The Abdus Salam International Centre for Theoretical Physics

United Nations Educational, Scientific and Cultural Organization

IAEA International Atomic Energy Agency

2240-8

Advanced School on Scaling Laws in Geophysics: Mechanical and Thermal Processes in Geodynamics

23 May - 3 June, 2011

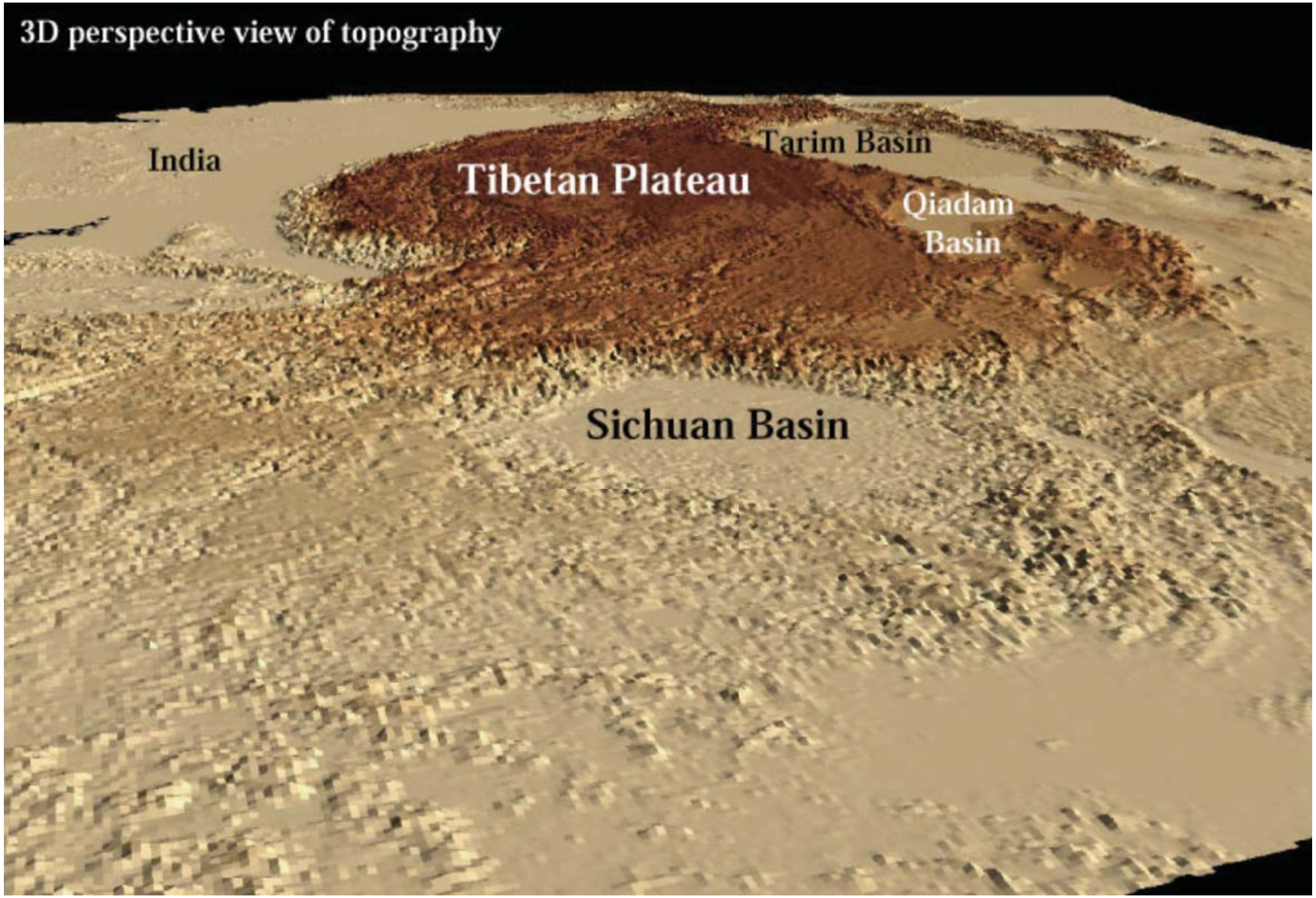
Channel Flow

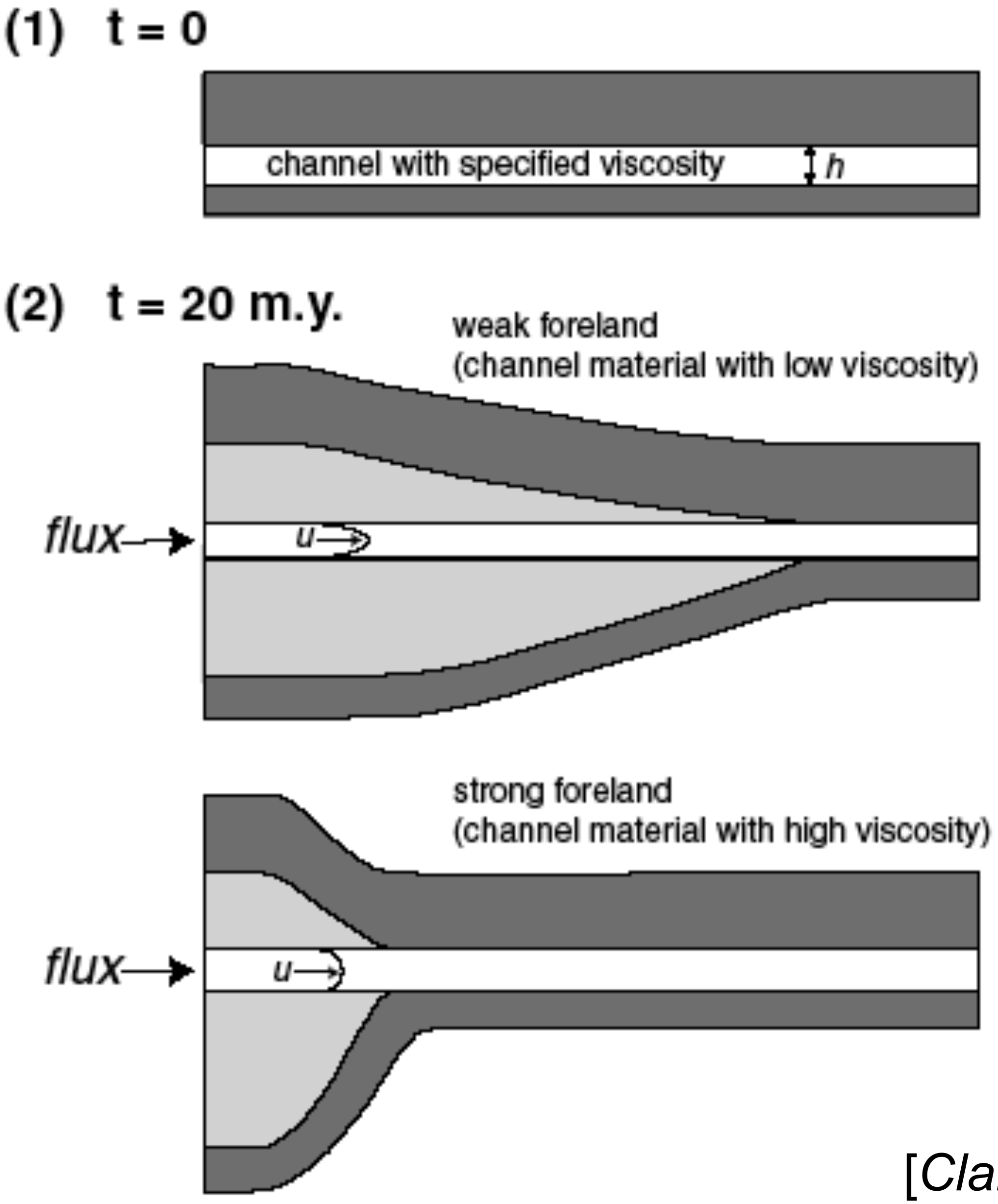
P. Molnar

Univ. of Colorado at Boulder, USA

Strada Costiera 11, 34151 Trieste, Italy - Tel.+39 040 2240 111; Fax +39 040 224 163 - sci_info@ictp.it

Channel flow, where there is no thrust faulting or crustal shortening?

