SMOREs 2021
As Above So Below: A Simulation of the Continental Lithosphere and LLSVPs as Thermal Insulators using ASPECT

Dante Hickey, Reed College

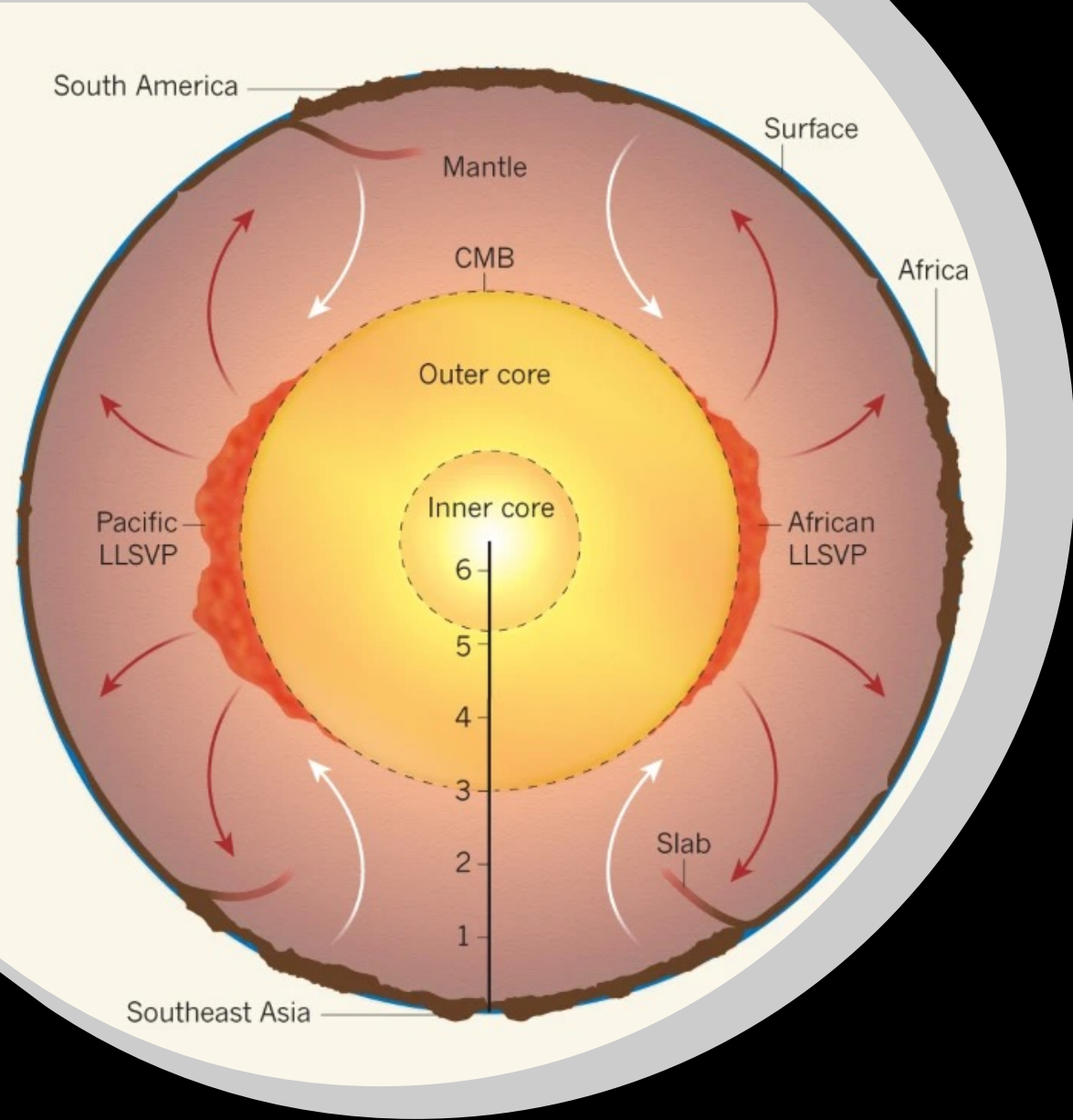Mentors: Catherine Cooper, WSU and Eric Mittelstaedt, University of Idaho

