THE EFFECTS OF LITHOSPHERE STRUCTURE ON MANTLE DYNAMICS THROUGH THE SUPERCONTINENT CYCLE

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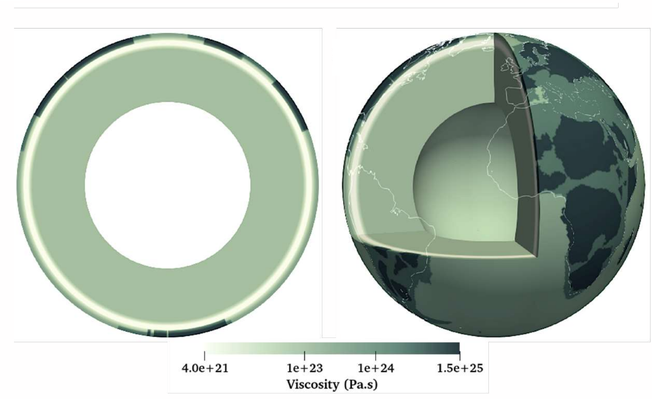
INTRODUCTION

- Supercontinents are one of the largest spatial & temporal processes on Earth
- Aim to investigate the effect of lithosphere structure throughout the supercontinent cycle
- We explore the interactions between slabs & plumes beneath supercontinent with different continental viscosities & thicknesses
- Find that structure during assembly can affect dynamics through to breakup

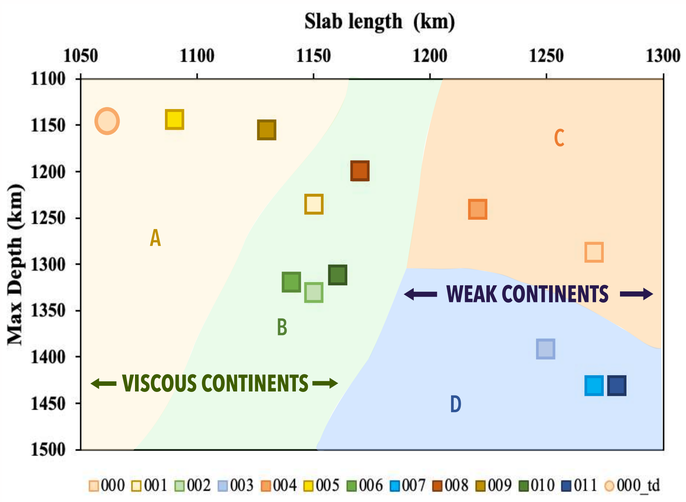
METHODS

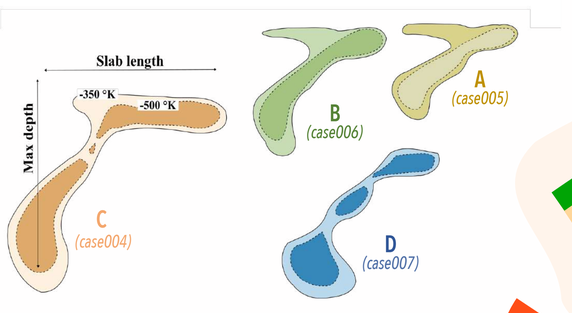
- Use 3D mantle circulation code, TERRA [1][2][3], to simulate supercontinent cycle from 460 Ma - present
- Apply plate motion history [4], with parameter to define continents & cratons
- Vary thickness of lithosphere between 90-270 km, & viscosity between 10^{23}-10^{26} Pa s

