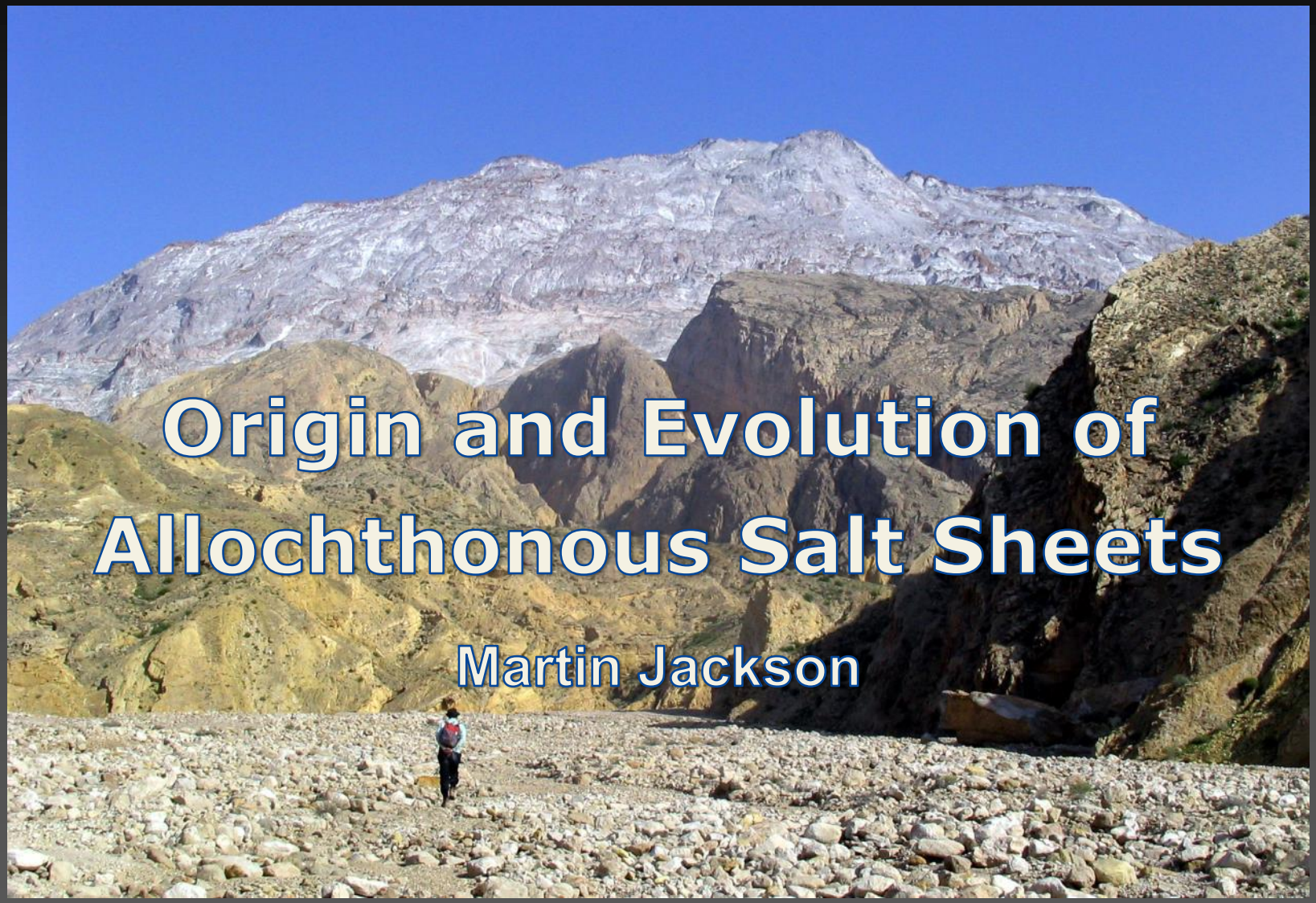
