Mobile or not mobile: exploring the linkage between deep mantle composition and early Earth surface mobility

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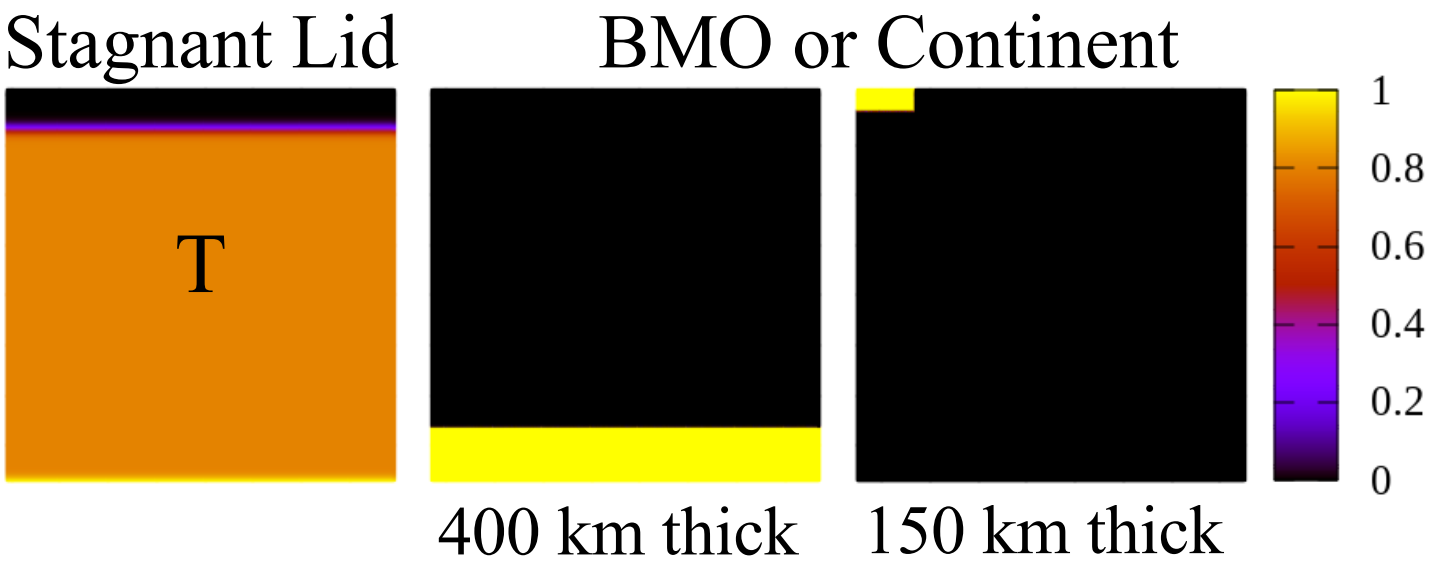
Initial Conditions

- Isothermal, free-slip top/bottom with reflecting sidewalls
- Run forward for approximately 2 Gyr (t=0.01)

