Suppes GE0201 handout
Fall 2007

Reade's scepticism...

As geologic data requiring great thrust sheets accumulated, controversies blossomed over their mechanics. For example, T. Mellard Reade wrote in the *Geological Magazine* of 1908:

> In attempts to unravel some of the weightier problems of geology it has lately been assumed that certain discordances of stratification are due to the thrusting of old rocks over those of a later geological age. Without in any way suggesting that the geology has in any particular instance been misread, I should like to point out the difficulties in accepting the explanation looked at from a dynamical point of view when applied on a scale that seems to ignore mechanical probabilities. Some of the enormous overthrusts postulated are estimated at figures approaching 100 miles. If such a movement has ever taken place, would it not require an incalculable force to thrust the upper over the lower . . .? I venture to think that no force applied in any of the mechanical ways known to us in Nature would move such a mass, be it ever so adjusted in thickness to the purpose, even if supplemented with a lubricant generously applied to the thrust-plane. These are the thoughts that naturally occur to me, but as my mind is quite open to receive new ideas I shall be glad to know in what way the reasoning can be met by other thinkers.

Frictional resistance = μ x Weight

Frictional force = μ × weight

μ = coefficient of friction

≈ 0.6 - 0.8

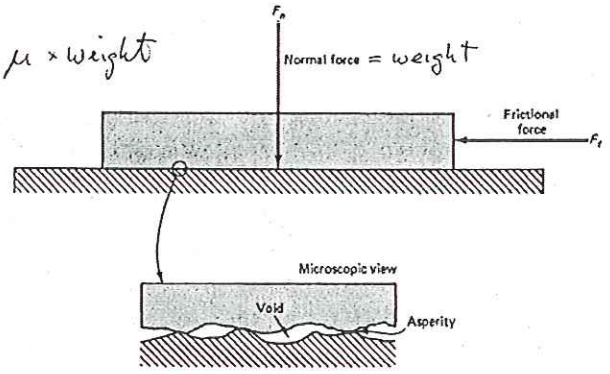
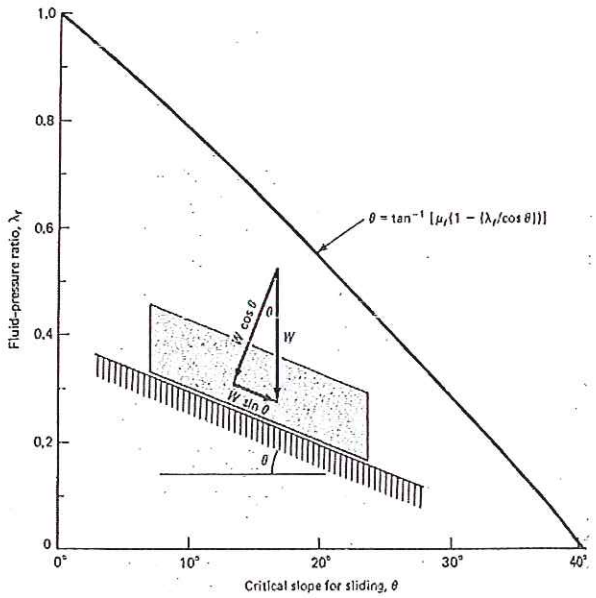


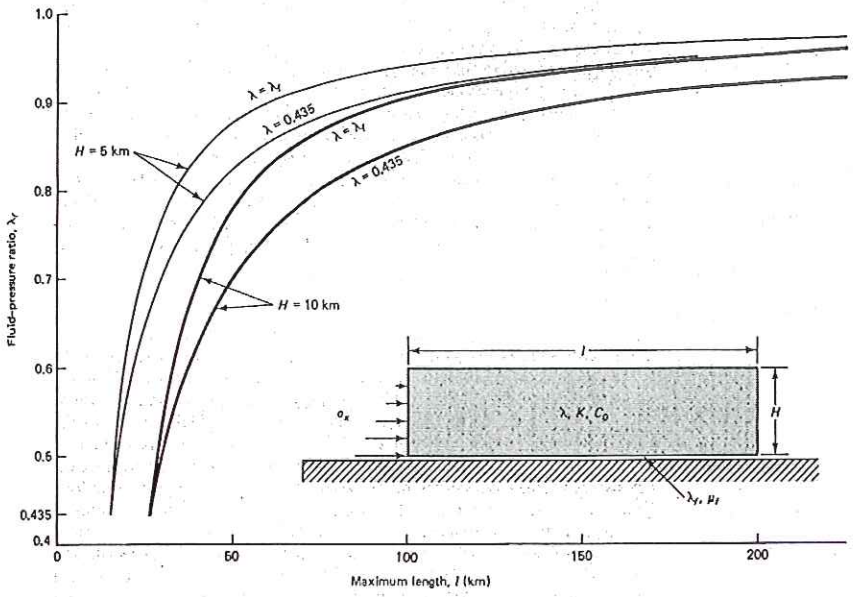
FIGURE 8–32 Schematic drawing of friction experiment.

M. King Hubbert and the role of fluid pressure....

- Hubbert & Rubey (1959)
- Excess fluid pressures found in petroleum exploration
- Has two effects:
  - Weakens rock
  - Reduces friction on faults
- Net effect on thrust faults & gravity sliding
  - Reduces angle needed to slide downhill
  - Increases maximum length of block that can be pushed

Gravity sliding





Before plate tectonics...

- Still strong aversion to horizontal shortening as the cause of mountain belts in many circles.
- Most people, including Hubbert & Rubey, favored thrusts as gravity slides, even though their theory didn't require this.
- People looked for extentional zones in the cores of mountain belts as the source of the gravity slides.