University of Idaho

WASHINGTON STATE UNIVERSITY

COMPUTATIONAL INFRASTRUCTURE for GEODYNAMICS

NSF

South America — Surface
Mantle
CMB — Africa
Outer core
Inner core
Pacific LLSVP — African LLSVP
6
5
4
3
2
1
Slab
Southeast Asia

Romanowicz, B. The buoyancy of Earth's deep mantle. *Nature* **551,** 308–309 (2017).
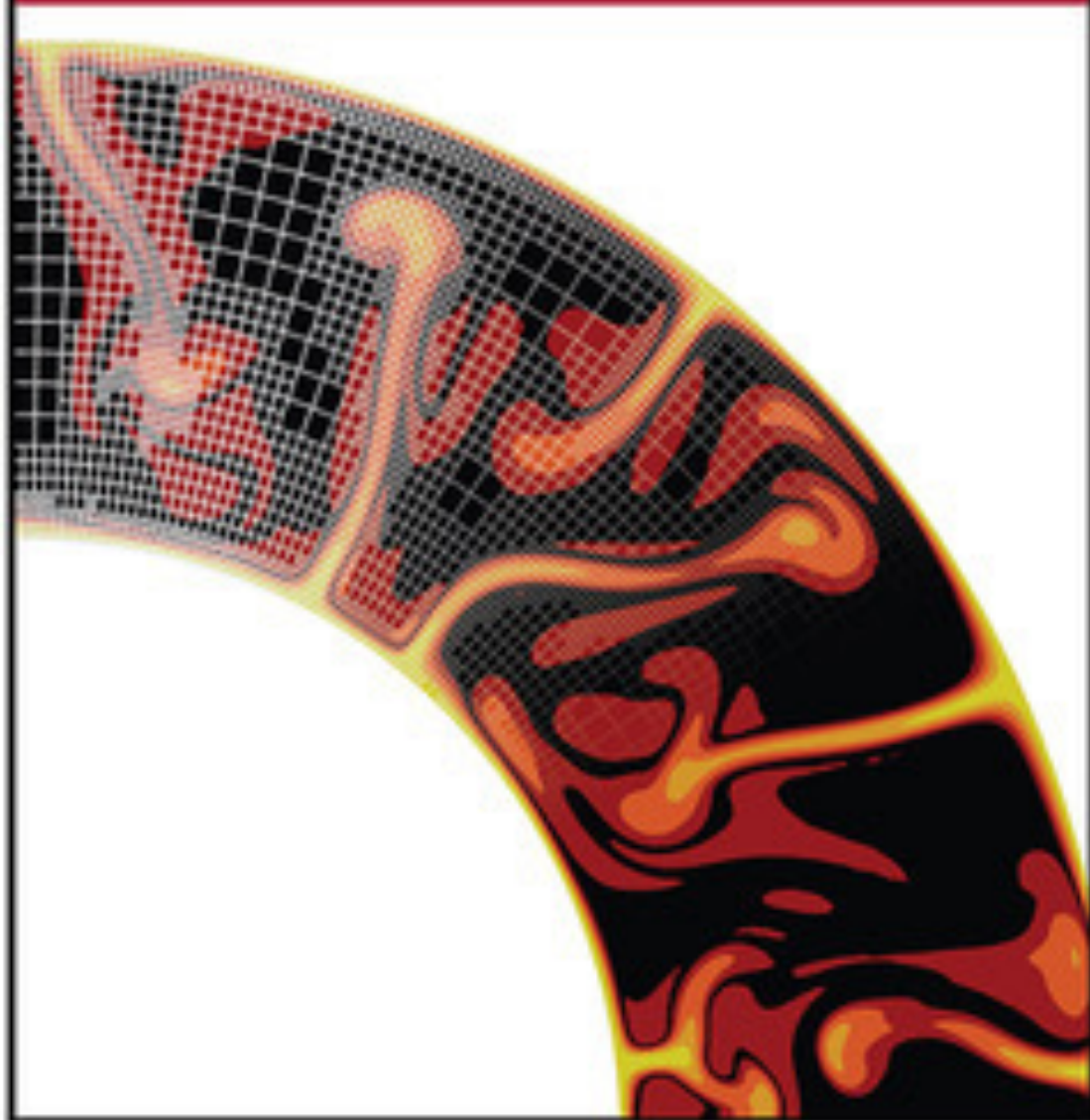
Background Information