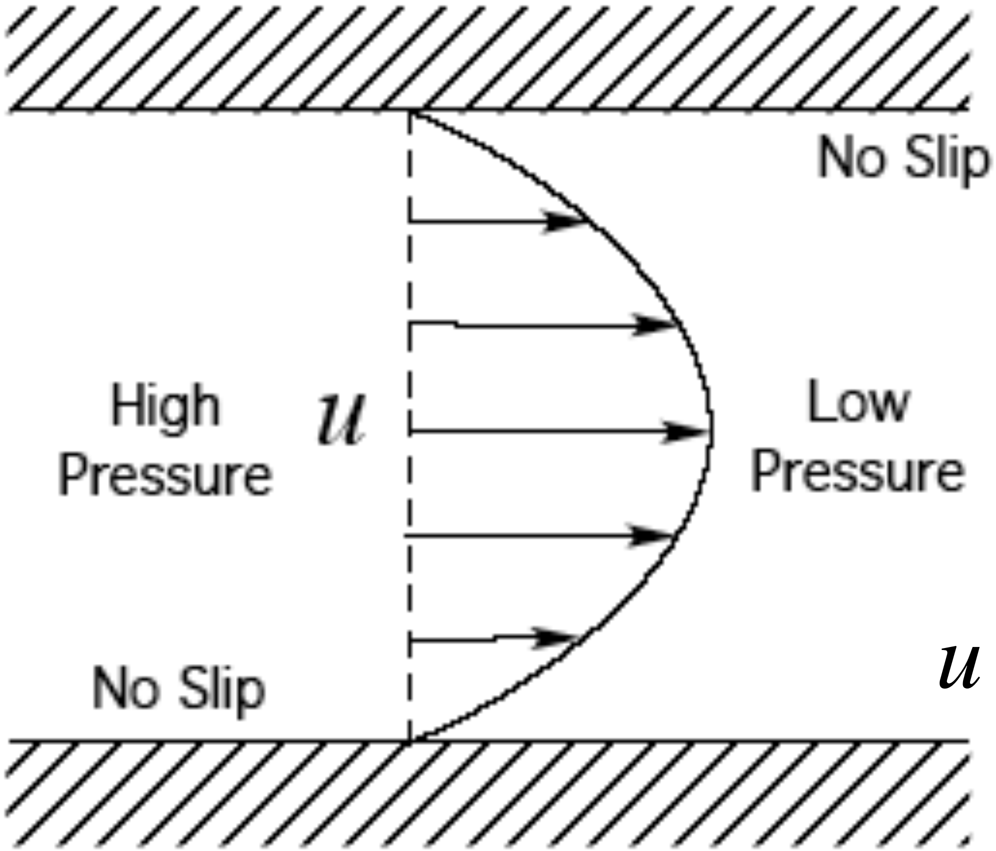




Channel Flow of lower crust: a mechanism for thickening crust without surface deformation

[*Clark and Royden, Geology* 2000]

Channel flow



Constant pressure gradient:

Channel thickness, d

$$u = -\frac{\partial P}{\partial x}\frac{1}{\eta}\left(zd - z^2\right)$$

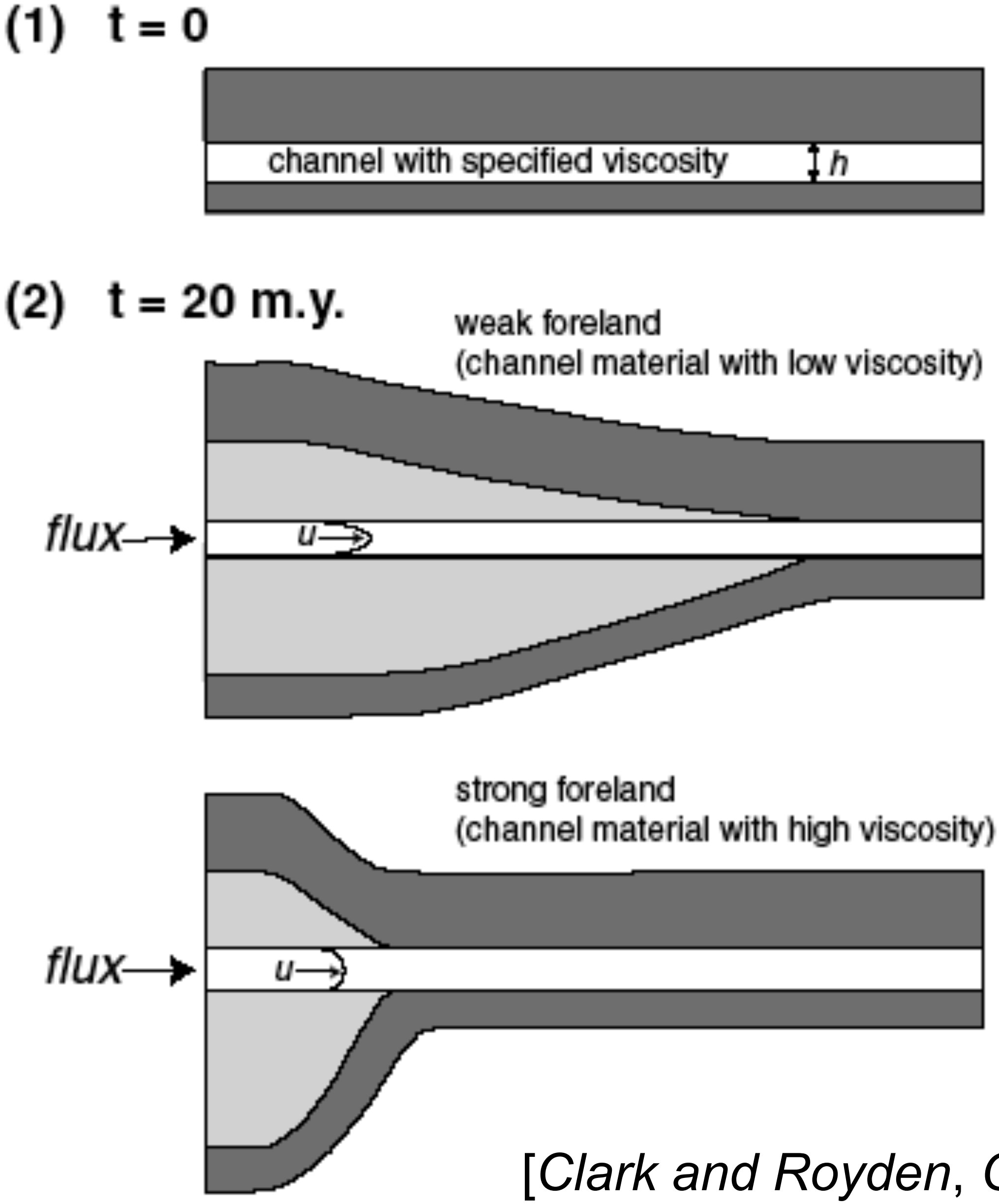
$$u = -\frac{\partial P}{\partial x}\frac{1}{\eta}\left(zd - z^2\right)$$

Flux of material, *F*, through channel

$$F = \int_0^d u(z)dz = -\frac{\partial P}{\partial x}\frac{1}{\eta}\int_0^d \left(zd - z^2\right)dz$$