Problems of the classic formulation...

- Fluid pressures are important but they aren't the solution to the thrust fault problem.
- Geologic evidence is that most thrust faults aren't large landslides.
- The physics-lab model of a rigid rectangular block is misleading (blocks are tapered and they deform internally).
- Senior thesis of Dan Davis '78

Alberta foothills

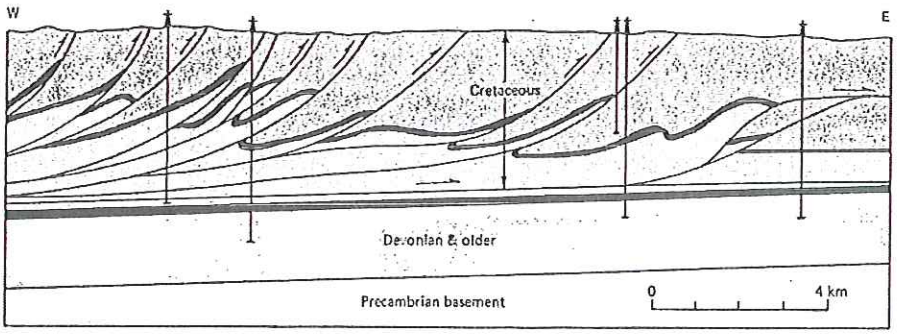


FIGURE 13–21 Detailed cross section of part of Foothills belt of the Canadian fold-and-thrust belt, showing complex imbrication of the Mesozoic strata but underformed Paleozoic at depth. (Simplified after Ollerenshaw, 1973.)

Ray Price's Canadian Rockies...

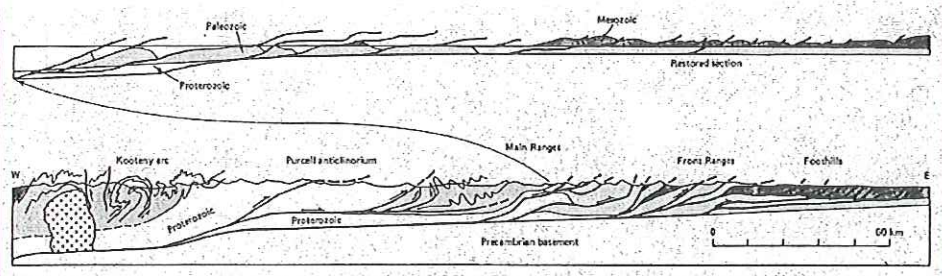
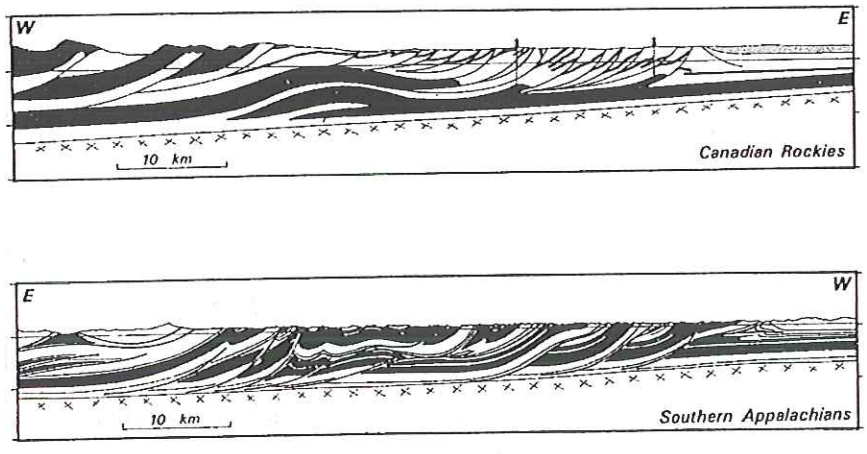
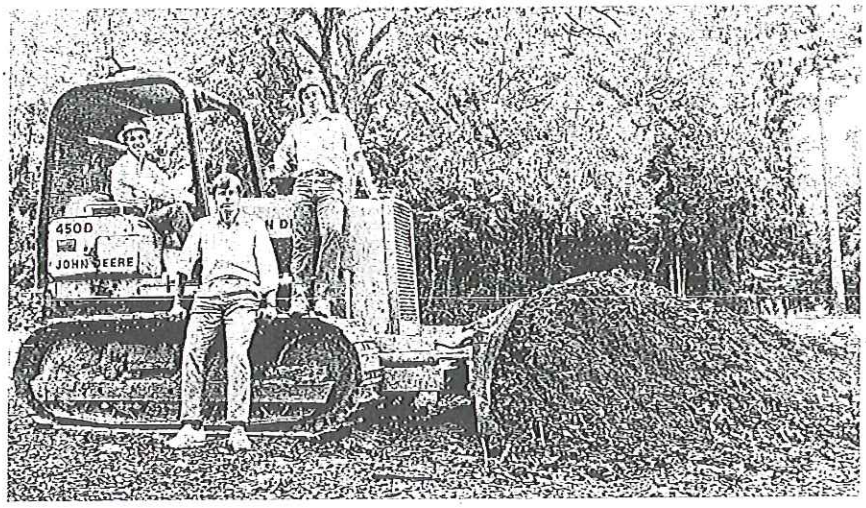


FIGURE 13–20 Cross section and restored section of the eastern Canadian Rockies. (Simplified after Price and Fermor, undated.)