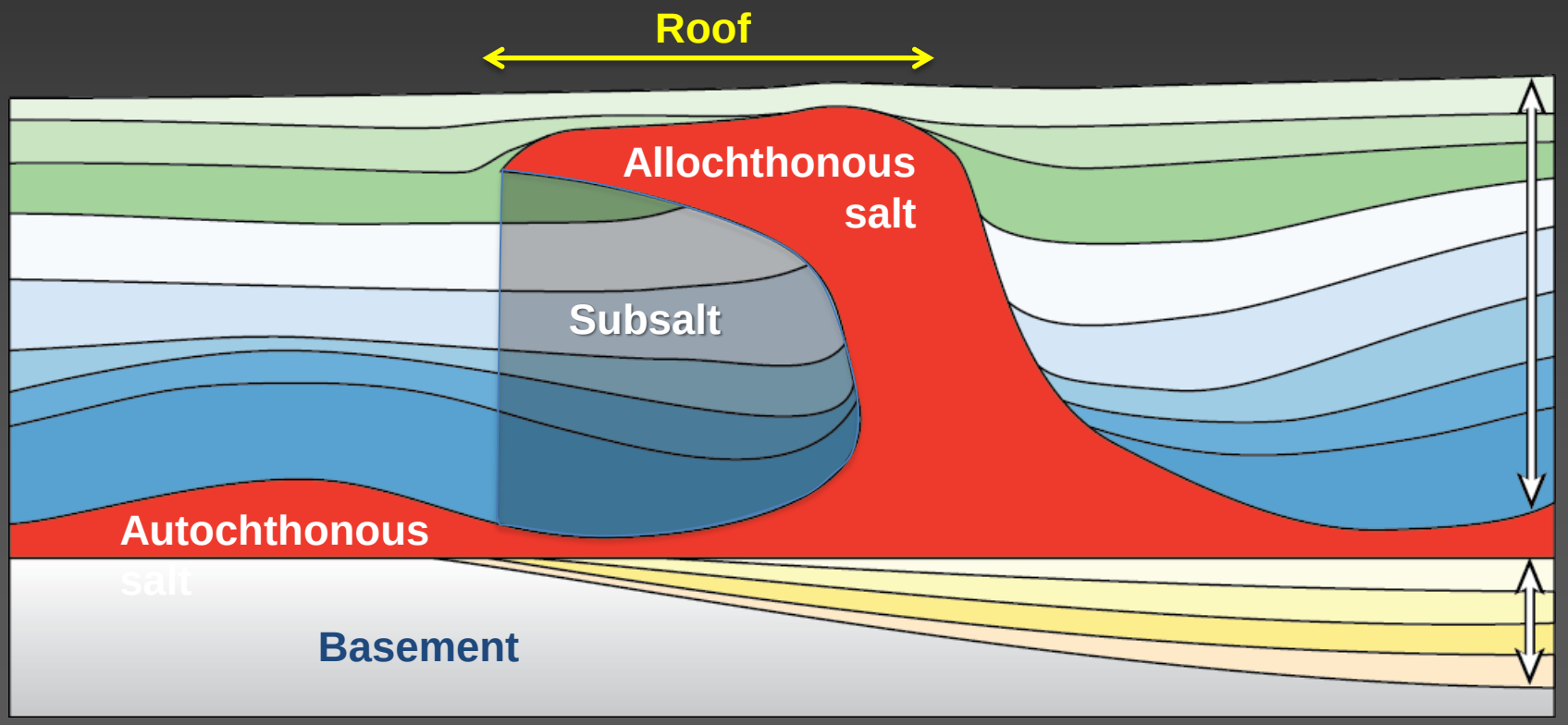