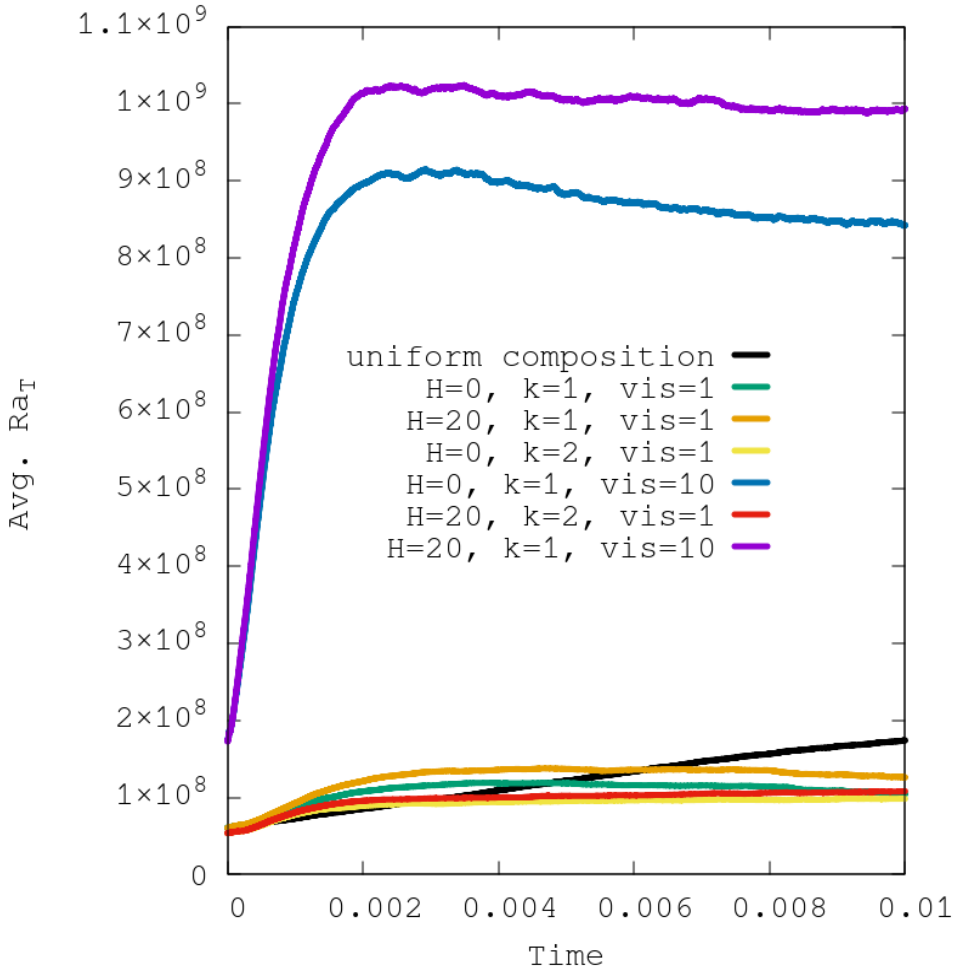


Vary parameters in basal magma ocean

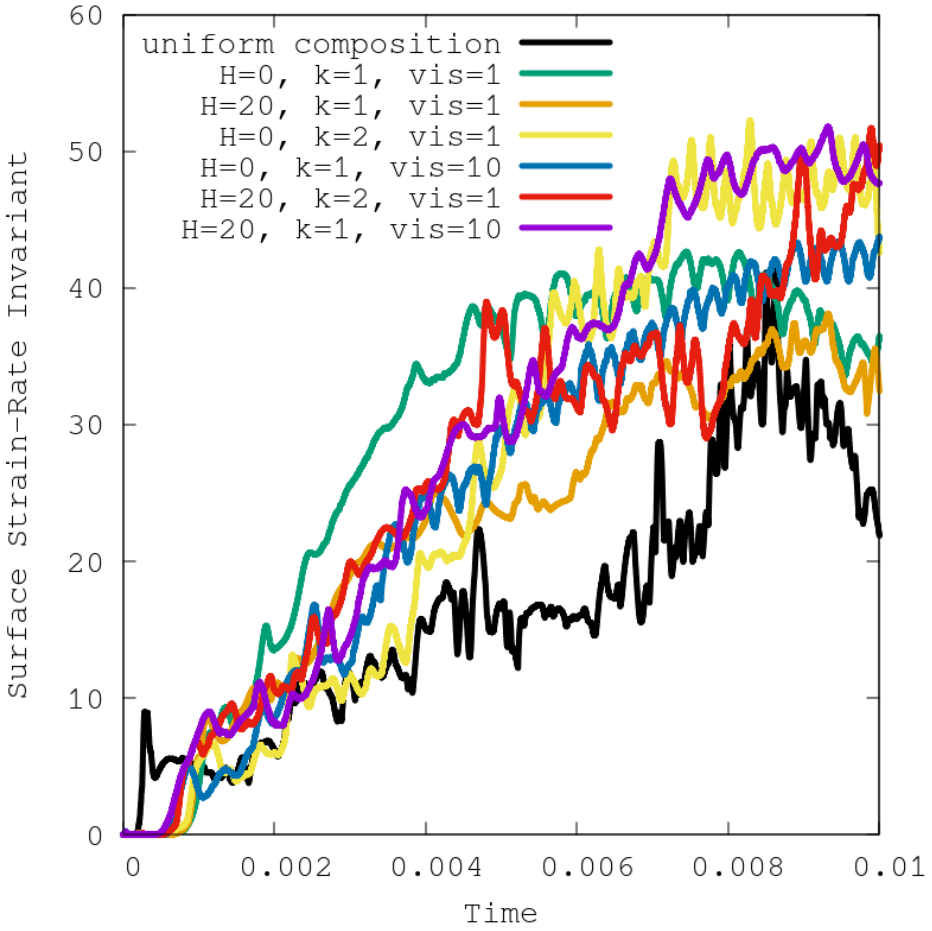
- $Ra_T=2x10^3$ and $\Delta\eta_T=10^6$ (with $\tau_{yield}=\infty$ and $\eta^*=10\text{-}6$)
- Primordial layer may contain a high concentration of radiogenic element, patches of low viscosity melt or metals
- Primordial layer has one of the following:
  - Increased internal heating (H=20)
  - Decreased viscosity ($\Delta\eta_C=10$)
  - Increased conductivity (k=2)
- The Earth's mantle was hotter in the past
- Low viscosity gives rise to a high mean Ra_T
- Model mean Ra_T ranges between 10^8 - 10^9