Ancient thrust belts





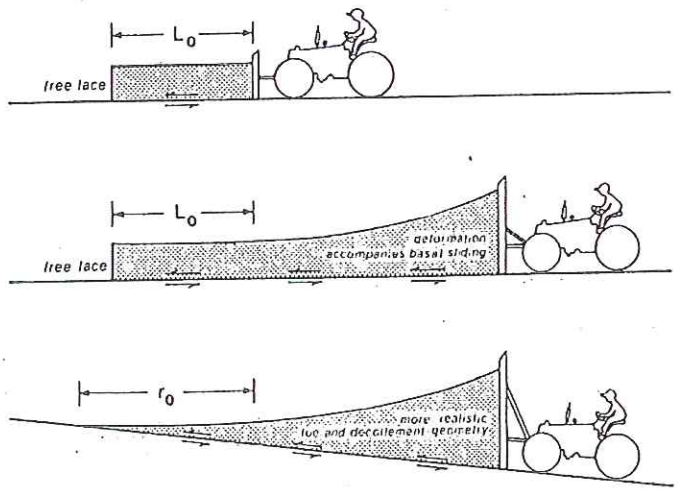
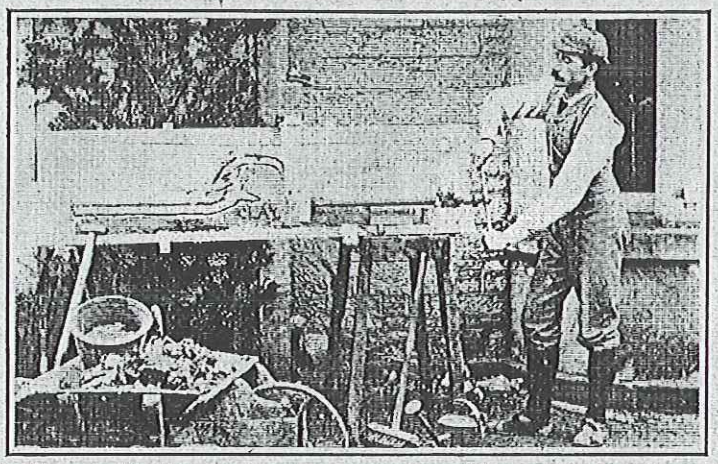


Fig. 3. Cartoon comparing the present analysis with that of *Hubbert and Rubey* [1959].

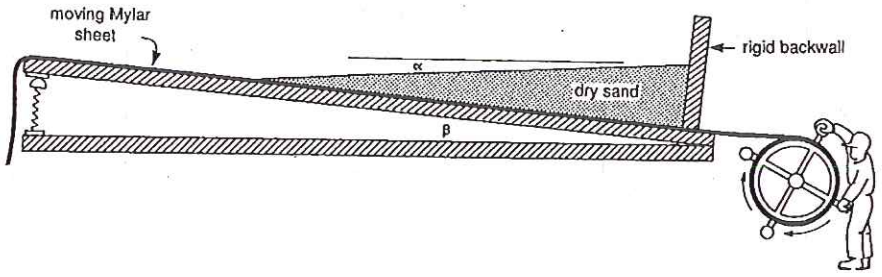
EXPERIMENTAL RESEARCHES IN MOUNTAIN BUILDING
The Geological Survey of Scotland

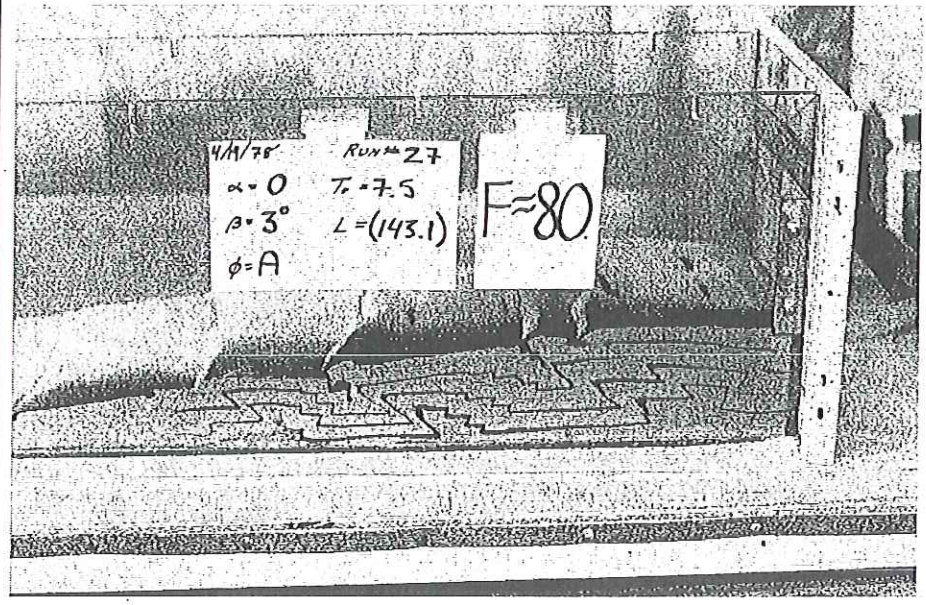


H. M. Cadell conducting his experiments in mountain building outside The Grange, Bo'ness, Linlithgowshire, in order to simulate the geological structure of the North-West Highlands of Scotland.

