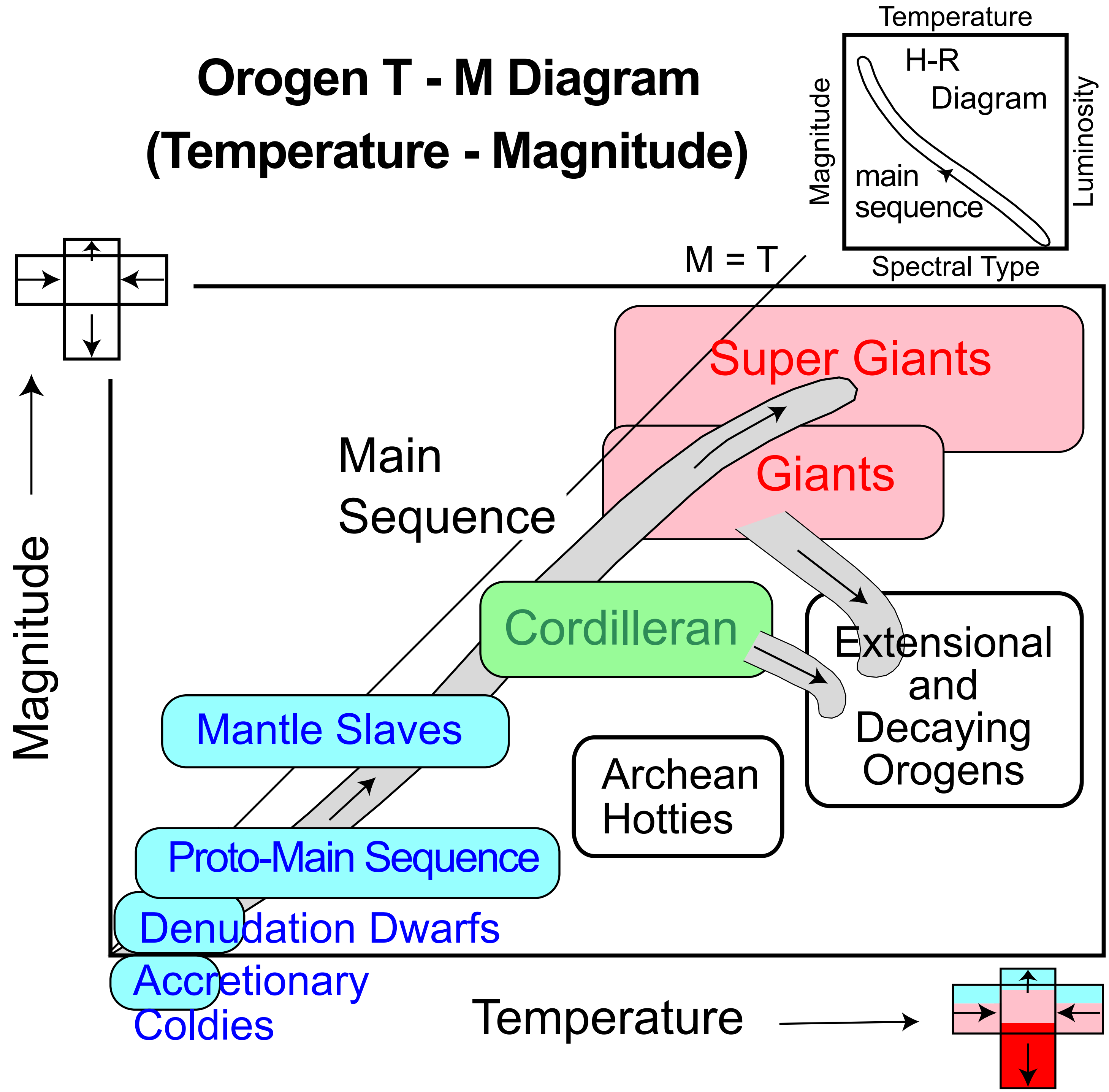
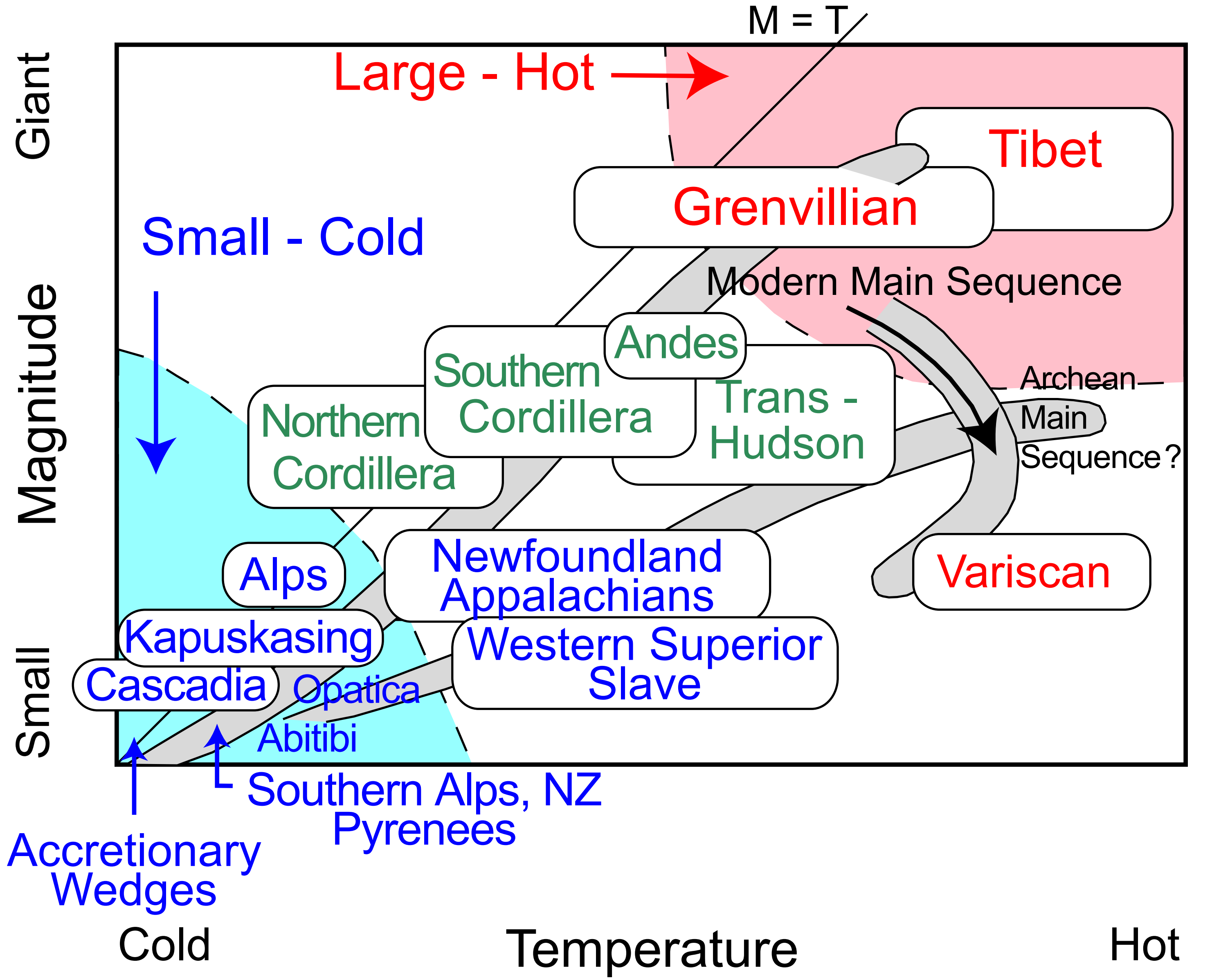
Orogen T - M Diagram
(Temperature - Magnitude)



Beaumont_Figure 1a

CB_London-Dec2004_orogen_TM_Fig1a.ai

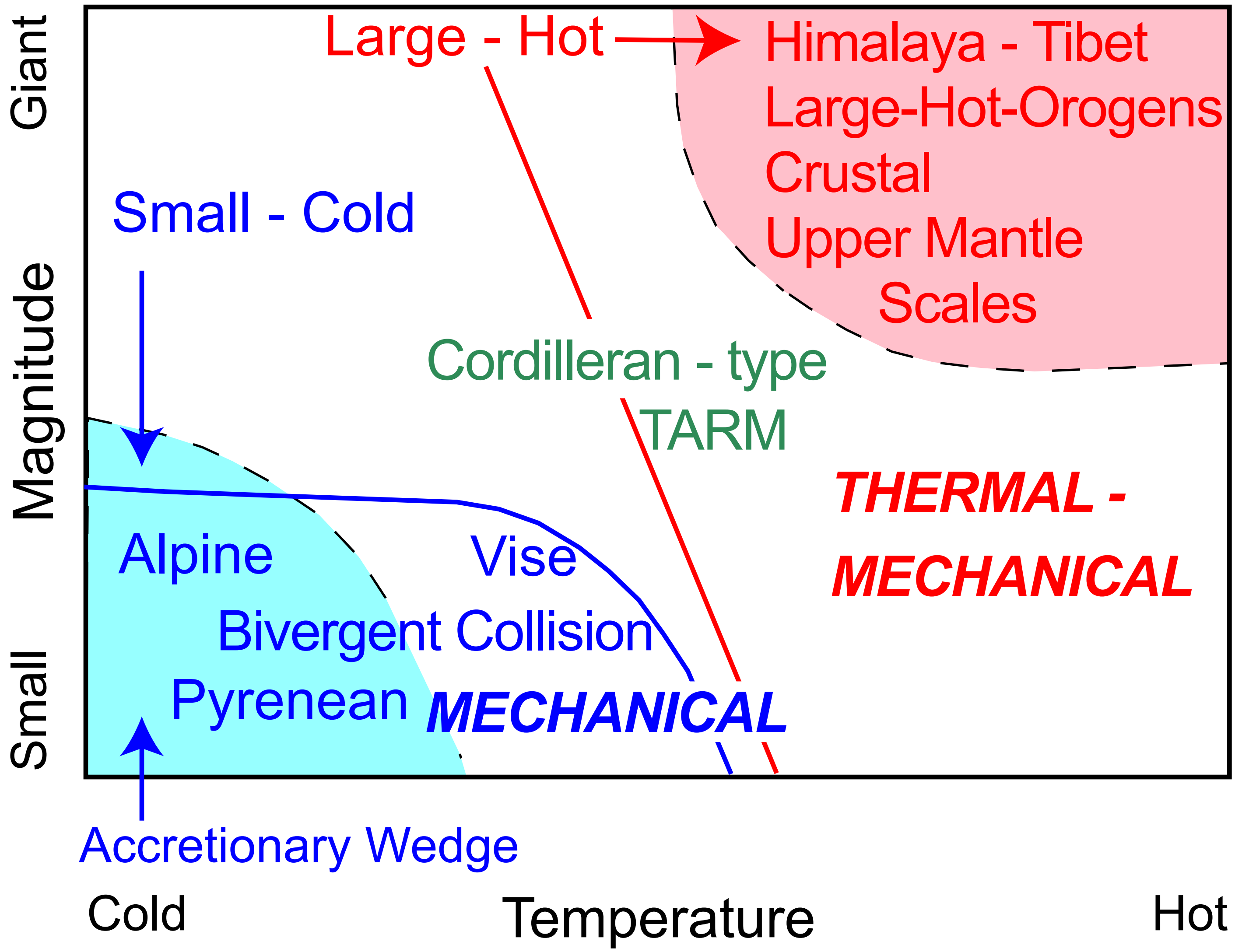
Orogen T - M Diagram
Canadian and Other Orogens



