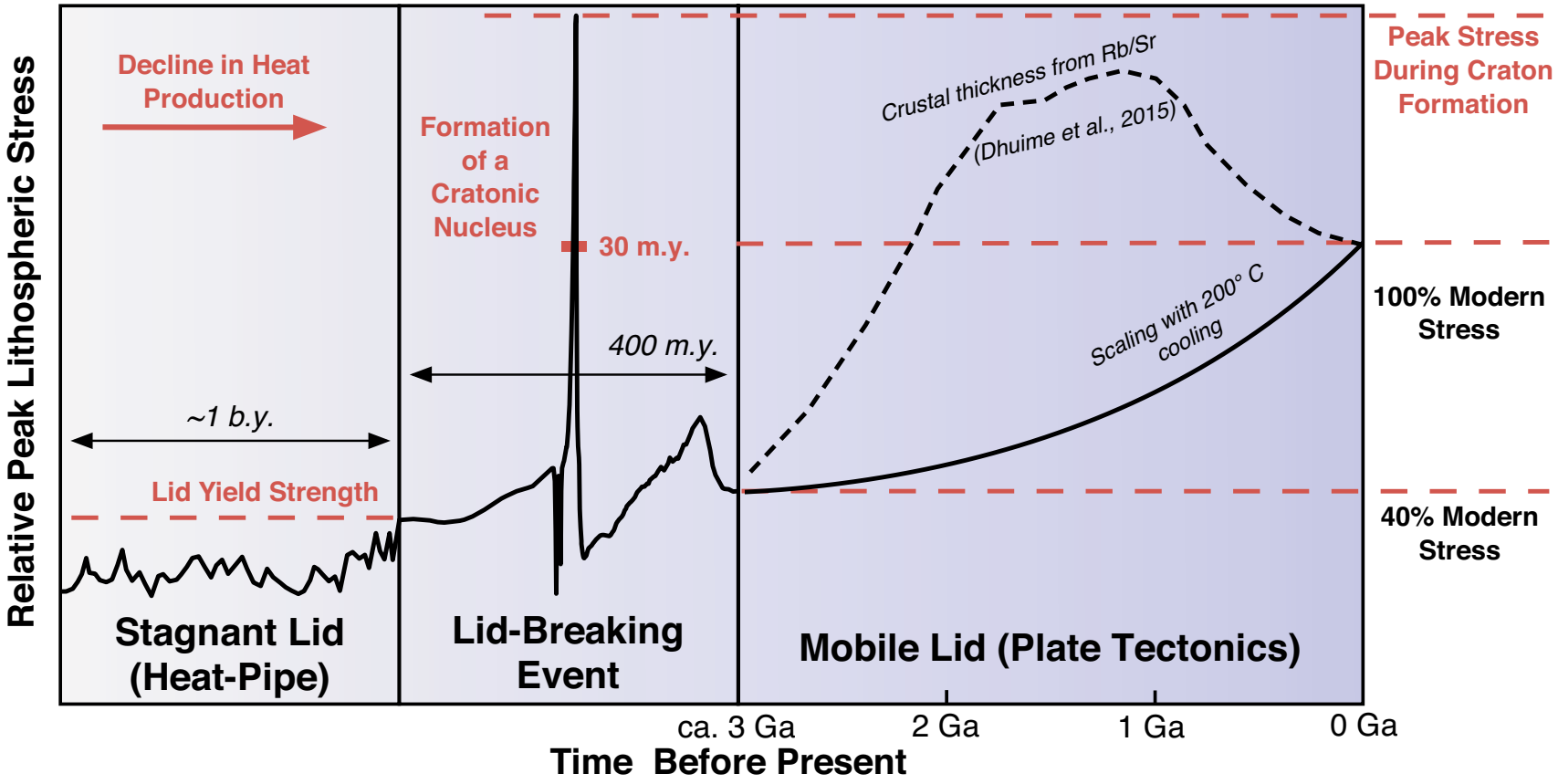


Stability vs Longevity

Mantle Conditions Change with Time…
…and so do Requirements for Stability

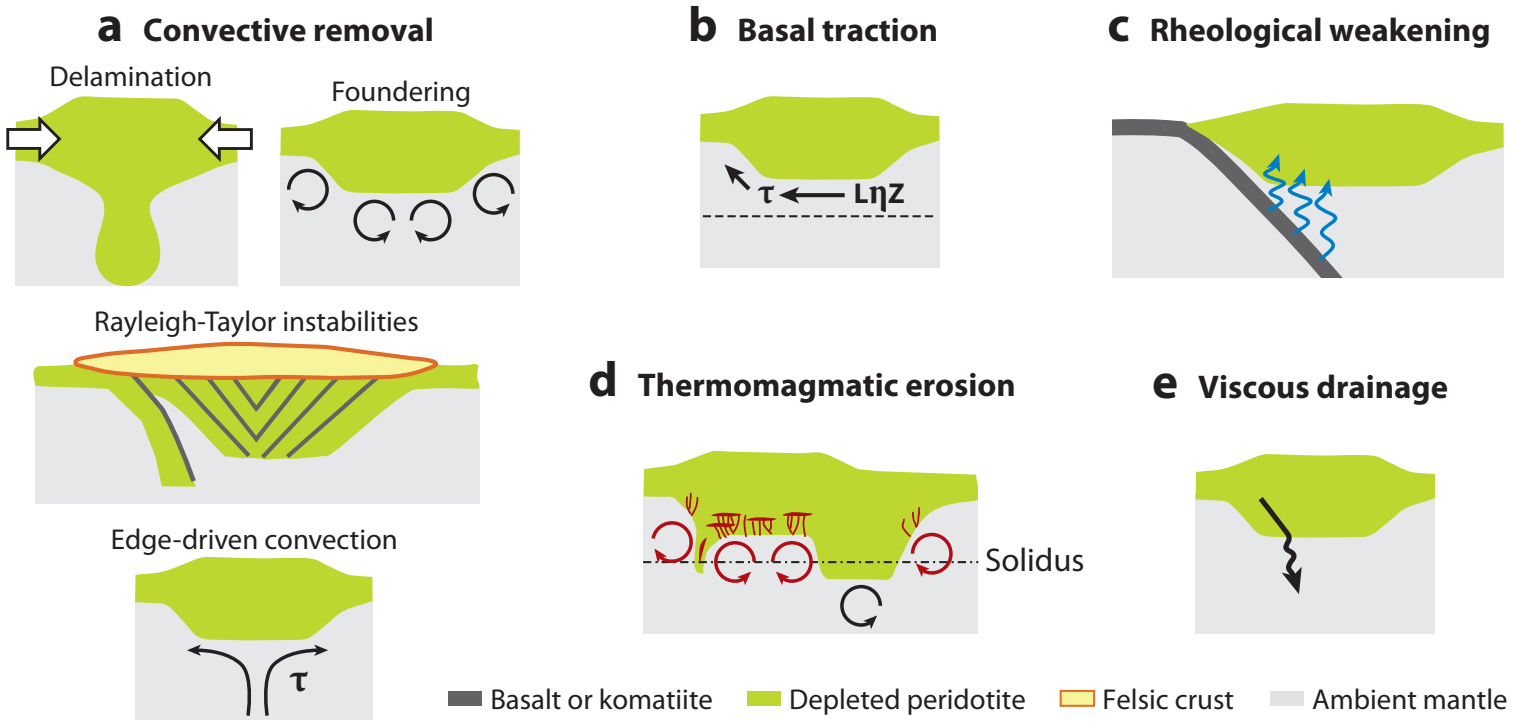
- Thicker lithosphere promotes stability and longevity
- Only the most buoyant and strongest lithosphere is long-lived
- Modification of material properties may put some cratons on different trajectories
- Past conditions do not promote formation of thick, strong, buoyant lithosphere (assuming plate tectonics style dynamics)