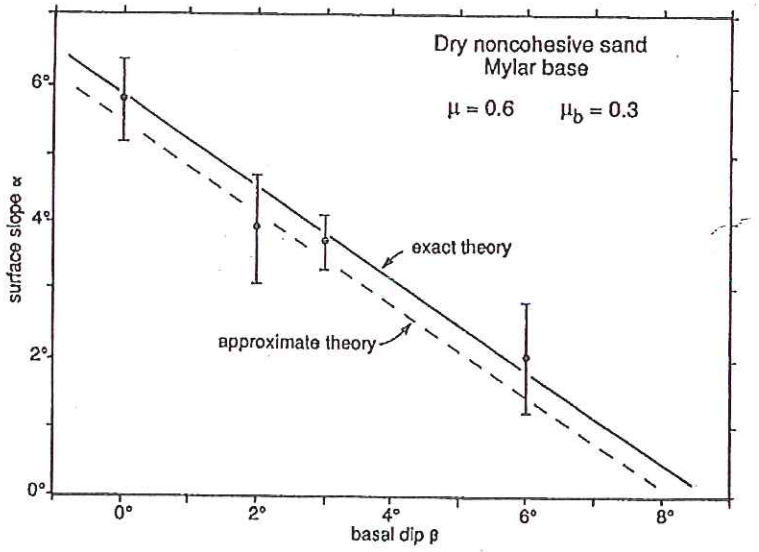
Photograph, taken in 1887, reproduced with permission of Mr W. A. Cadell and the Council of the Royal Society of Edinburgh by courtesy of the Institute of Geological Sciences, Edinburgh.

Dan Davis' apparatus

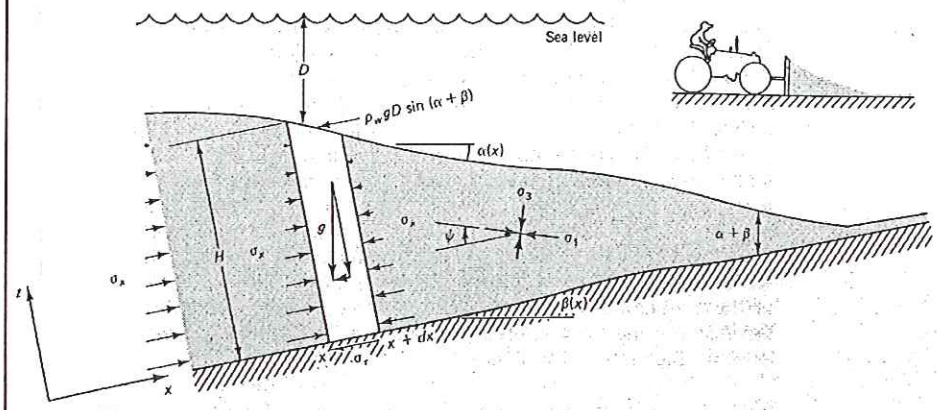




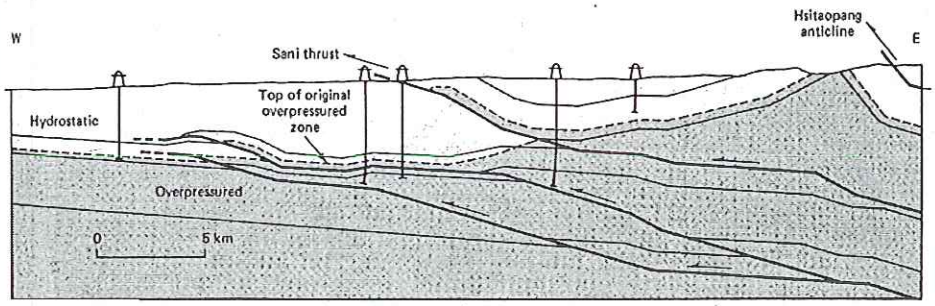
Dan Davis' results...