Beaumont_Figure 1b

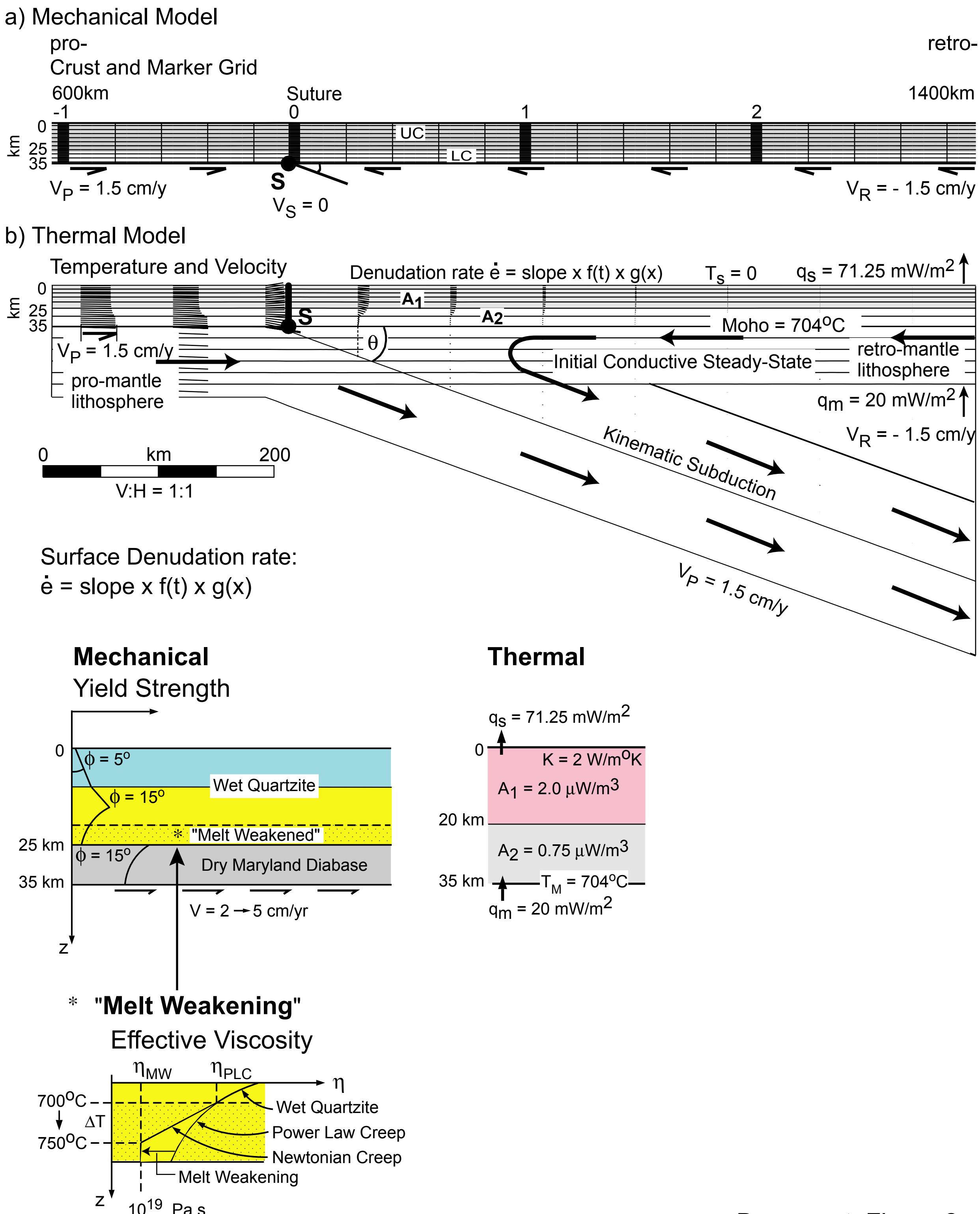
CB_London-Dec2004_orogen_TM_Fig1b.ai

Orogen T - M Diagram
Geodynamical Model Types



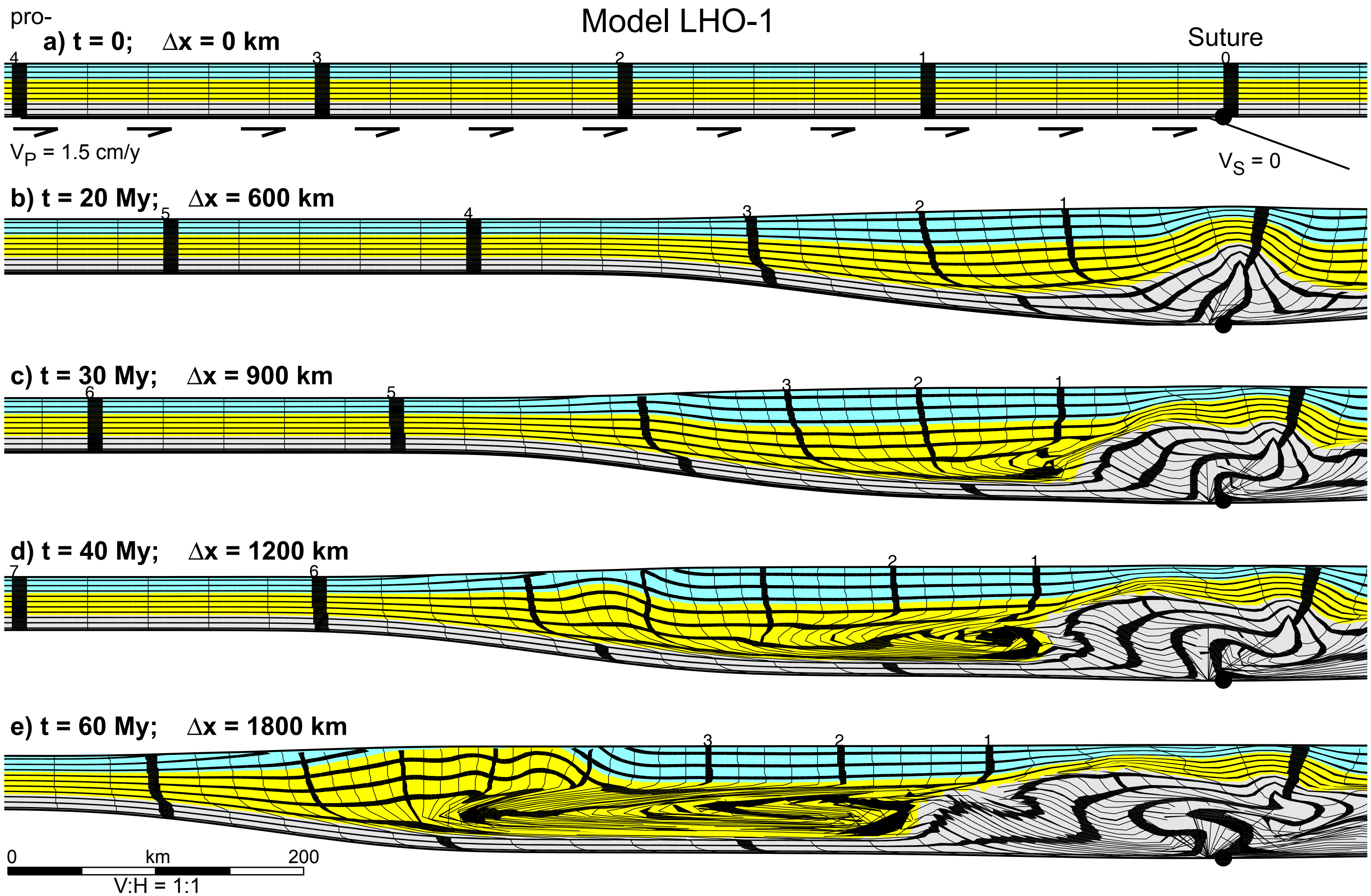
Beaumont_Figure 1c

CB_London-Dec2004_orogen_TM_Fig1c.ai



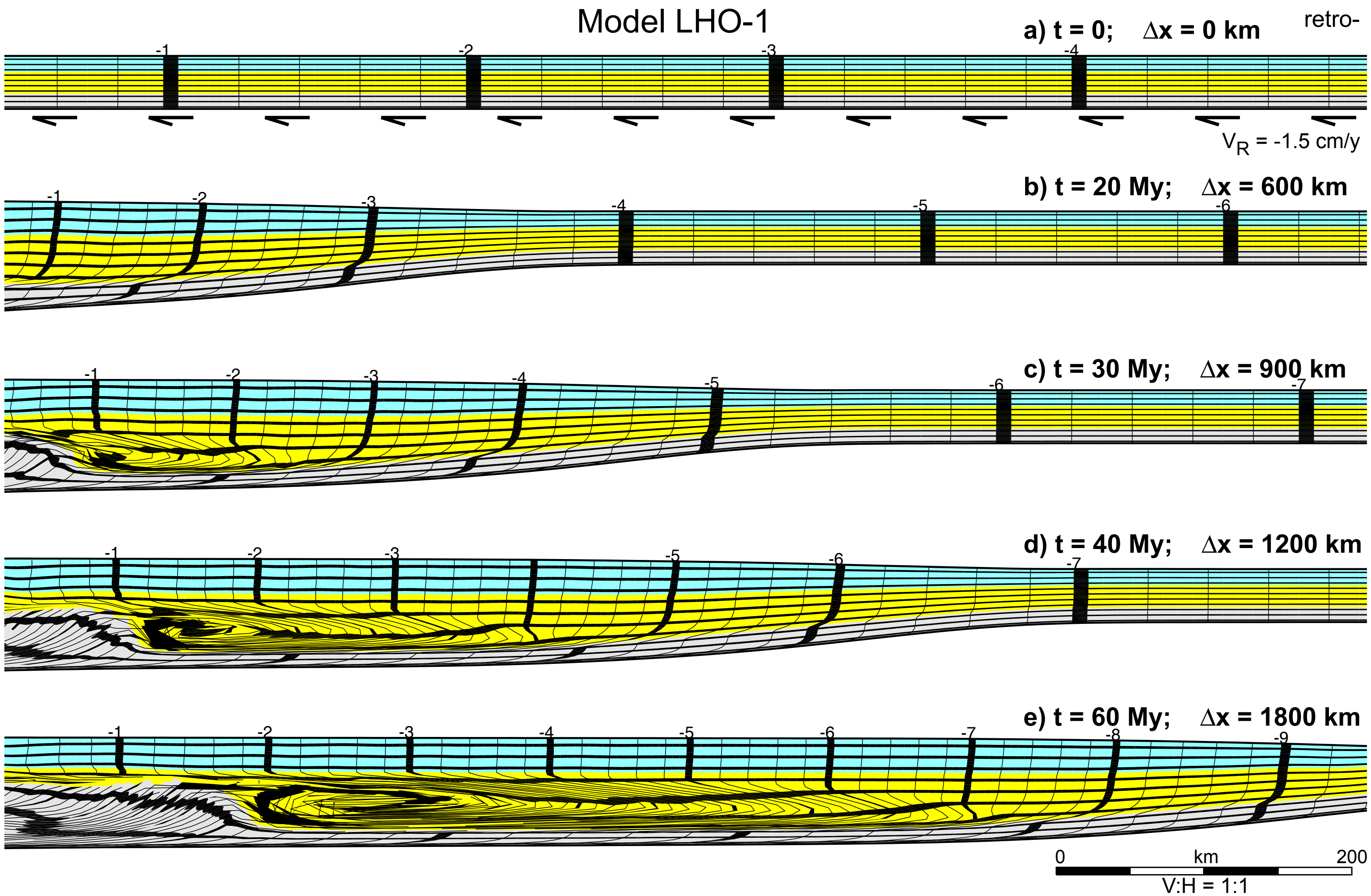
Beaumont_Figure 2