Scan QR code for more information & parameter space



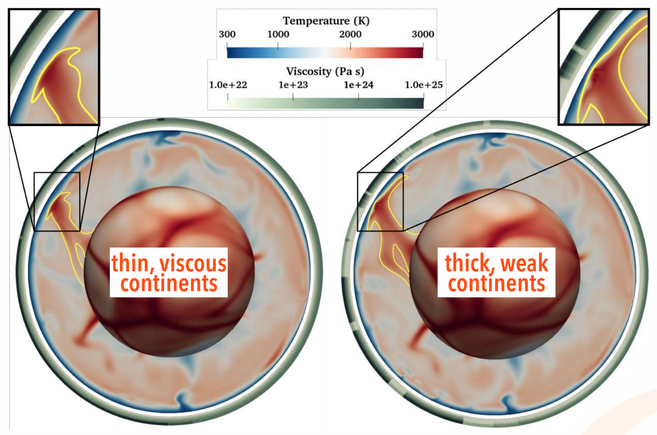
1 SLAB TRAJECTORY





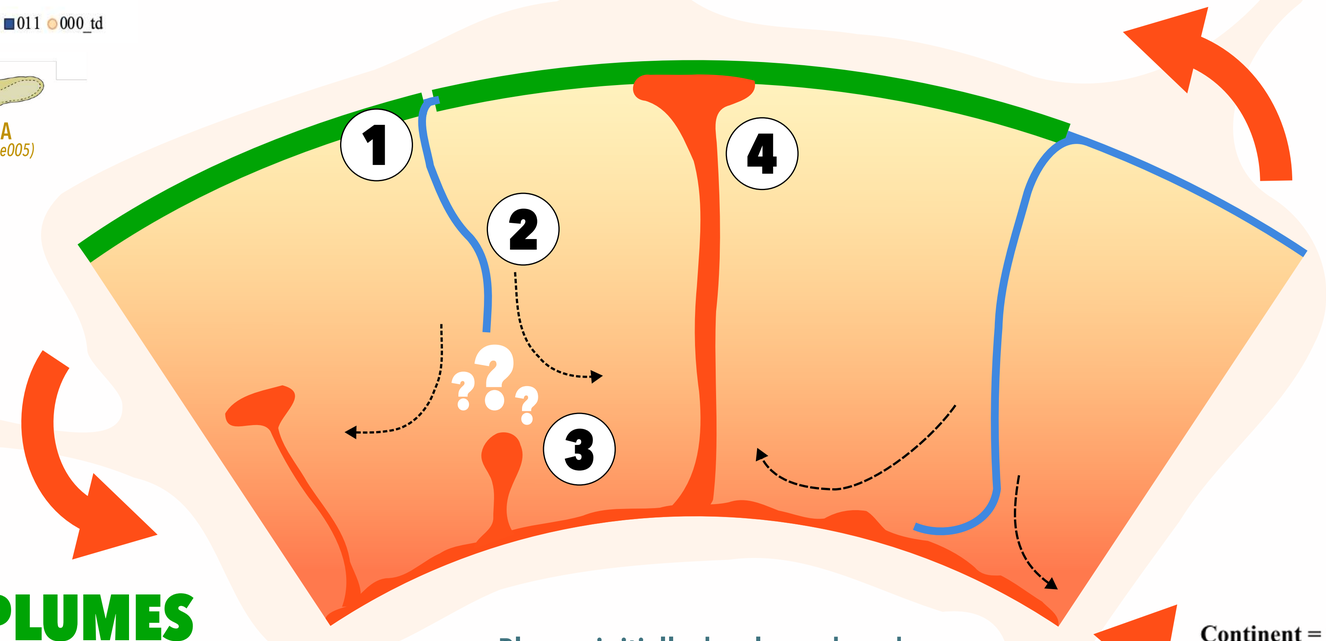
- Lithosphere structure affects slab dip
- Rigidity of viscous supercontinent forces slab downwards
- If continent is as viscous, or less viscous than oceanic lithosphere, slab migrates laterally until buoyant enough to sink further

4 LITHOSPHERE THINNING BY PLUMES



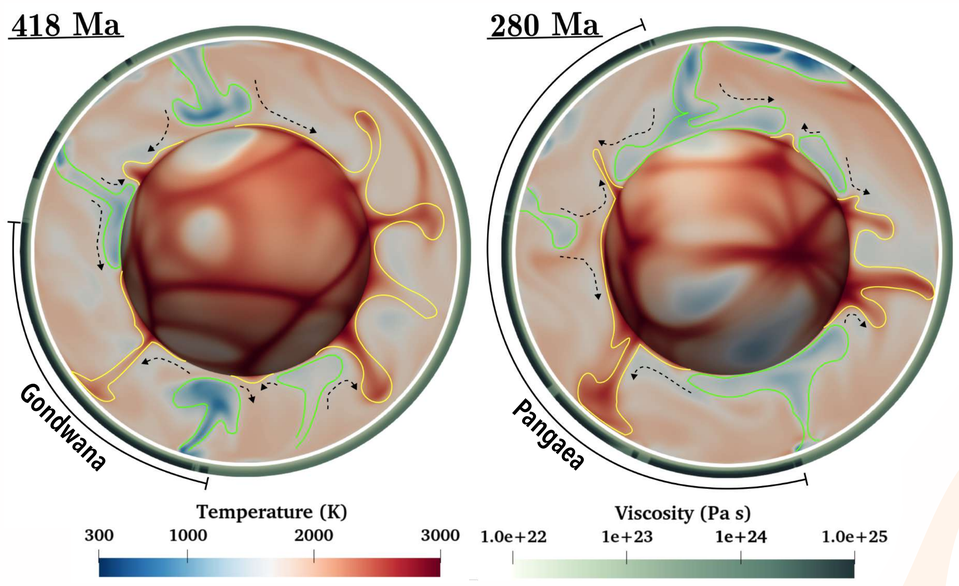
- When plumes are not dampened out in our models, they coalesce beneath supercontinent
- Larger plumes (associated with weak continents) thin the lithosphere, even when continents are very thick
- May relate to increased role of plume push in breaking supercontients