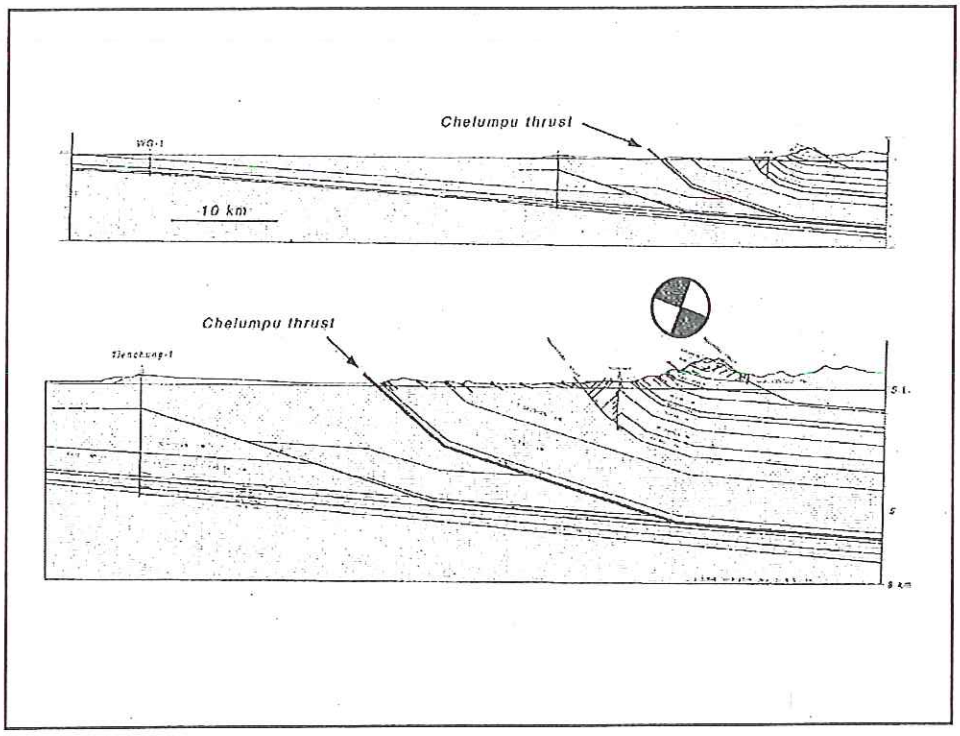


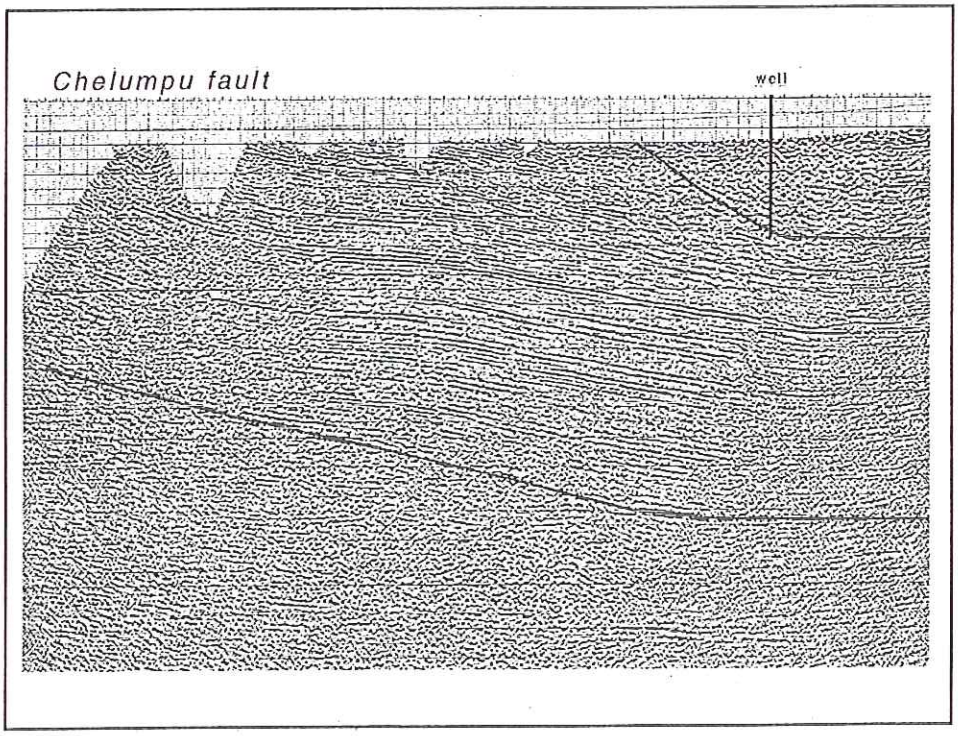
Taper = wedge strength/friction



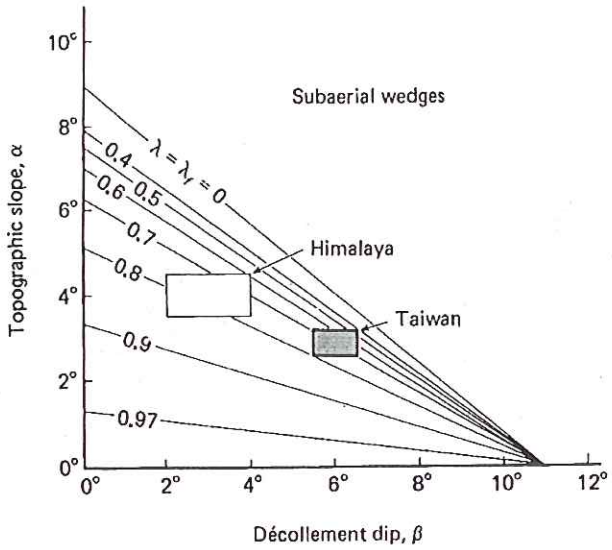
Taiwan fluid pressures

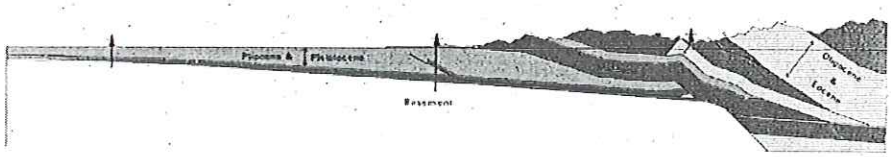



Chelumpu thrust
10 km
Chelumpu thrust

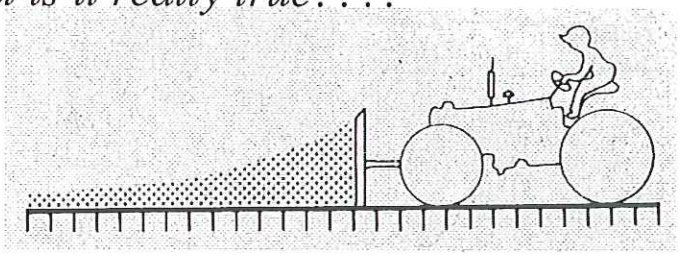

Chelumpu fault
well

The bottom line...