Origin and Evolution of Allochthonous Salt Sheets

Martin Jackson

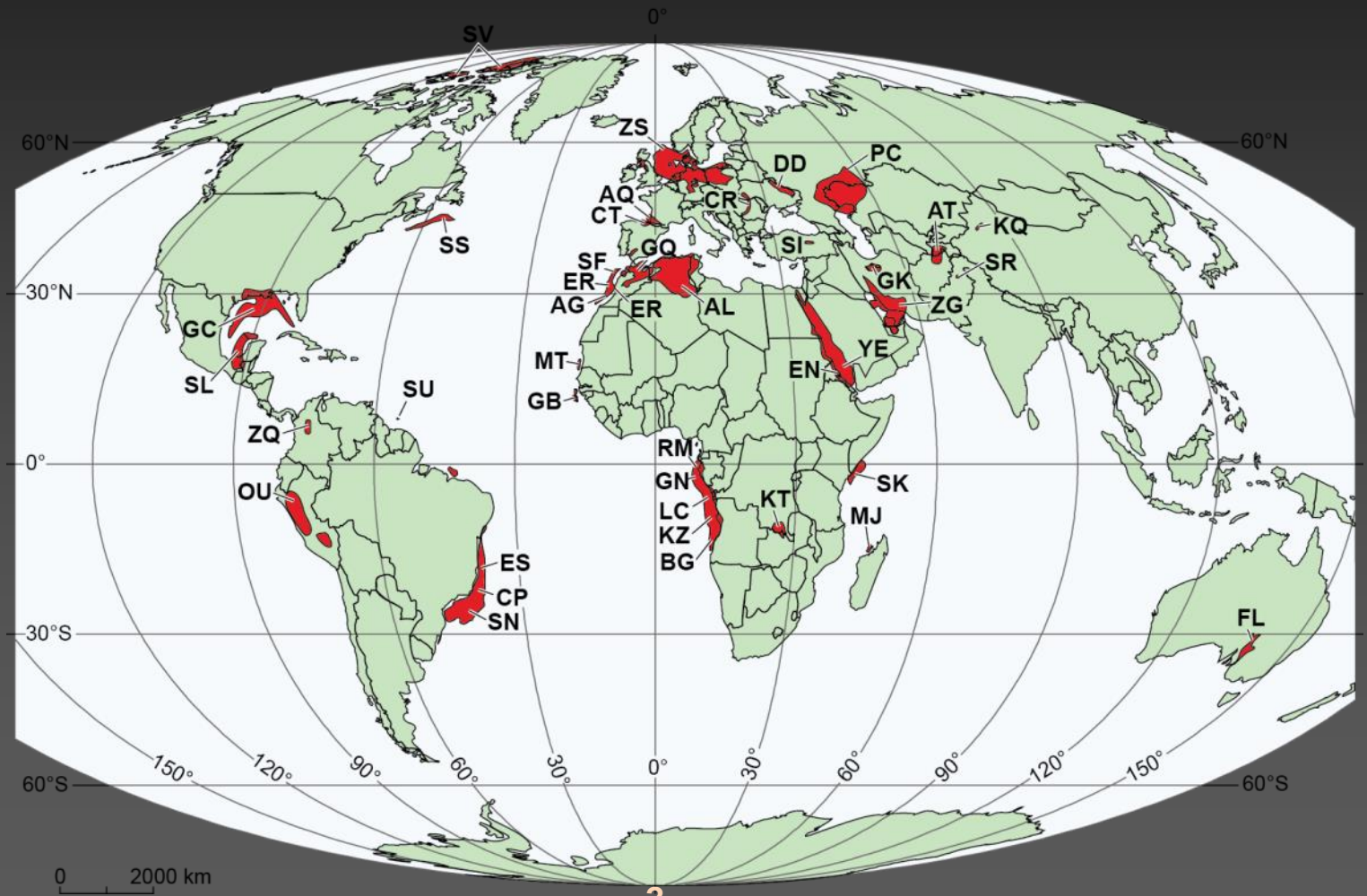
What?

- Allochthonous: moved from origin
- Could be applied to any deformed evaporite
- More usefully, allochthonous = sheet-like body of salt above younger strata
- Allochthonous salt = salt sheet

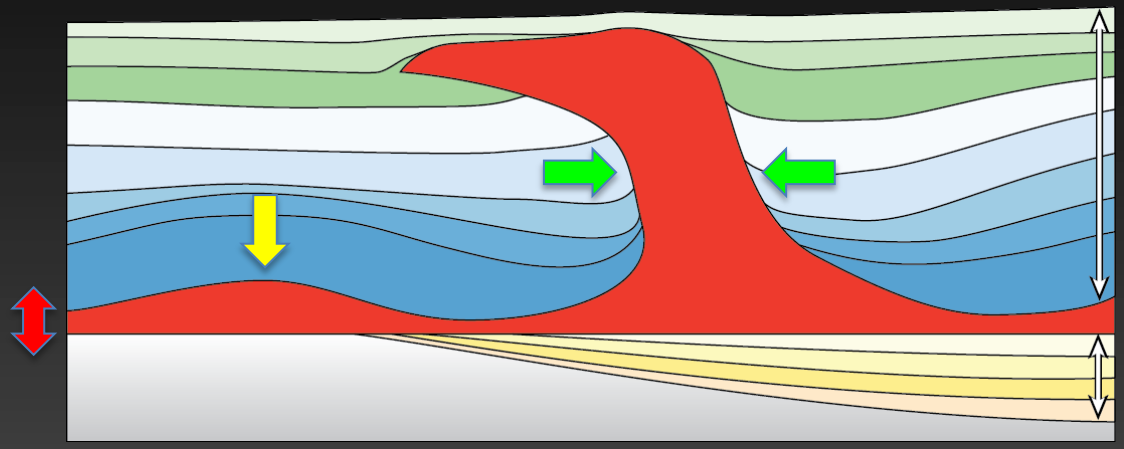


Where?