Beaumont_London-Dec2004_GRL-ts1_model-properties_F02.ai



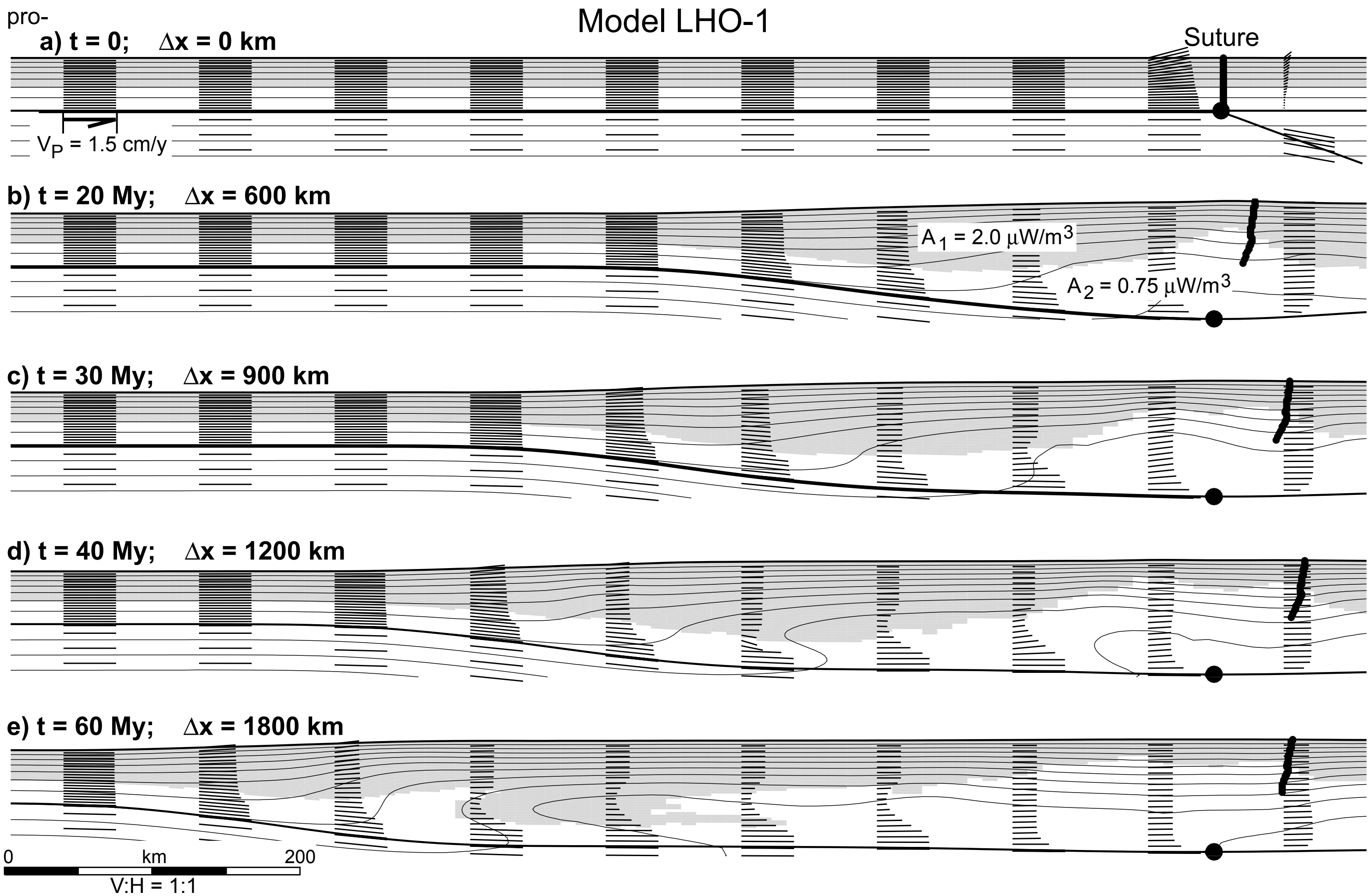
Beaumont_Figure3_Part1.ai

Beaumont_Figure3_Part1_GRL-62_Lgid-matcol_pro.ai



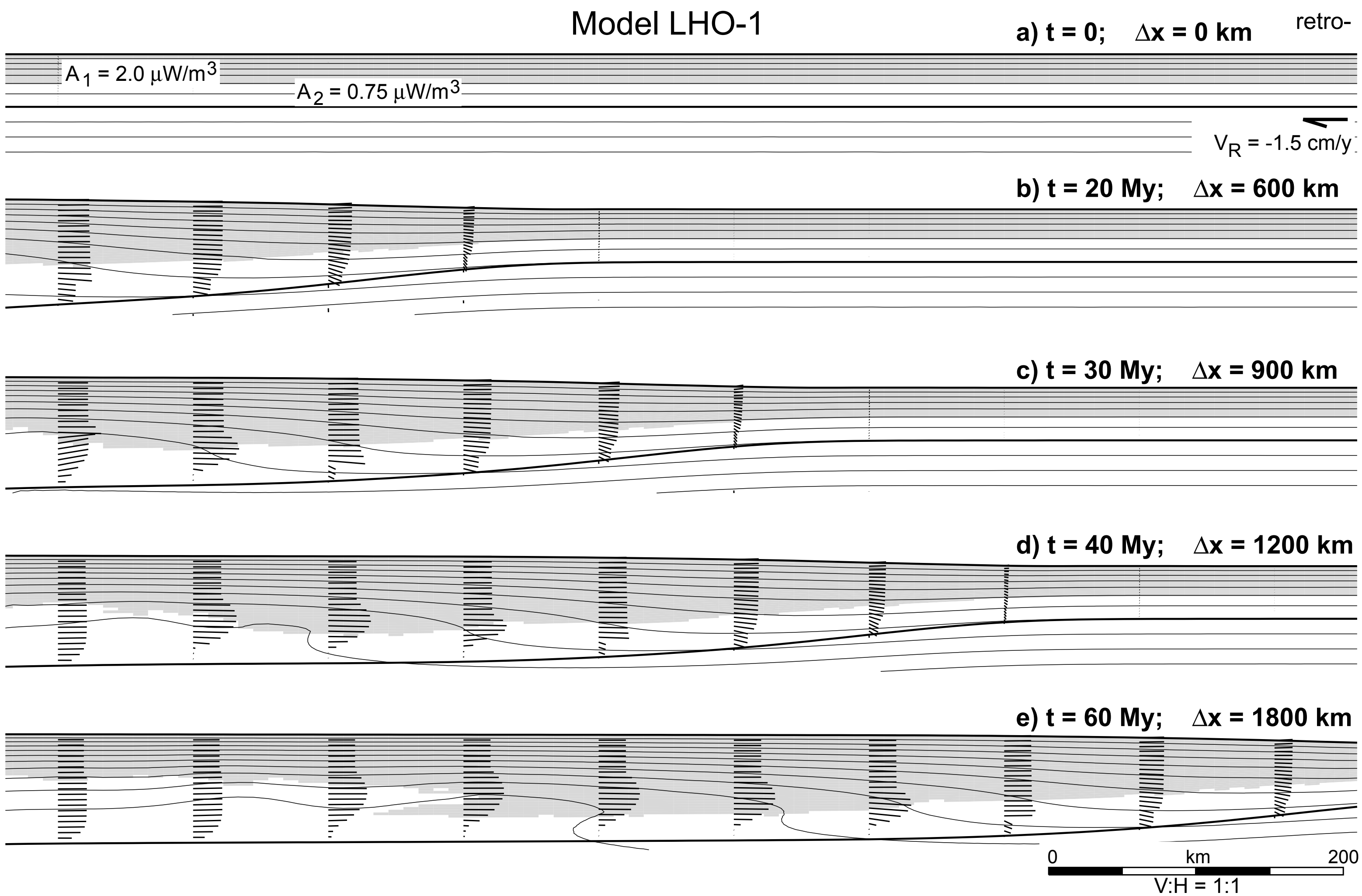
Beaumont_Figure 3_Part 2

Beaumont_Figure3_Part2_GRL-62_Lgrid-matcol.ai