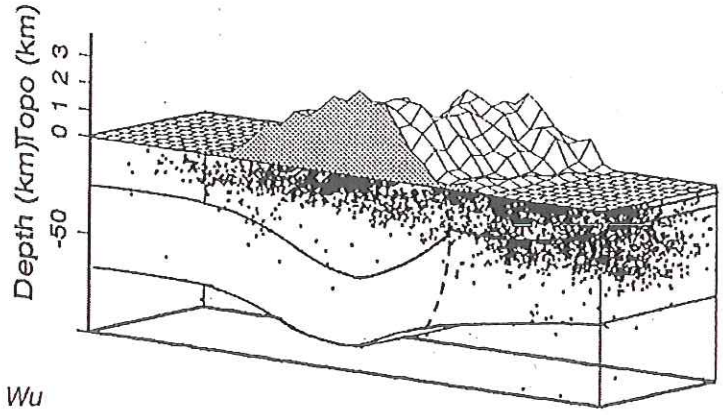


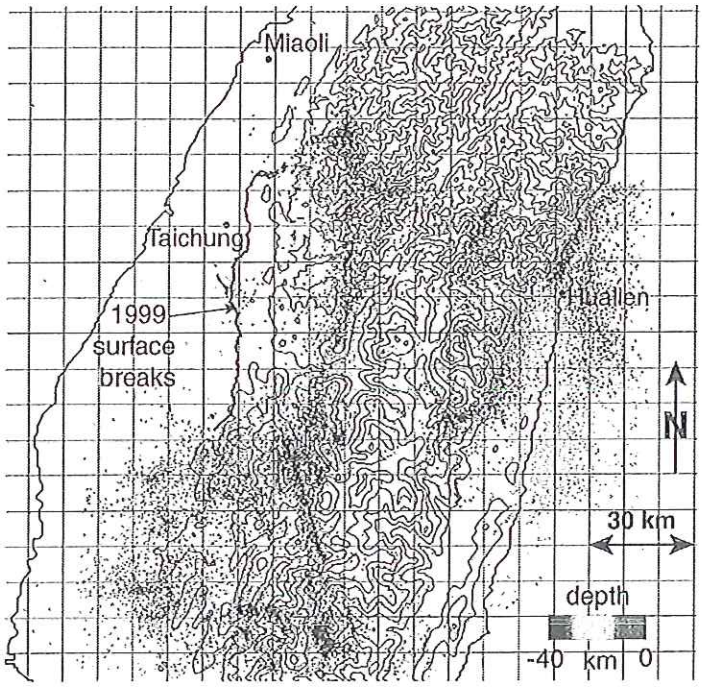


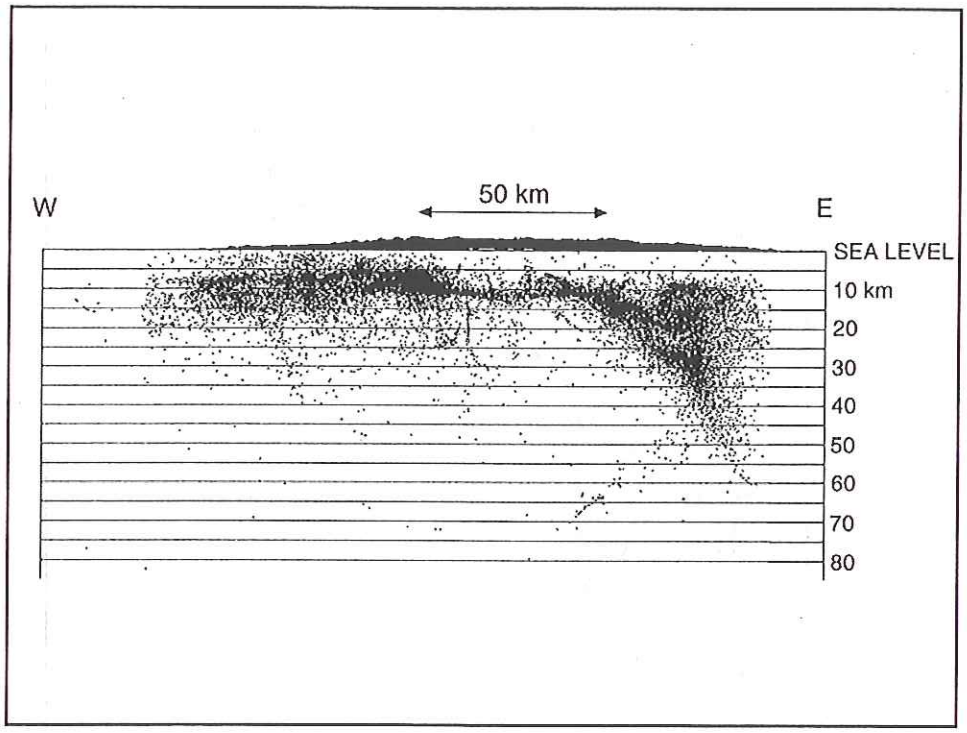
But is it really true????