3 PROXIMITY OF SLABS & PLUMES

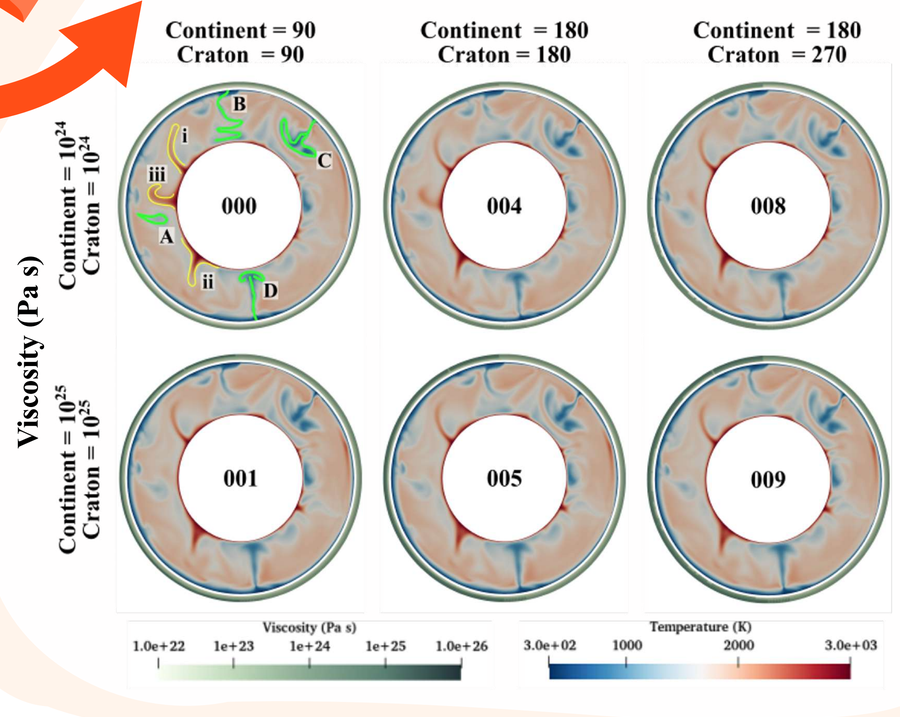


- Slab A and plume iii may interact beneath the supercontinent, depending on slab trajectory
- When slab is directly above evolving plume, signature of plume is dampened out
- When slab is adjacent to plume, plume is swept laterally near CMB
- Thick, viscous continents promote plume dampening in these models

2 SLAB RETURN FLOW SHAPING PLUMES



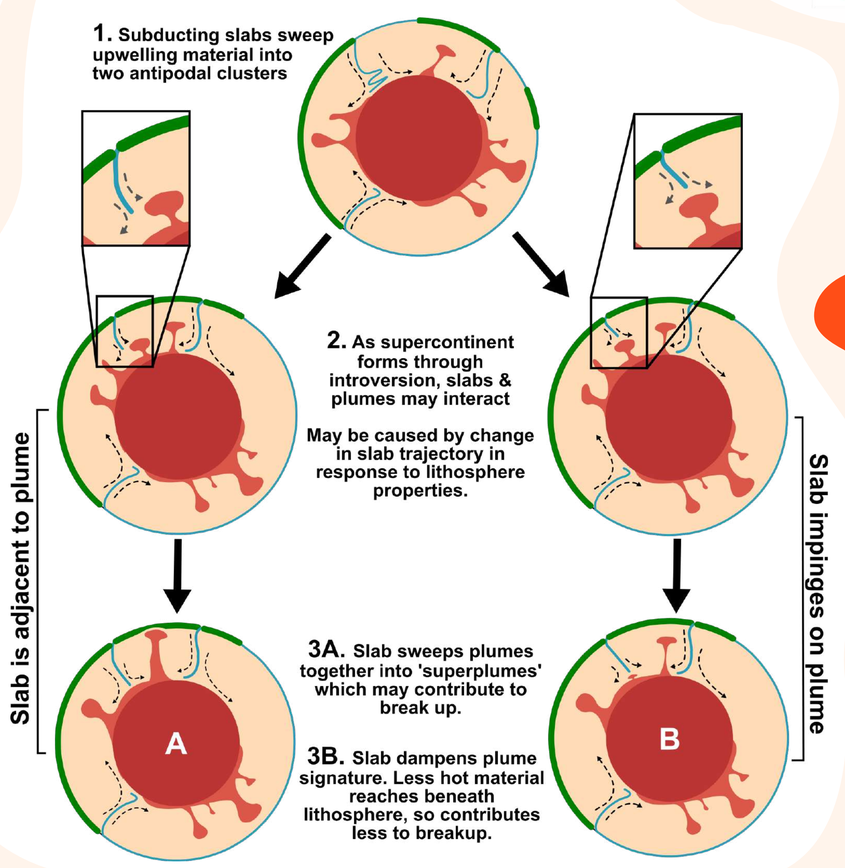
- Plumes initially develop as broad upwellings near CMB
- Slab return flow sweeps upwelling material towards one locus, become plumes
- Circum-continental subduction sweeps upwellings beneath supercontinent
- Antipodal plume clusters develop beneath large continent and ocean



DISCUSSION

- Models demonstrate close relationship between lithosphere structure and mantle dynamics
- Effects of continental thickness and viscosity can be observed in the mantle from assembly through to breakup of supercontinent
- Viscosity and thickness affect slab dip which, in this suite of simulations, determines the proximity of slabs and plumes beneath supercontinent interior
- Interaction of slabs and plumes may determine magnitude of plume near the surface

CONCLUSIONS



ACKNOWLEGEMENTS

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