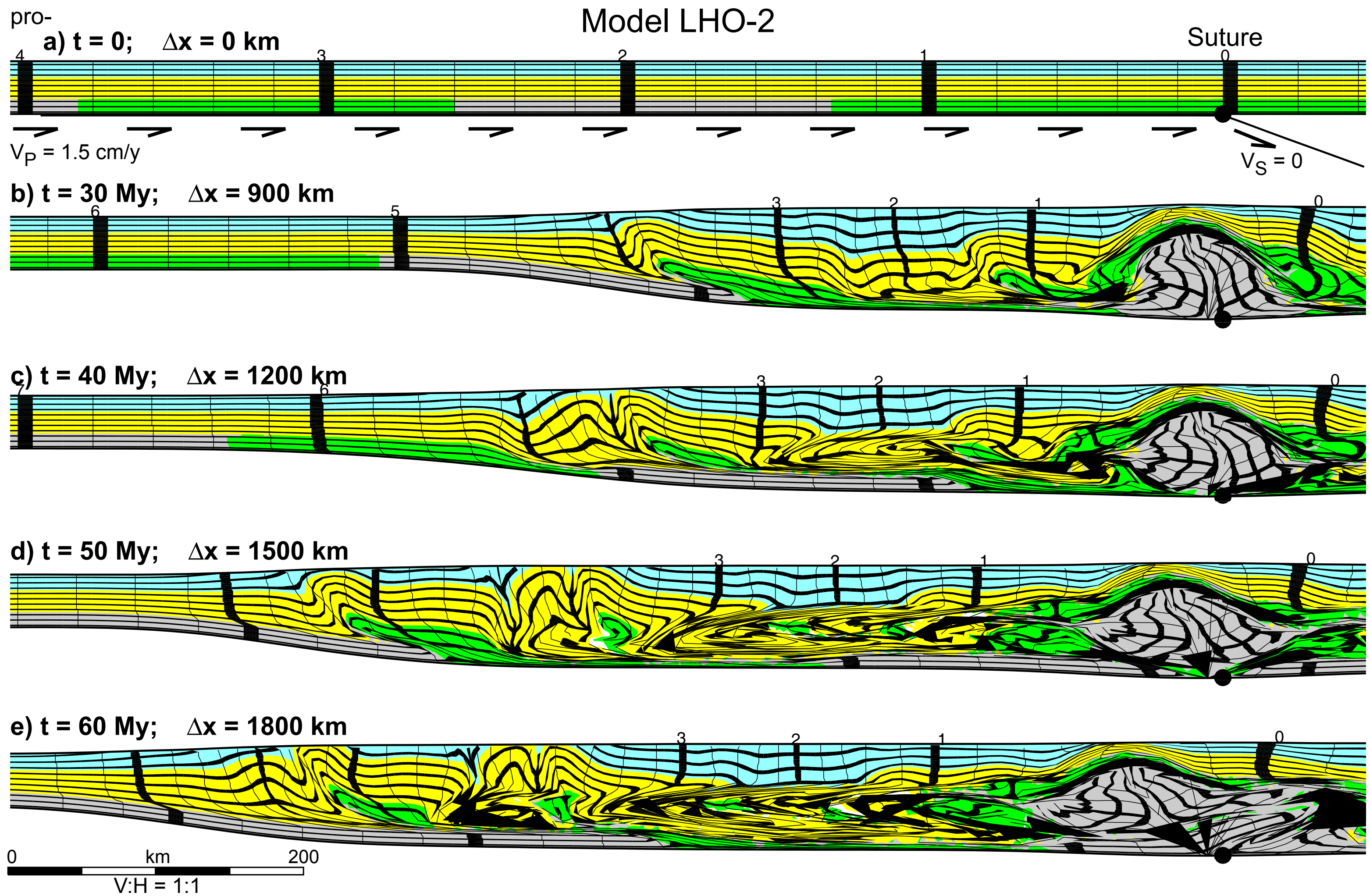
Beaumont_Figure 4_Part1

Beaumont_Figure4_Part1_GRL-62_Tvel-radcol_pro.ai



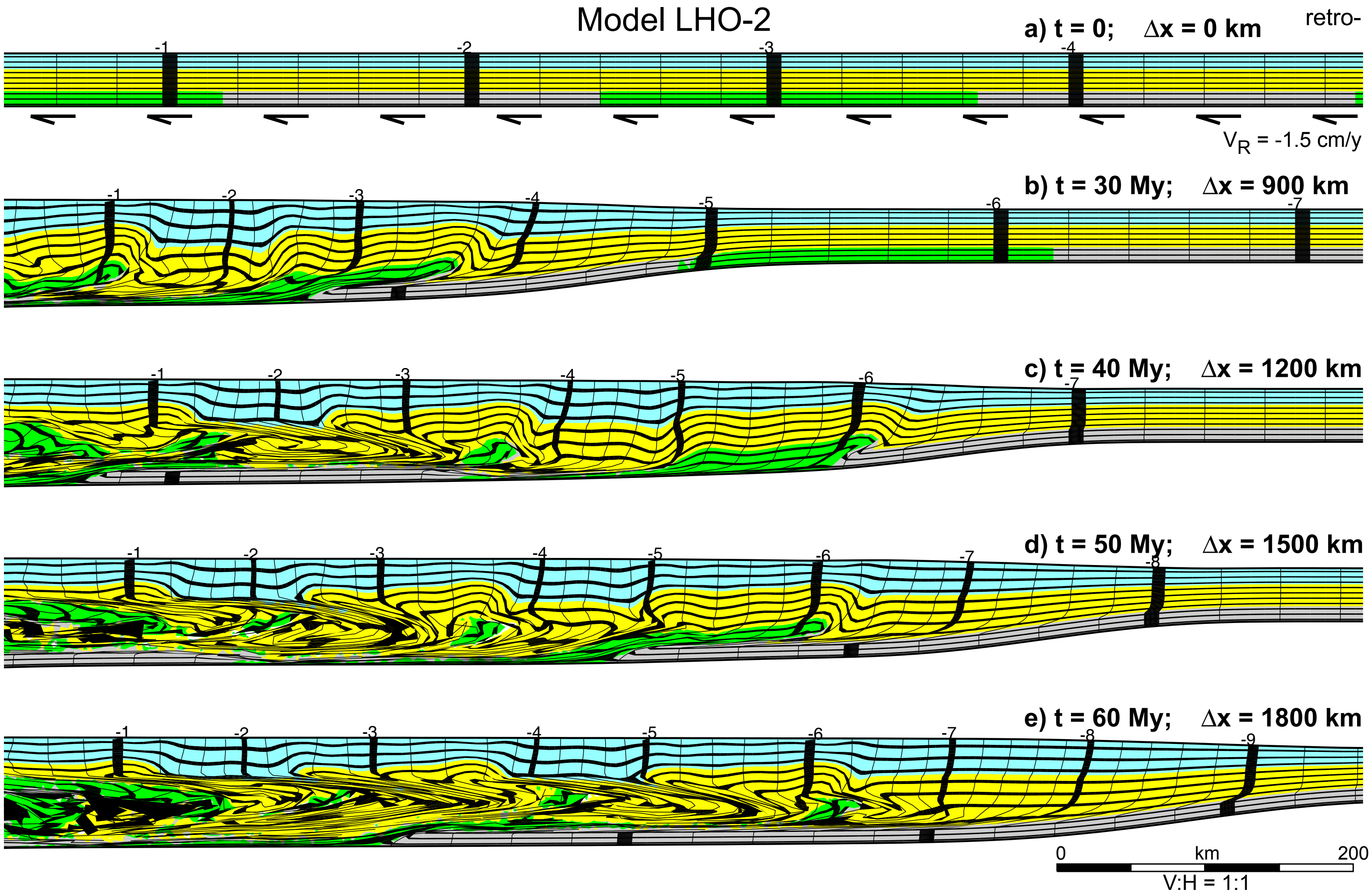
Beaumont_Figure4_Part2

Beaumont_Figure4_Part2_GRL-62_Tvel-radcol_retro.ai



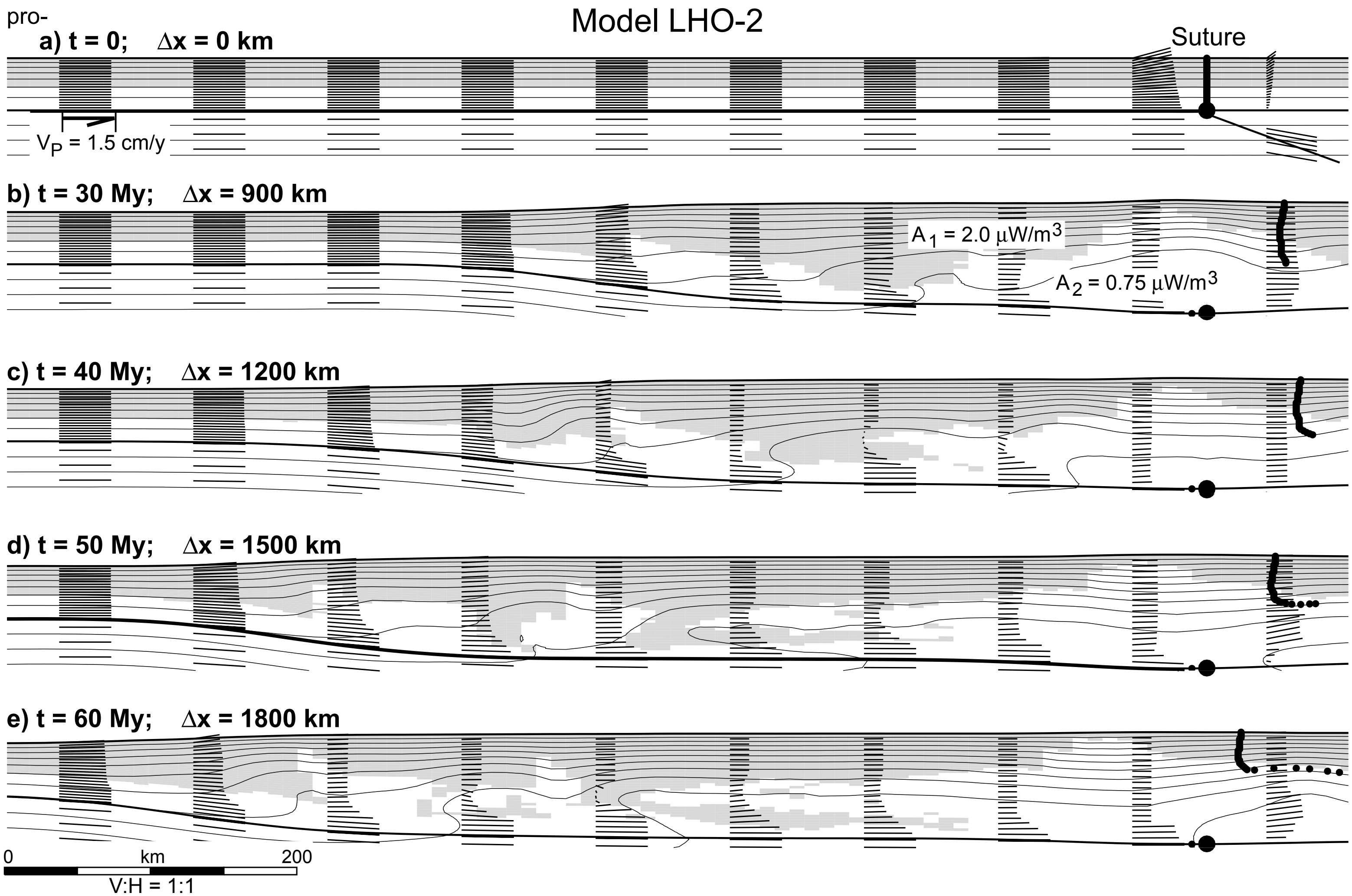
Beaumont_Figure5_Part1