$$F = -\frac{\partial P}{\partial x}\frac{d^3}{6\eta}$$

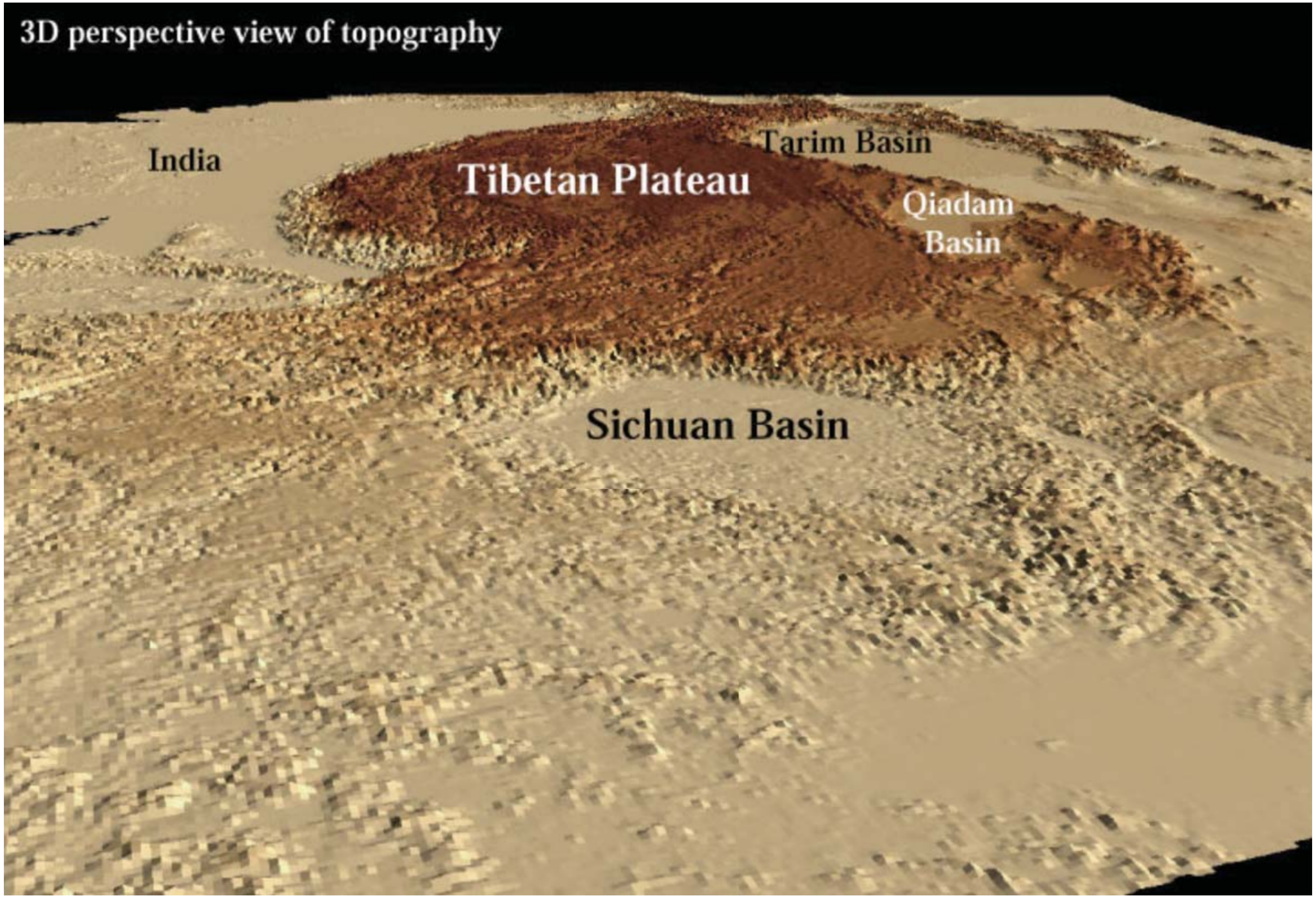
The **flux** through the channel is **proportional** to the **cube** of the **channel thickness**, d^3, and **inversely proportional** to the **viscosity**.