Convective Vigor

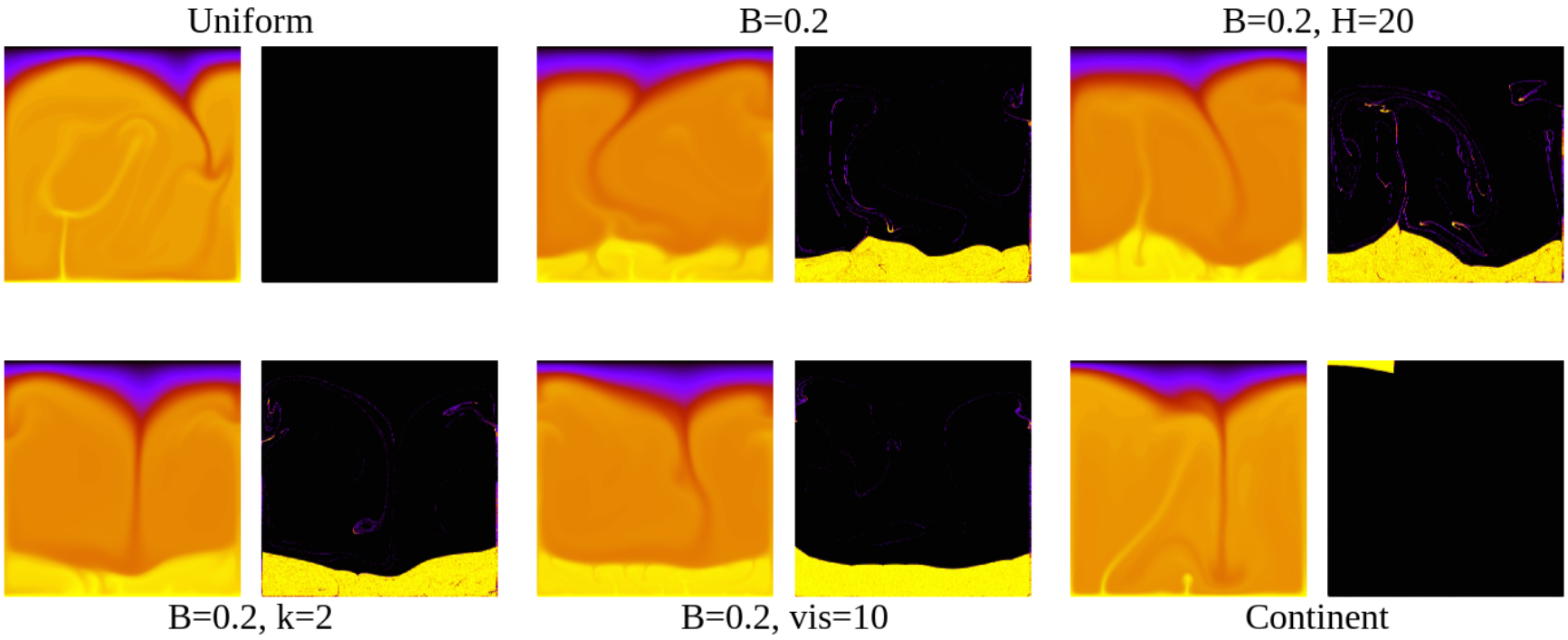
- Model mean Ra_T ranges between 10^8 - 10^9
- Our models have high Rayleigh numbers (convective vigor)
- Early Earth should be hotte and thus more convective (ie higher Ra)



Potential for surface yielding

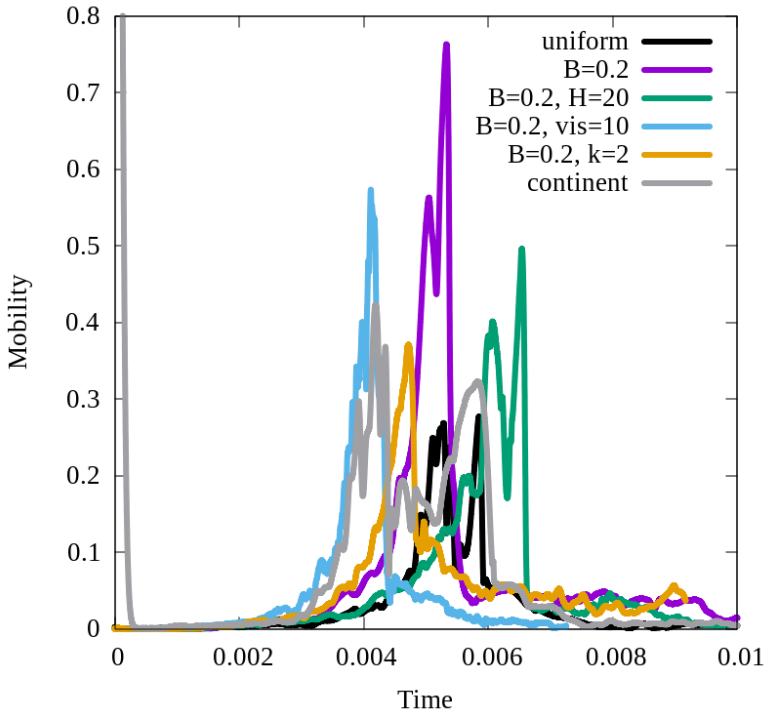


Non-Newtonian rheology



Potential for surface yielding – non-newtonian

- Episodic-lid convection
- Compositional features increase peak lithosphere mobility
- Onset time of lithosphere mobility affected by primordial composition



Conclusions

- Primordial composition affects the onset time of surface mobility in the early Earth
- Surface mobility increases in the presence a primordial layer or continent

Future work:

Can a primordial composition be found such that long-term surface mobility, indicative of plate tectonics, is maintained?