Beaumont_Figure5_Part1_GRL-63_Lgrid-matcol_pro.ai



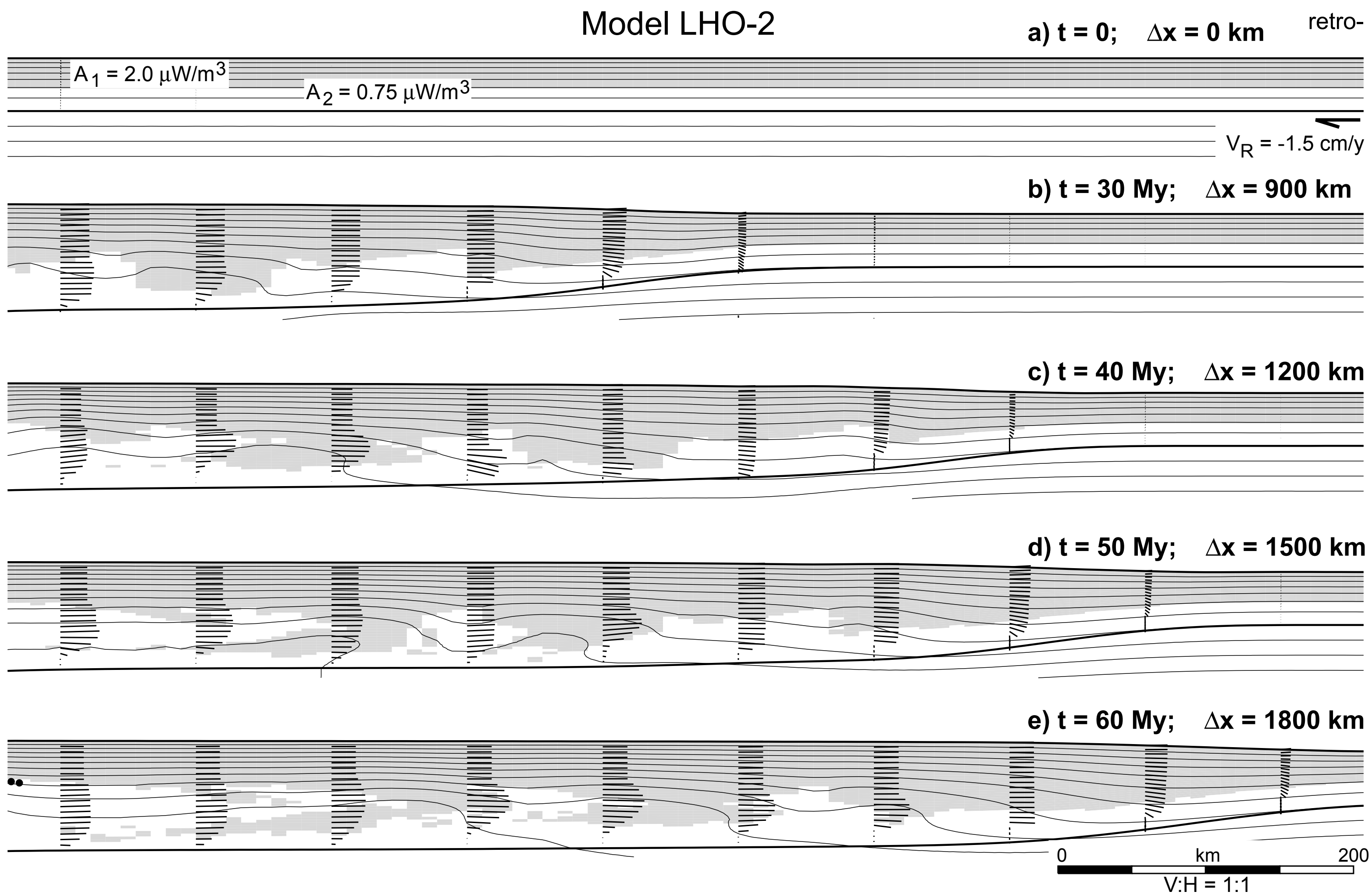
Beamont_Figure5_Part2

Beaumont_Figure5_Part2_GRL-63_Lgrid-matcol_retro.ai



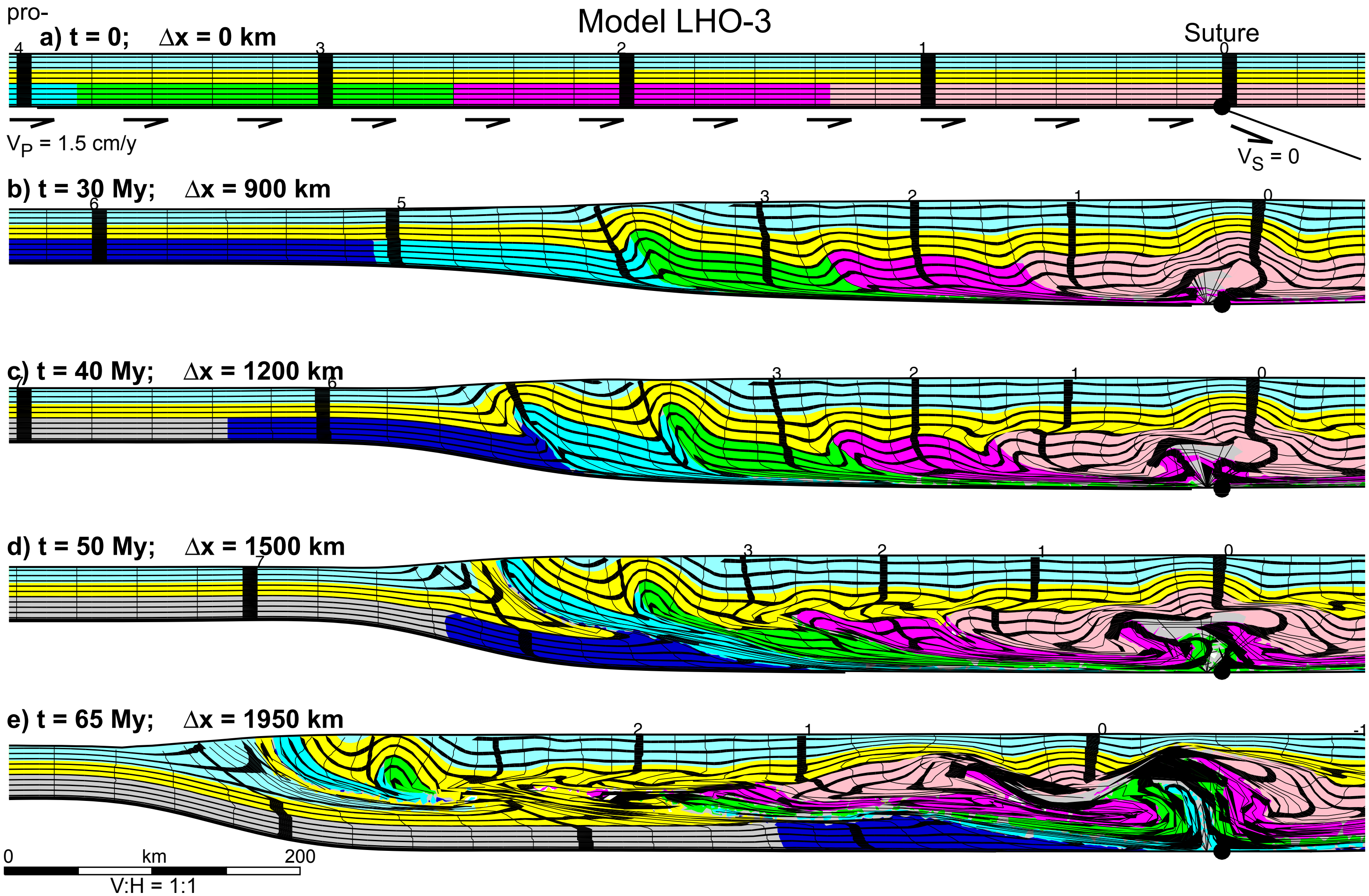
Beaumont_Figure6_Part1

Beaumont_Figure6_Part1_GRL-60_Tvel-radcol_pro.ai



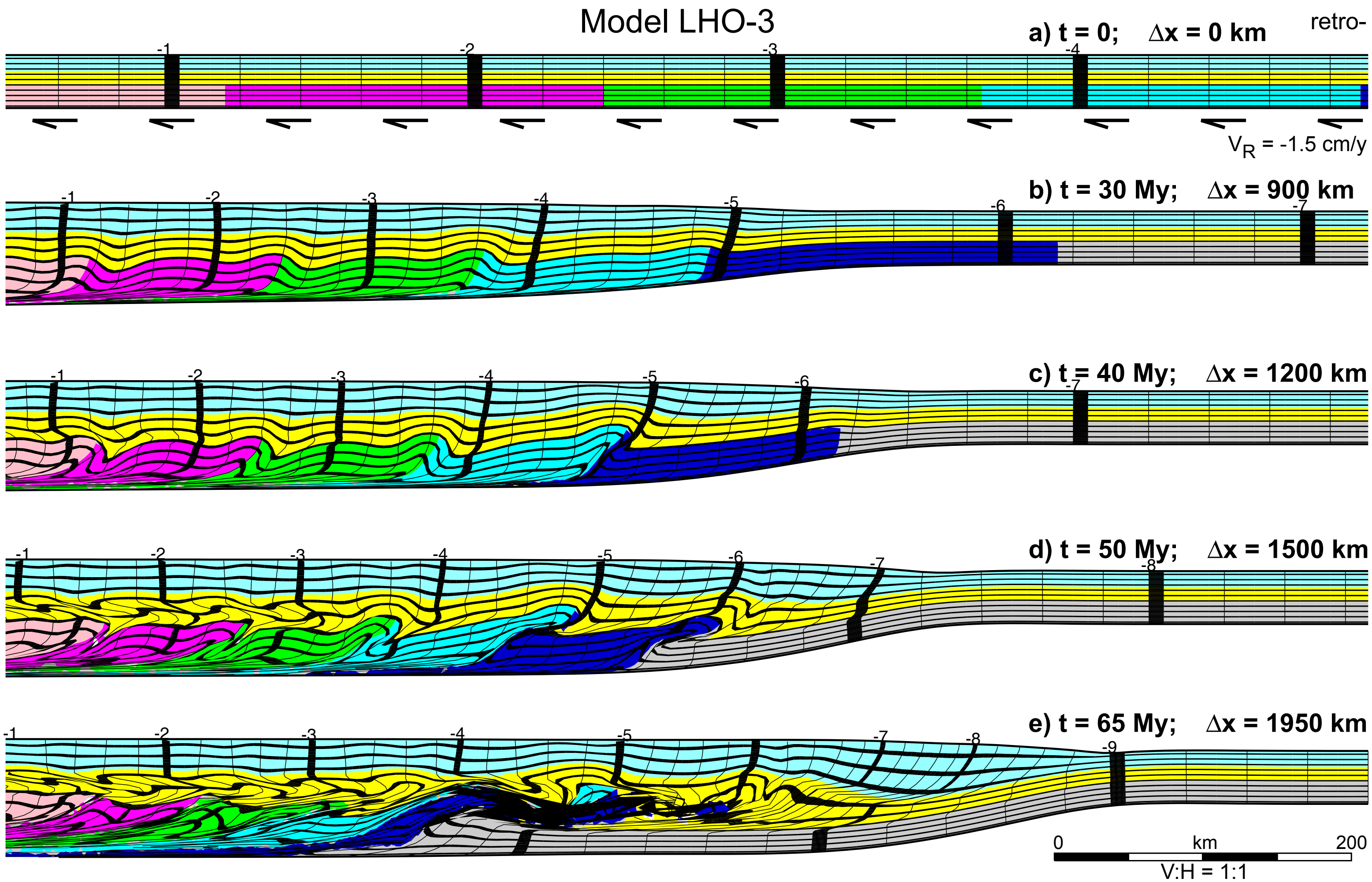