- Heat Flux: Rate of Energy transfer, W/m^2
  - Important for cooling of Earth's core

- Large Low-Shear-Velocity-Provinces (LLSVPs)

- Continental Lithosphere and LLSVPs act as Thermal Insulators for Earth

Project Goal and Methods

- Interested in Earth's heat flux with these bodies present

- Models simulated using ASPECT (Advanced Solver for Problems in Earth's Convection)

- Programs ran on Stampede2 supercomputer cluster

Bangerth, W.; Dannberg, J.; Fraters, M.; Gassmoeller, R.; Glerum, A.; Heister, T.; Naliboff, J. (2021), ASPECT v2.4.0-pre, Zenodo, doi: 10.5281/zenodo.5131909

Model Properties

- Global refinement of 7
  - 196,608 Cells

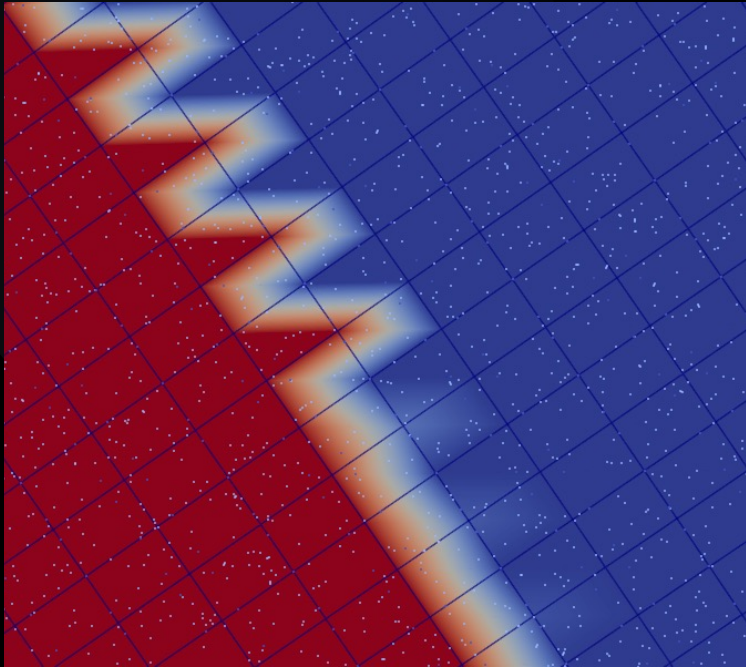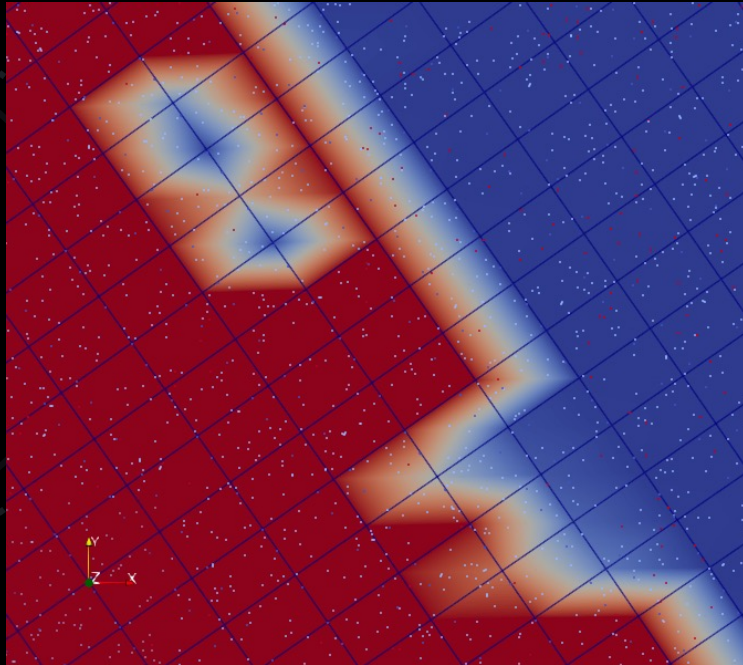| Field	