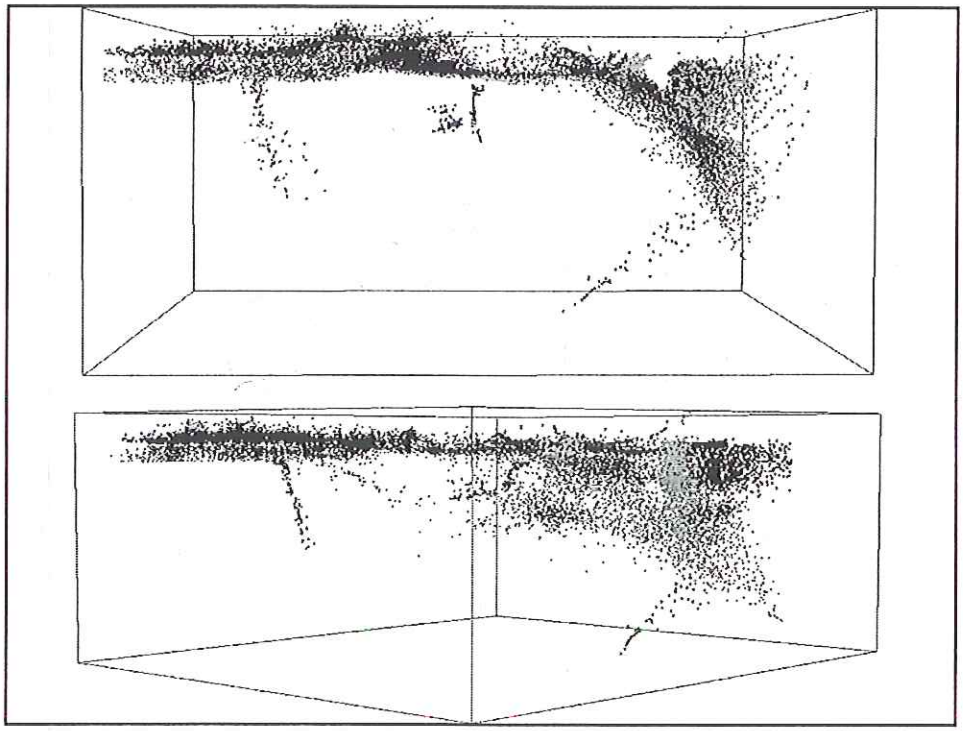


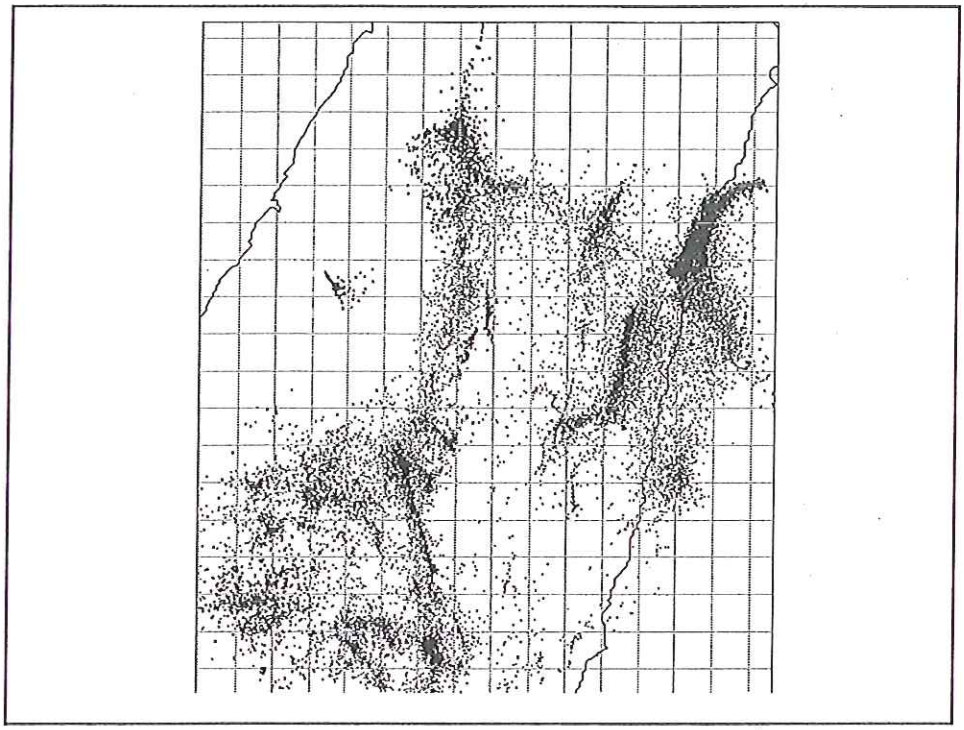
A ductile indentation,
with no basal detachment or wedge...????