Beaumont_Figure6_Part2

Beaumont_Figure6_Part2_GRL-63_Tvel-radcol_retro.ai



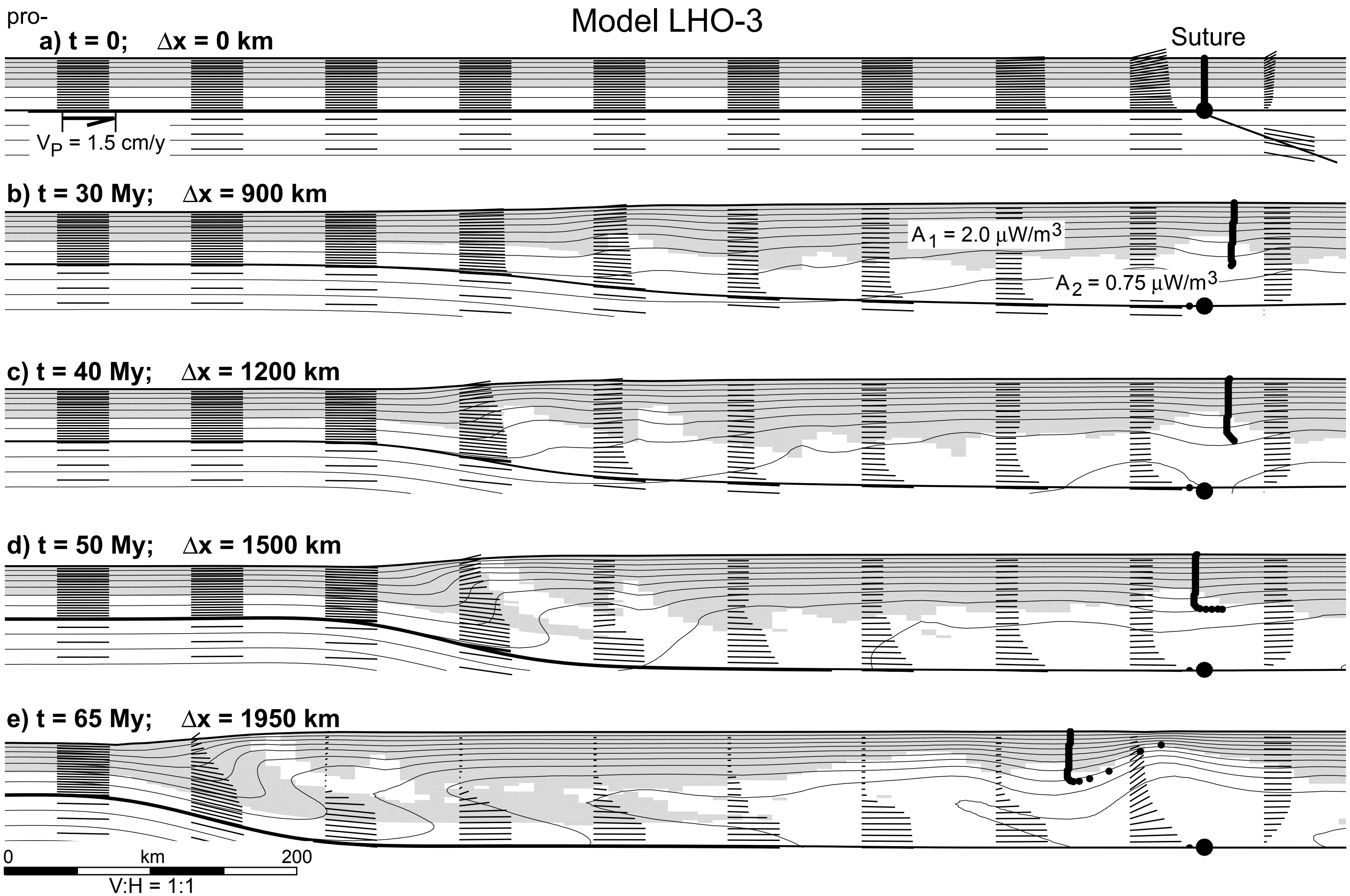
Beaumont_Figure7_Part1

Beaumont_Figure7_Part1_GRL-60_Lgrid-matcol_pro.ai



Beaumont_Figure7_Part2

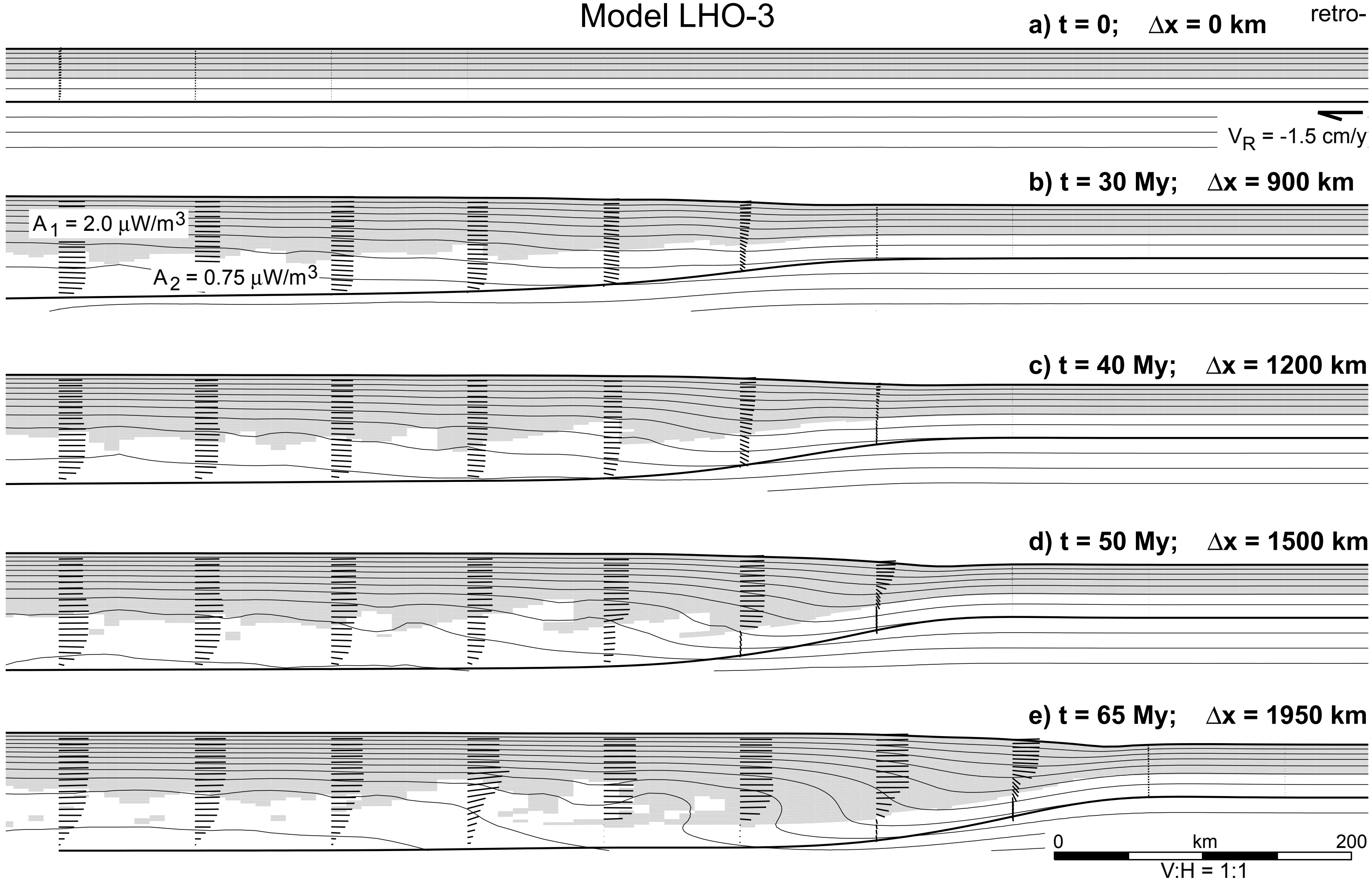
Beaumont_Figure7_Part2_GRL-60_Lgrid-matcol_retro.ai