Viscosity (Pa s)	Density (kg/m^3)	Thickness (km)
Background Mantle	1e21	3300	2490
Lithosphere	1e24	3200	200
LLSVPs	1e24	3400	200
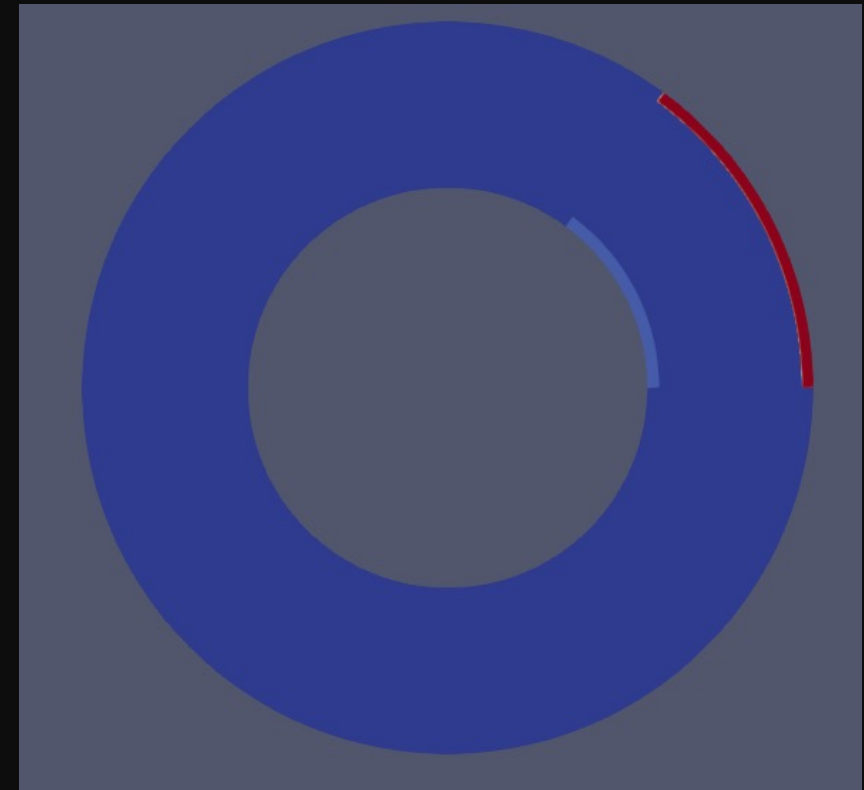
Deformation Issue
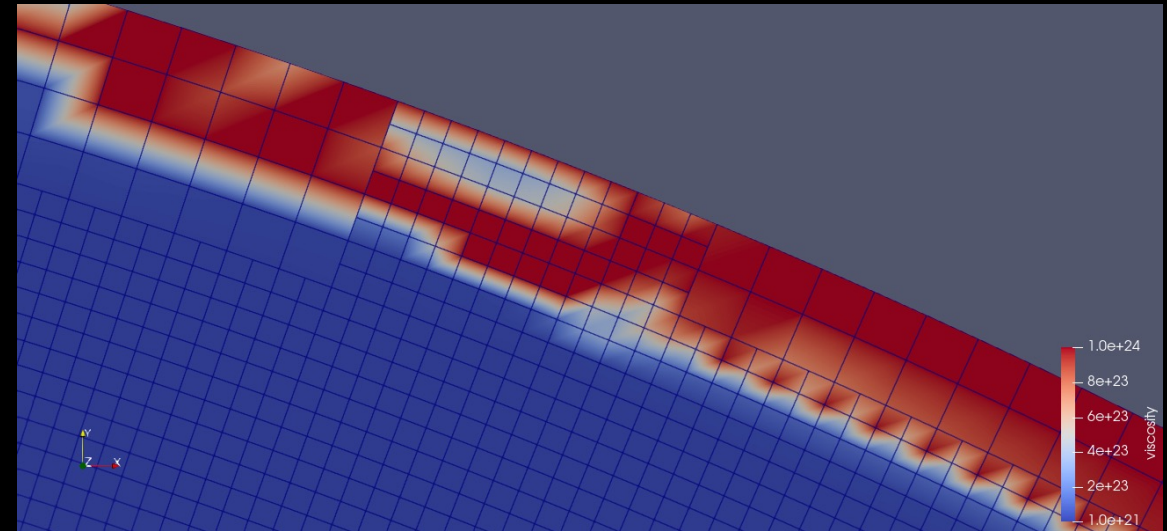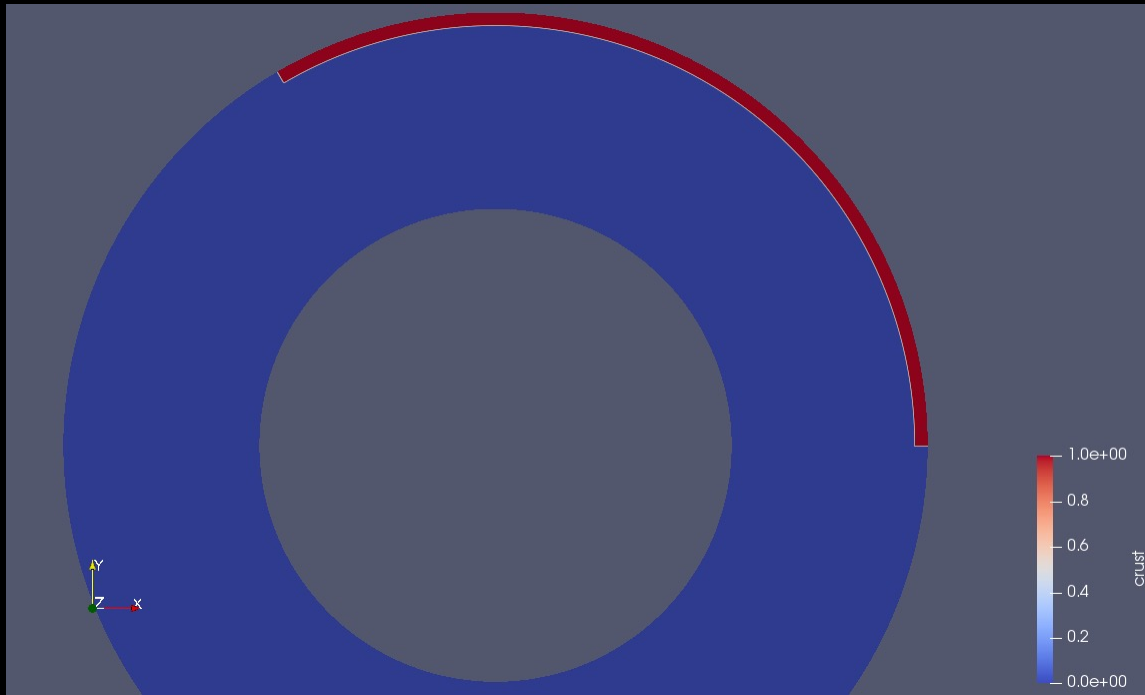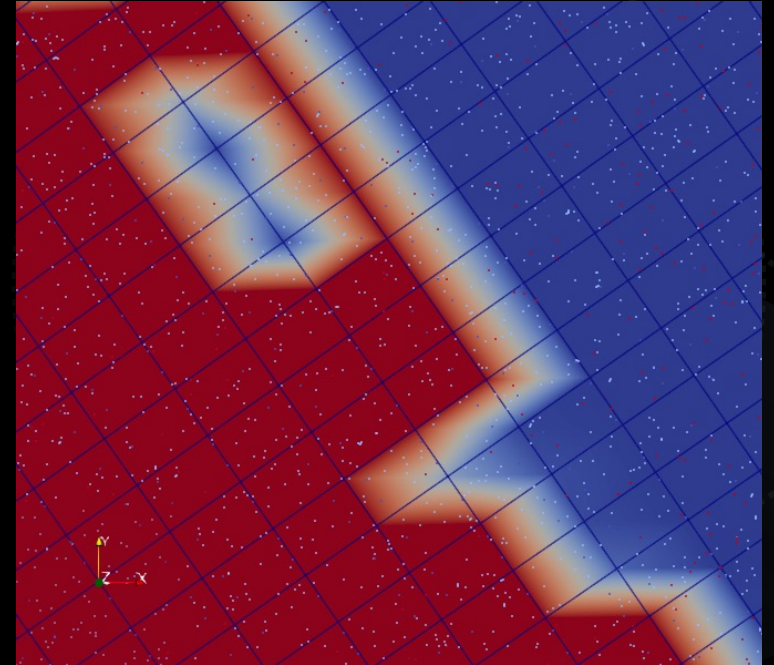
Particles