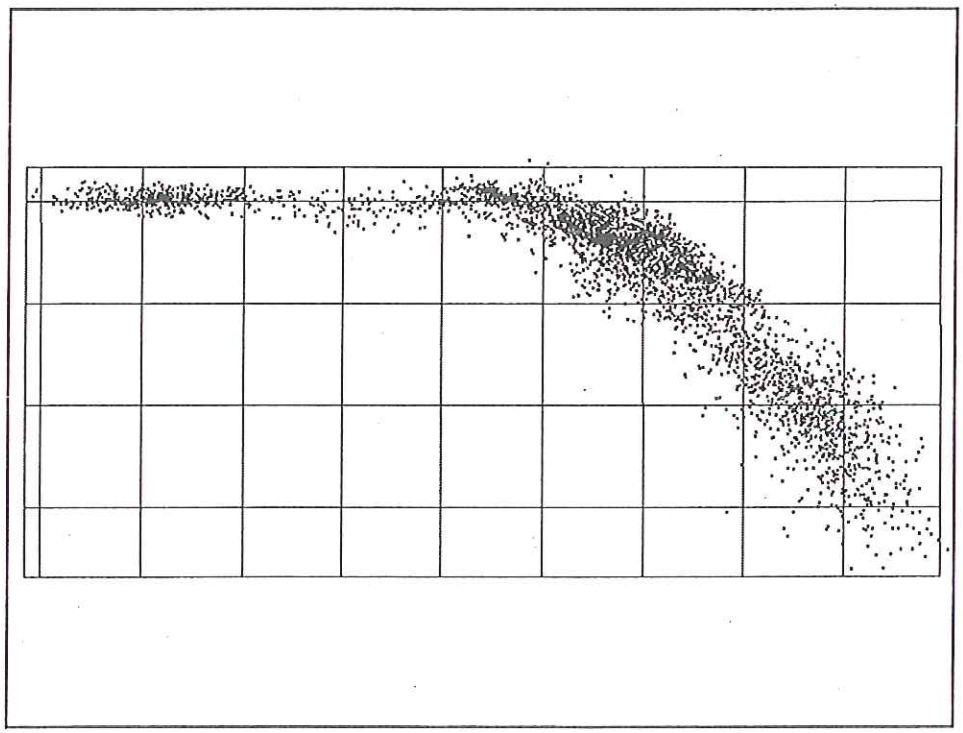


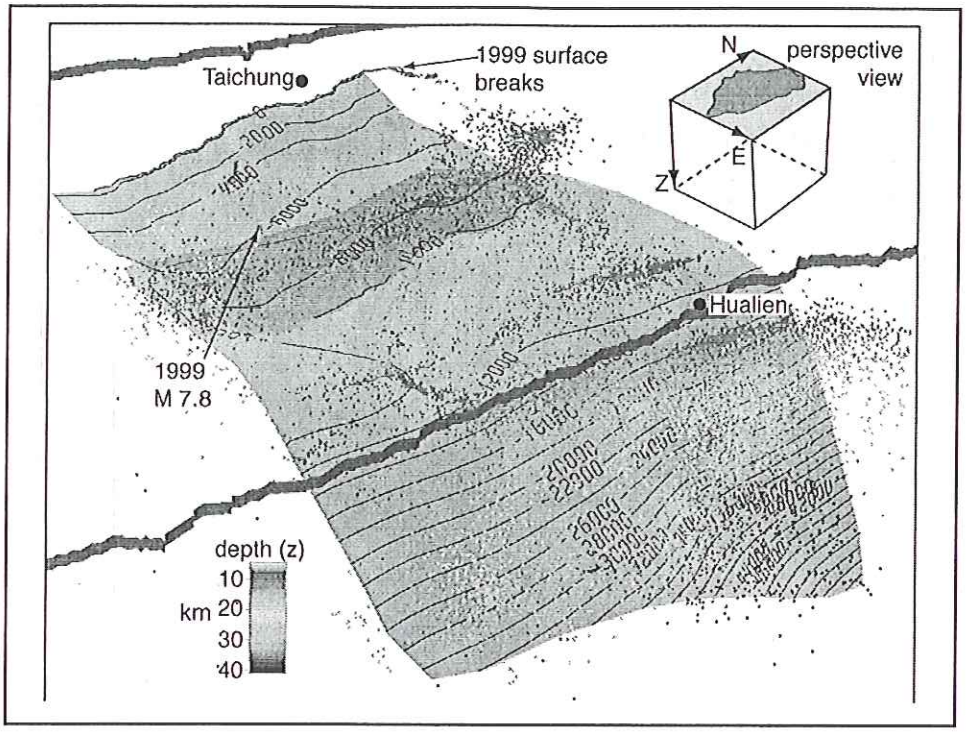



W
50 km
E
SEA LEVEL
10 km
20
30
40
50
60
70
80

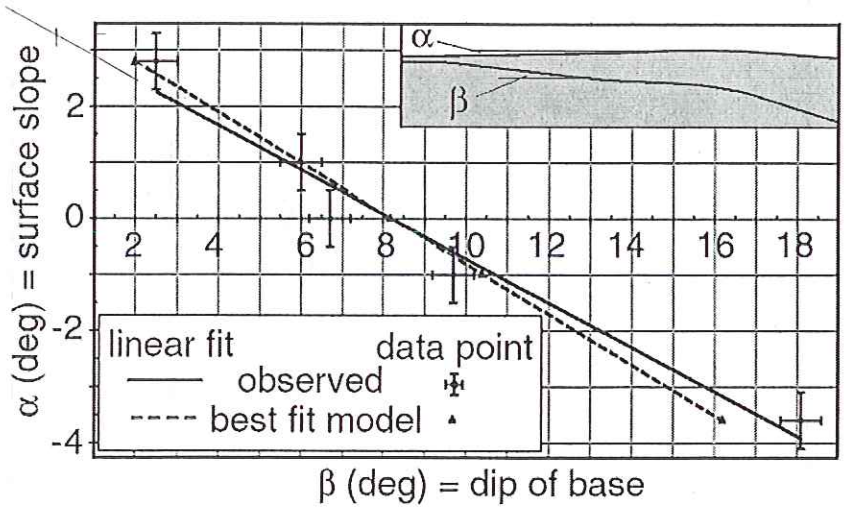






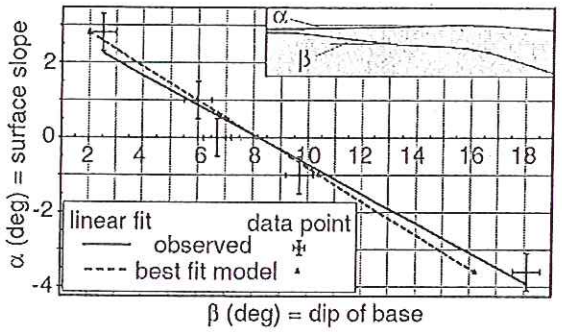


Linear in taper space...



Implication:

Taiwan topography is dominated by changing dip of Main Detachment, not by changing mechanical properties.



Topography & the Main Detachment...