Beaumont_Figure8_Part1

Beaumont_Figure8_Part1_GRL-60_Tvel-radcol_pro.ai

Model LHO-3



Beaumont_Figure8_Part2

Beaumont_Figure8_Part2_GRL-60_Tvel-radcol_retro.ai

Upper Mantle Scale Models

- Himalayan - Tibetan scale, continent-continent collision, thermal-mechanical coupled models

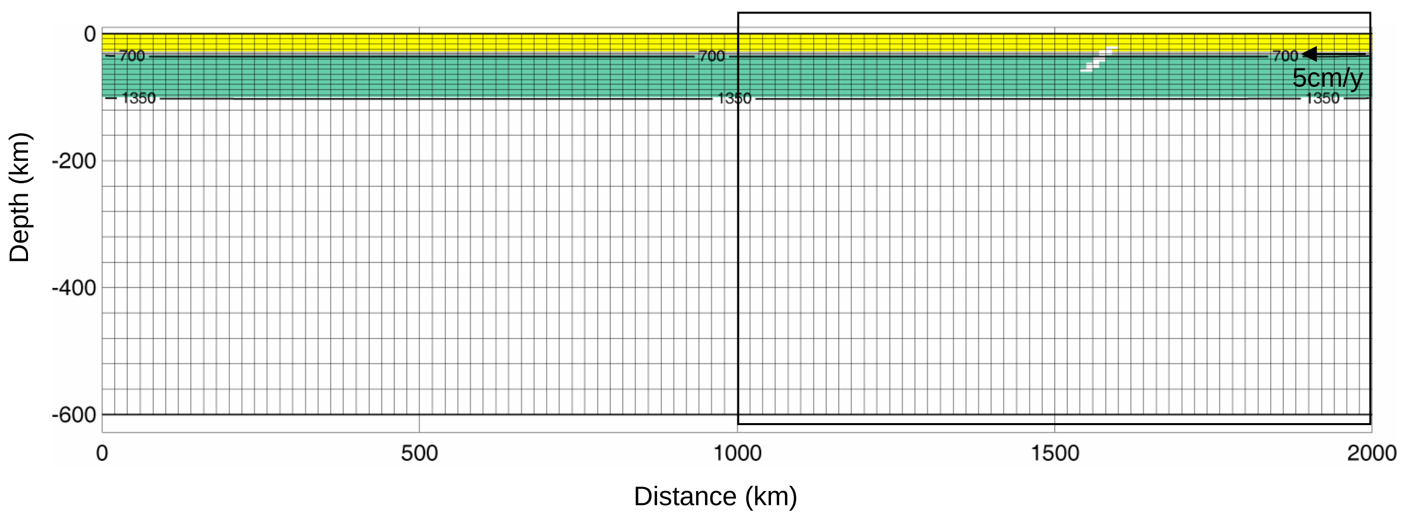
  V_p = 5 cm/yr   0 → ~ 40 Myr

- <u>LHO-LS1</u>   no erosion

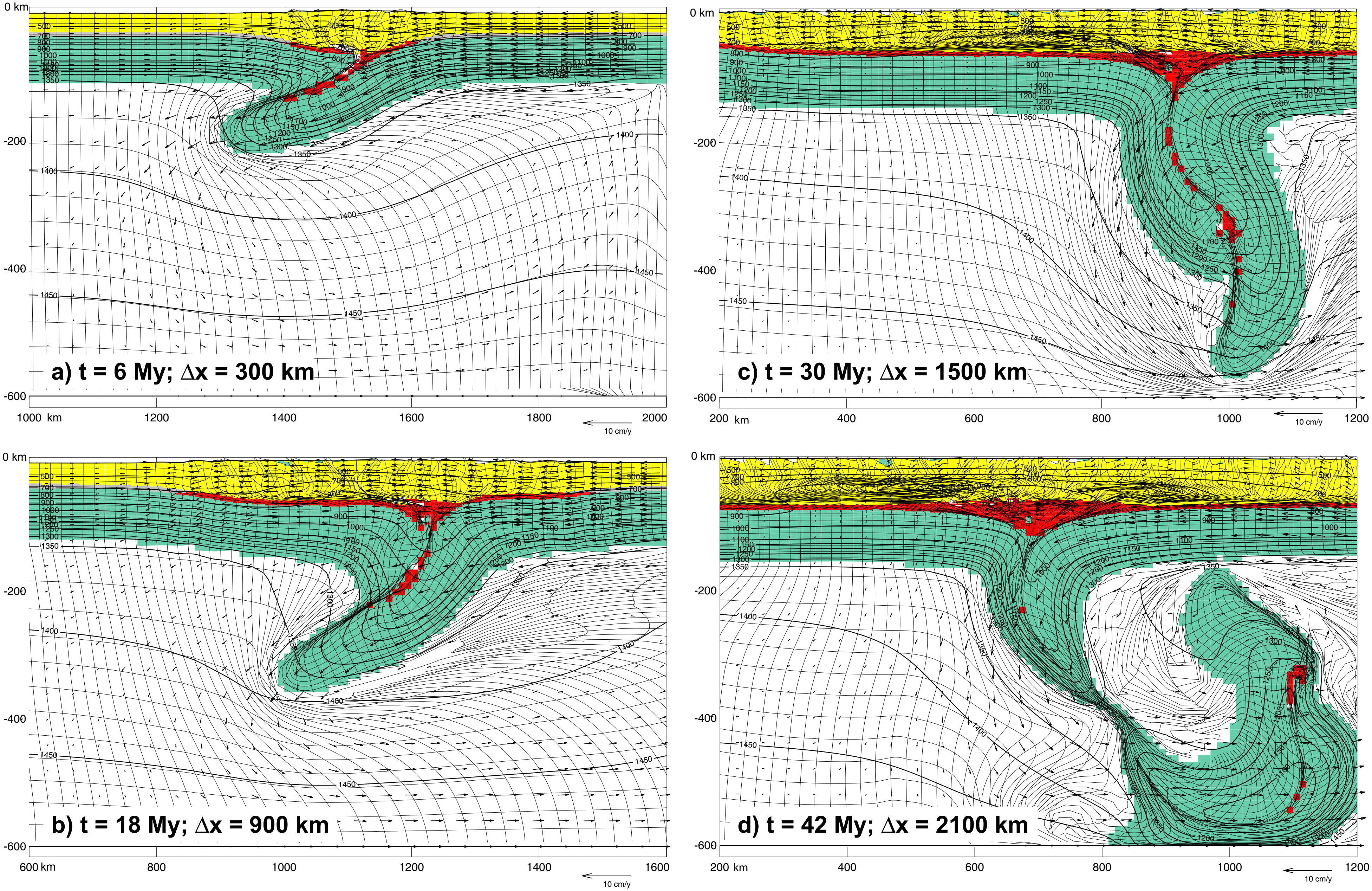
	ϕ	η_e (Pa.s)	ρ (kg/m^3)
Upper Crust	$15^o \rightarrow 2^o$	B* (WQz x 5)	2800
Lower Crust	$15^o \rightarrow 2^o$	B* (DMD / 10)	2950 → 3100
Mantle Lithosphere	$15^o \rightarrow 2^o$	B* (WOl x 10)	3.300
Upper Mantle	$15^o \rightarrow 2^o$	B* (WOl)	3.260