- ~80 particles per cell
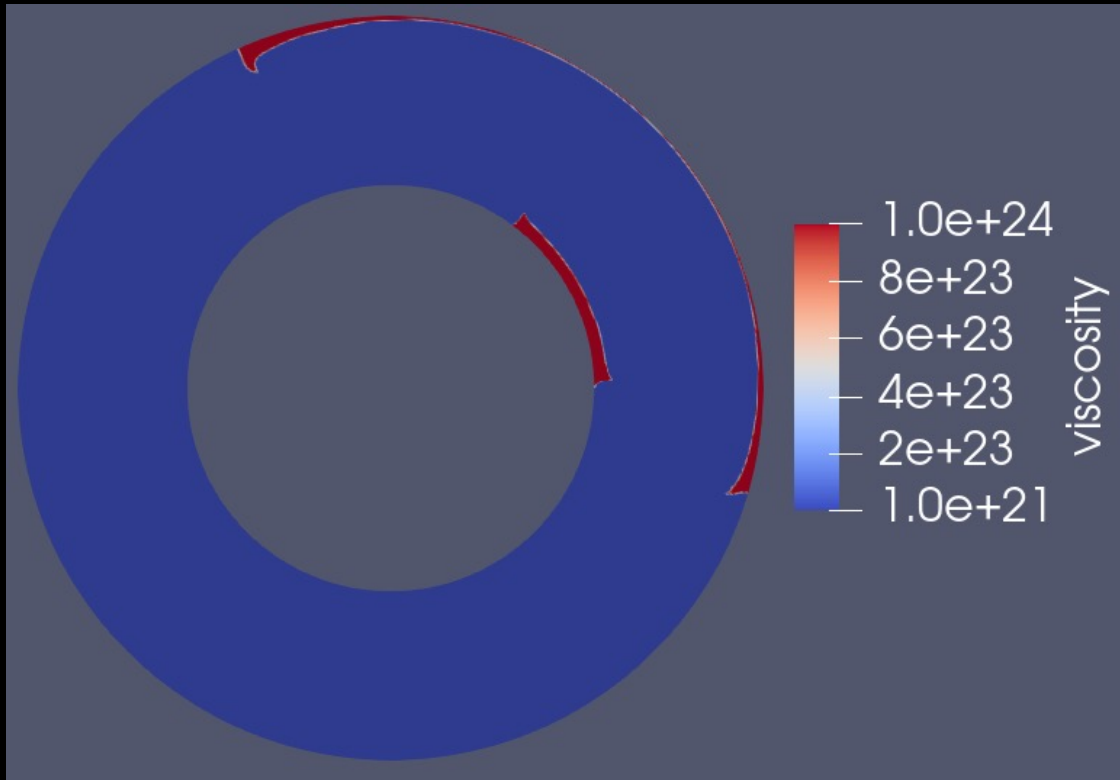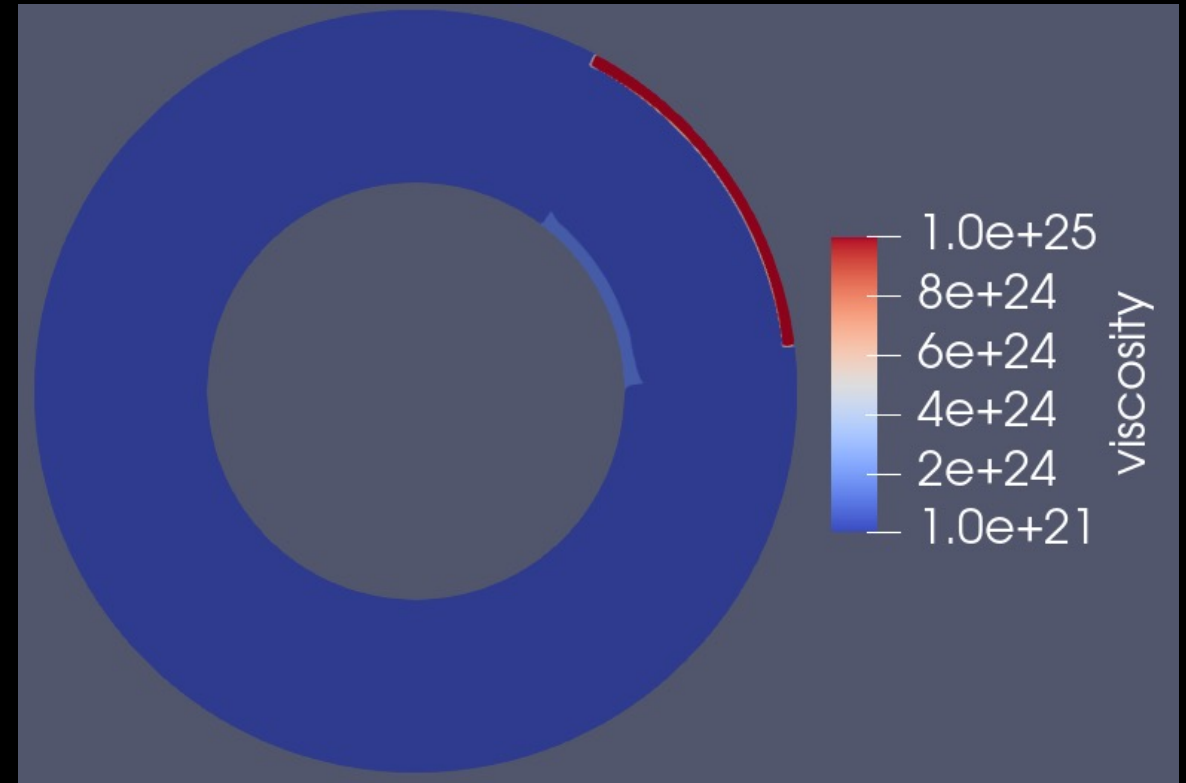- 16 Million total particles

t=1e6 yrs

t=2e6 yrs

t=3e6 yrs

Pancaking

- Lithosphere thinning and spreading
- High initial temperature pre steady state

- Increased Viscosity to 1e25 Pa s

Stay Tuned!

- Continuing project for my Senior Thesis at Reed College

REED
COLLEGE

Conclusion

Project extensions

- More realistic and complicated rheology
- Increased range of insulation
- Other Planetary bodies

Lessons learned

- How to build a model in ASPECT from the ground up
- How to navigate a remote cluster user the command line
- How to update and install software on a cluster
- How to perform data manipulation on ASPECT statistics
- How to view models in Paraview
- How to make movies from Paraview models
- How to troubleshoot on the CIG forum.

Acknowledgements

- My mentors Catherine Cooper and Eric Mittelstaedt

- The rest of the SMOREs mentors and mentees