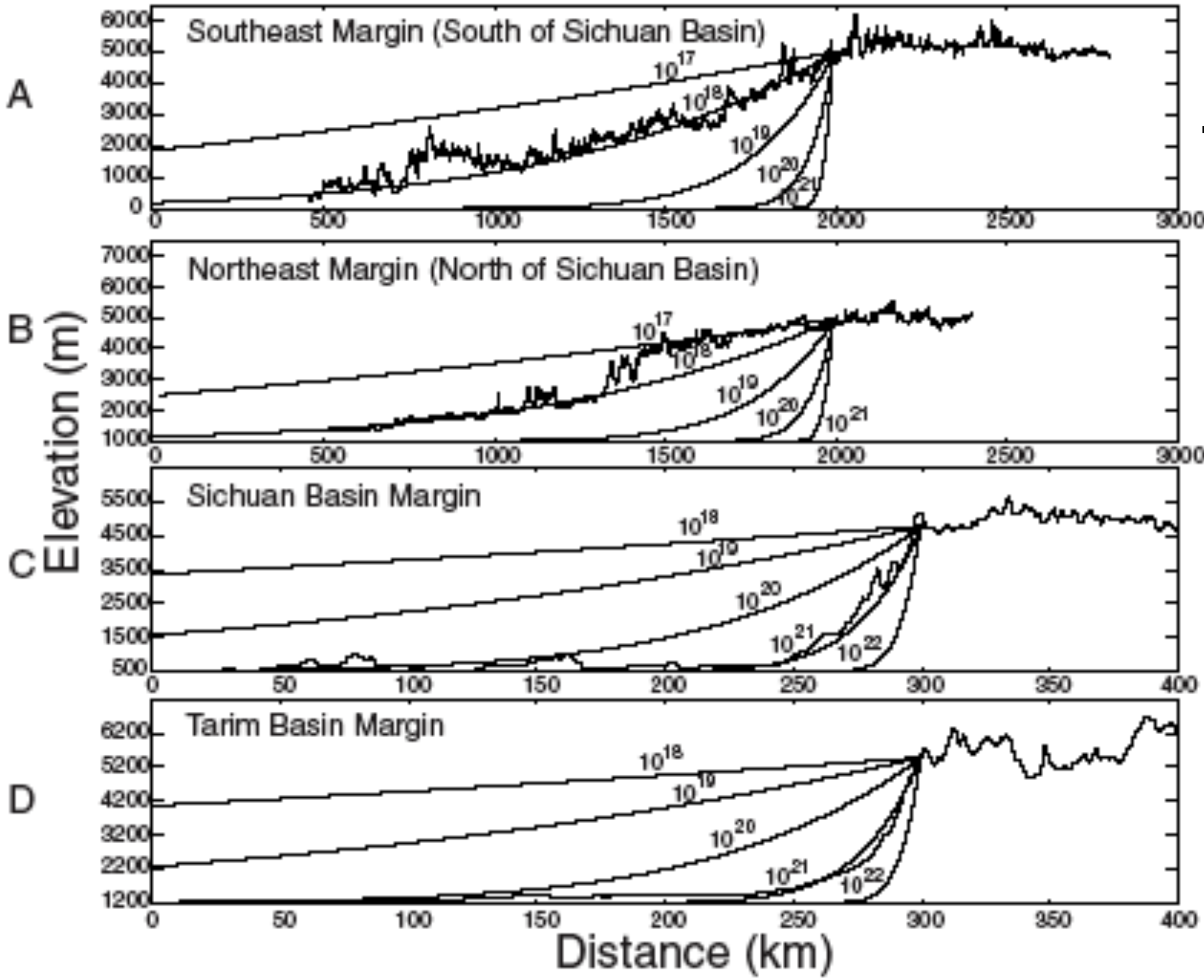
The topographic gradient gives a measure of the pressure gradient: *steep topography* implies a *high pressure gradient*, and hence requires either a **high viscosity** or a **thin channel**.

[*Clark and Royden*, *Geology* 2000]

Channel flow: where there is no thrust faulting or crustal shortening?



Channel flow in Tibet



Topographic profiles across the margins of Tibet

[*Clark and Royden, Geology* 2000]

Implications of channel flow in the crust

Deformation seen at the earth's surface need not resemble that at depth, in the lower crust or upper mantle.

High terrain might be created without crustal shortening manifested by thrust faulting at the earth's surface, or by thermal alteration of the upper mantle.