Maybe plate tectonics is/ isn't the key…



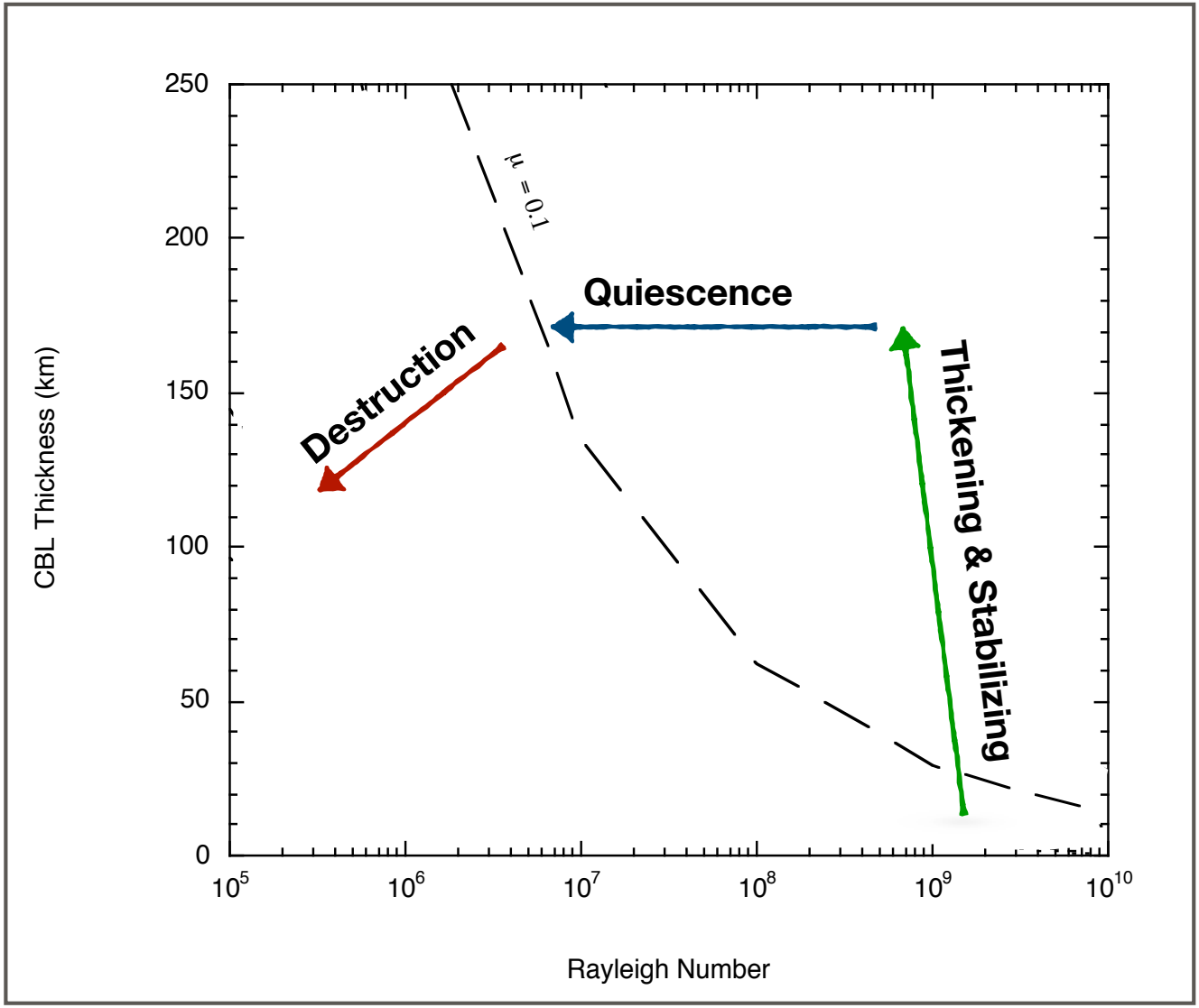
Beall, Moresi & Cooper, 2018

Flip Side…now to Destroy

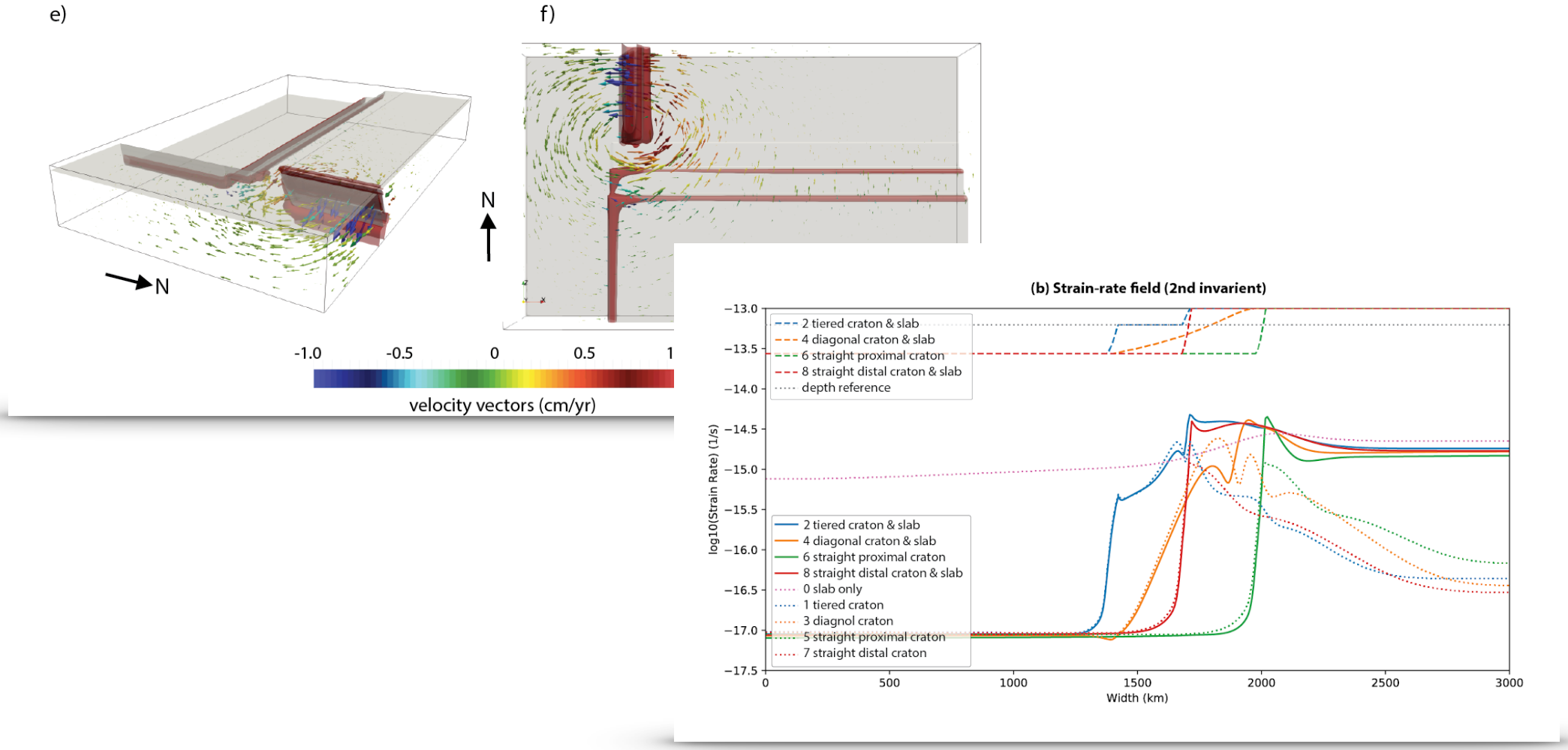


Lee et al., 2010

Not built to last? Weakened? Or just the normal course?



Erosion of Margins… runaway process?



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