- <u>LHO-LS2 as LHO-LS1 except</u>

	ρ (kg/m^3)
Mantle Lithosphere	3.310

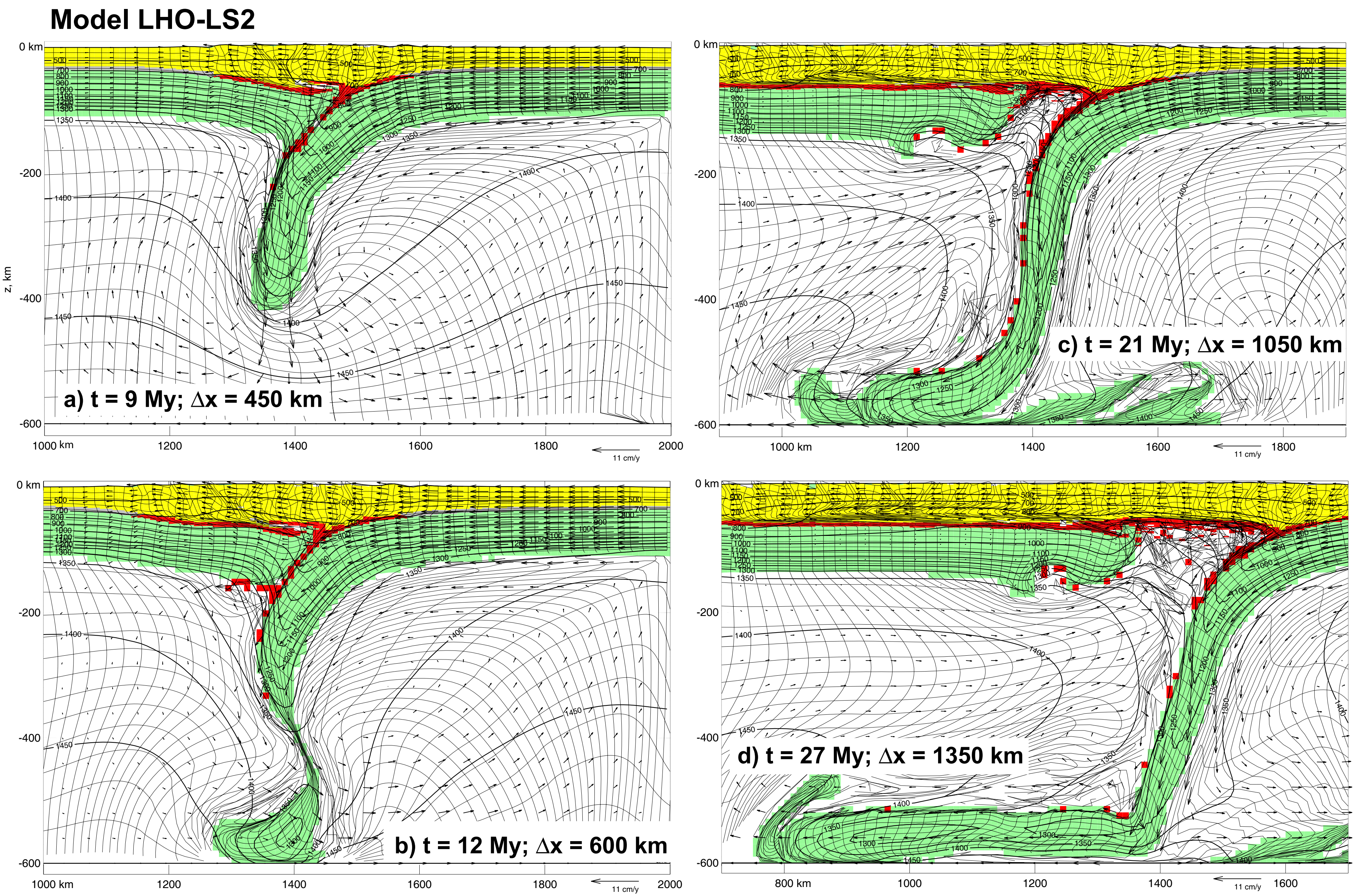


Model LHO-LS1



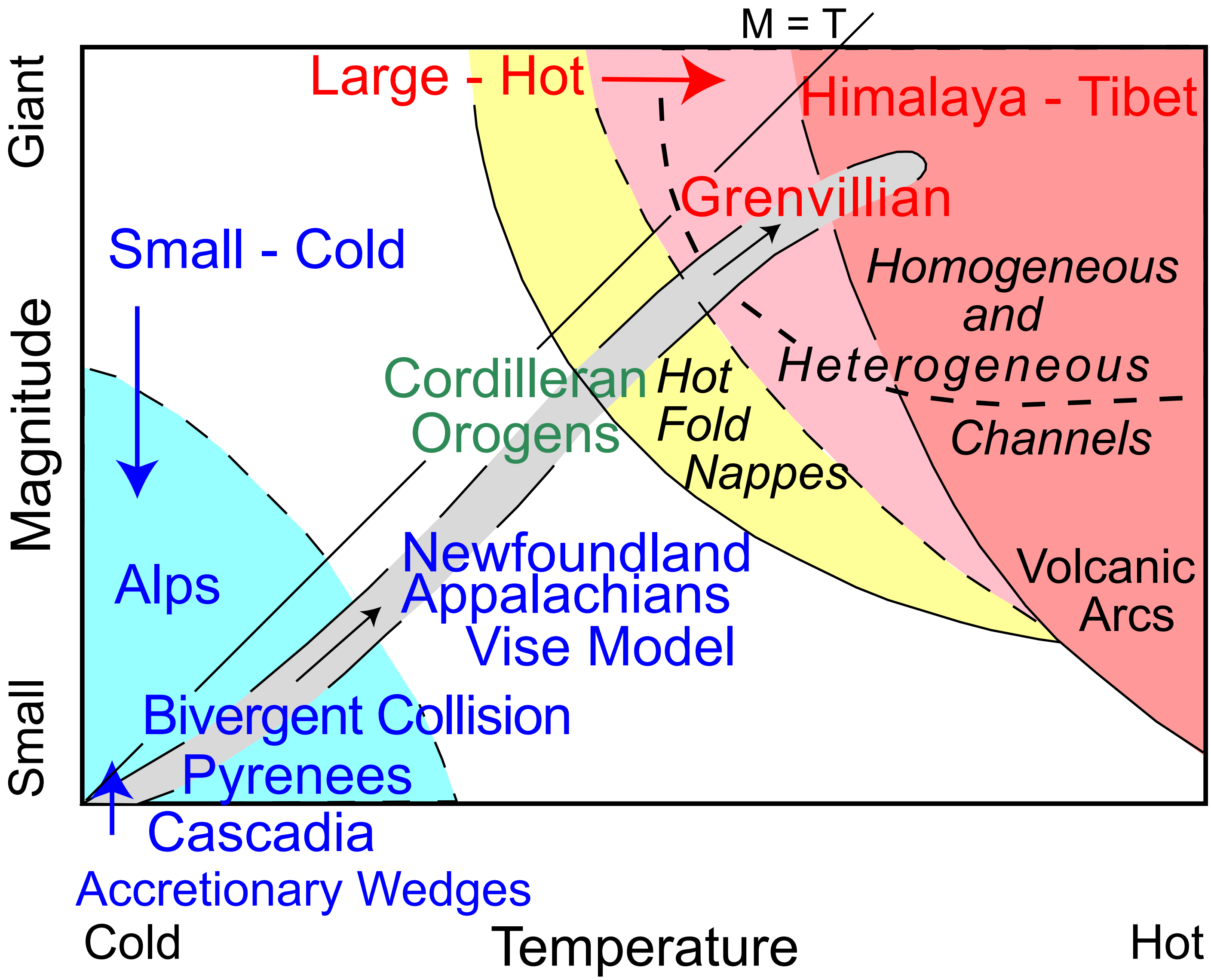
Beaumont_Figure 10.ai

Beaumont_Figure10_LHO-LS-test56_6-18-30-42My.ai



Beaumont_Figure 11.ai

Orogen T - M Diagram
Examples of Model Applications

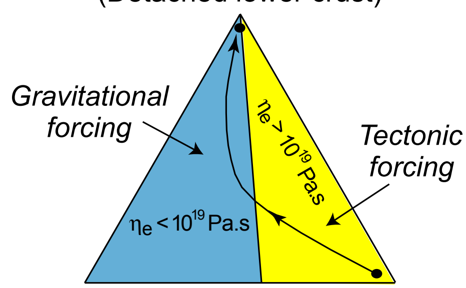


Beaumont_Figure12

CB_London-Dec2004_orogen_TM_Fig12.ai

Flow Modes

Mode 2:
Heterogeneous Channel
(Detached lower crust)



Mode 1:
Homogeneous
Channel

Mode 3:
Hot Fold Nappes
(Lateral Indentor)

η_e = Effective viscosity of mid-crust

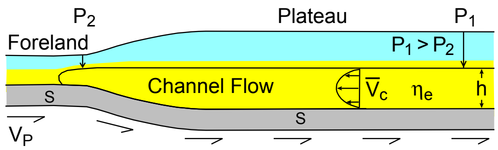
Flow modes are a continuum
End members illustrate particular styles

Beaumont_Figure 13

Beaumont_London-Dec2004_Flow-modes_Figure13_v2..ai

a) Mode 1: Homogeneous Channel Flow

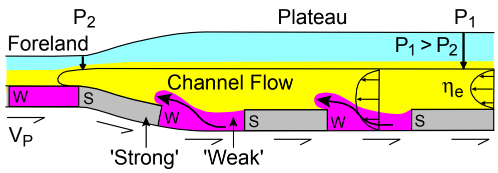
Driven by Gravitational forcing of Channel
Differential pressure, $P_1 - P_2$, pumps channel flow



- $\Delta P_{max} = P_1 - P_2 \sim 200$ MPa
- Requires $\eta_e < 10^{19}$ Pa.s when h ~ 20 km for efficient, $\overline{V}_c \sim 1$ cm/yr, flows
- May require melt weakening for $\eta_e < 10^{19}$ Pa.s
- Many orogens may be 'sub-critical', $\eta_e > \eta_{crit}$

b) Mode 2: Heterogeneous Channel Flow

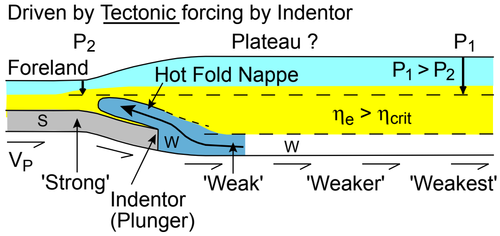
Driven by Gravitational forcing of Channel
+ Tectonic forcing by Heterogeneities



- e.g. Heterogeneous Strong / Weak lower crust (η_s / η_w)
- Weak lower crust tectonically expelled to create Heterogeneous Channel Flow
- May require melt weakening for $\eta_e < 10^{19}$ Pa.s

c) Mode 3: Hot Fold Nappes

Driven by Tectonic forcing by Indentor



- e.g. Indentor of Strong (Refractory) lower crust
- Weak lower crust +/- mid-crust tectonically expelled as Hot Fold Nappes
- Mid-crust sub-critical for channel flow
- When is an Indentor strong?
  - some experimental results ....

Beaumont_Figure14

Beaumont_London-Dec2004_Modes1-2-3-conclusion_Figure14_43percent.ai