Numerical models of lower crustal flow explain Yellowstone’s "tectonic parabola".
Anders et al. 1989
Proposed origins of the tectonic parabola

- Tectonic deformation
- Plume flattening
- Crustal flow

(Map topo: GMRT)
Proposed origins of the tectonic parabola

- Tectonic deformation
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Proposed origins of the tectonic parabola

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Hawaiian Plume Model
U = 8.6 cm/yr. Buoyancy Flux = 4.1 Mg/s

Ribe & Christensen, 1994

Humphreys et al. 2000
Fig. 13. Inferred crustal model across the eastern Snake River Plain. The datum for the crustal model is 1.2-km elevation. Interfaces are dashed where no seismic control.

Moho depth

Sparlin et al. 1982

Gao et al. 2011
McQuarrie & Rodgers, 1998
(Map topo: GMRT)

(Darold & Humphreys, 2013)
Wallowa Mtns.

Foundering blob.
Crustal anisotropy (ambient noise)

(A) Crustal fast-axis & Mantle $V_p$ [%]

(B) Fast-axis intersection density

(Castellanos et al. 2020)
Mantle anisotropy (SKS Splits)

(Niday & Humphreys, 2020)
McQuarrie & Rodgers, 1998
Phil Schoettle-Green
Following Wegmann et al., 2007
(Perry-Houts & Humphreys, In review)
\[ \eta \nabla^2 \vec{U} - \frac{2\eta}{h^2} \vec{U} + (\rho_m - \rho_c) g \nabla (w - 2h) = 0 \]

\[ \dot{h} = -\frac{2}{3} h (\nabla \cdot \vec{U}) \]
A) Load, Velocity, Thickening, and Topography

B) Topographic divide

Uplift (mm/yr):
- <0.001
- 0.01
- 0.1
- 1.0

Migration (mm/yr)

\( h_0 \) (m)

\( \eta_0 \) (Pa.s)
Active reorganization at major divide breach
Relief differences across drainage divides
\[ \eta \nabla^2 \vec{U} - \frac{2 \eta}{h^2} \vec{U} + (\rho_m - \rho_c) g \nabla (w - 2h) = 0 \]

\[ \dot{h} = -\frac{2}{3} h \left( \nabla \cdot \vec{U} \right) \]

\[ D \nabla^4 w + \rho_m g w + 2(\rho_c - \rho_m) g h = -\sigma \]

\[ D = \frac{E T_e^3}{12(1 - v^2)} \]

(Perry-Houts & Humphreys, In review)
Swath Across Numerical Model

- Low elevations near basalt sill
- Mountains elevations decreasing to the north

Swath from Idaho Falls, ID to Thopson Falls, MT

- Mountains elevations decreasing to the north

Nate Mitchell
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