- ~140 basins have salt tectonics
- Allochthonous salt in ~35 basins



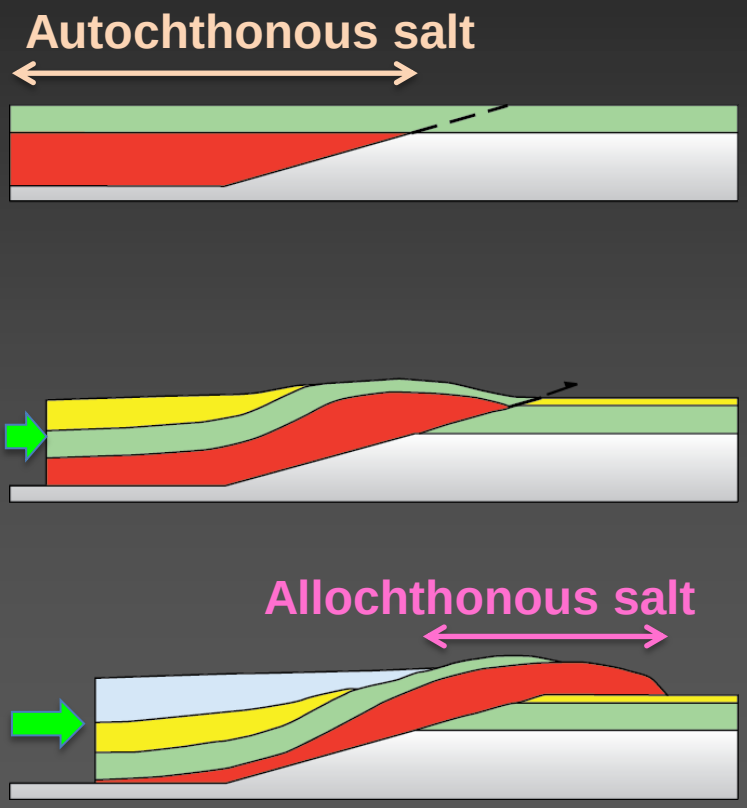
Origin



- *Essential*
  - Adequate salt → Thick autochthonous salt
  - Large gravitational load → Thick, dense overburden
- *Helpful*
  - Displacement load → Lateral tectonic compression

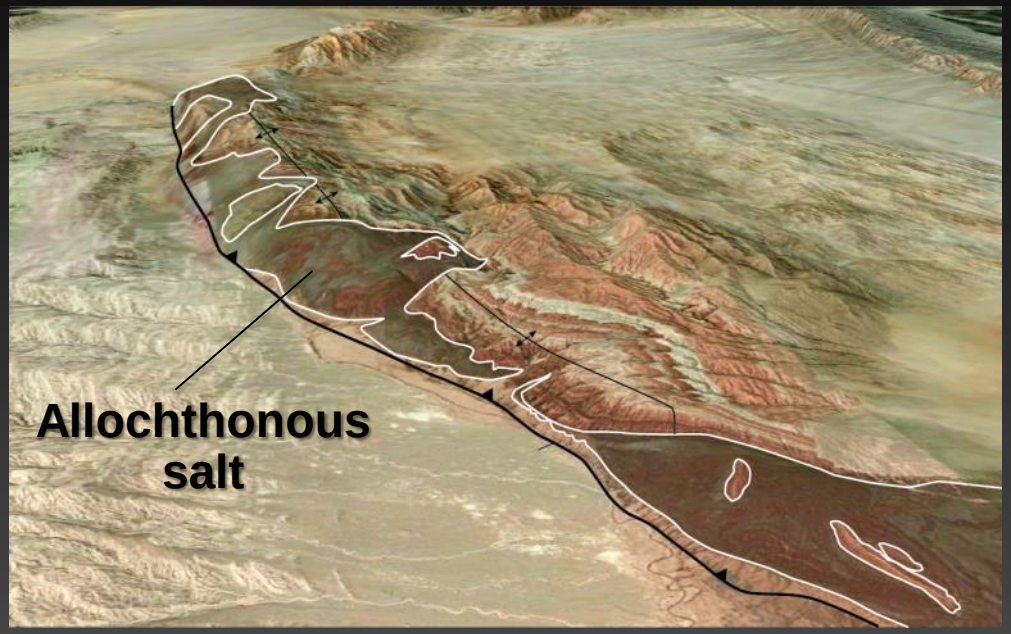
Form

- Line source: extrusion from orogenic thrust front

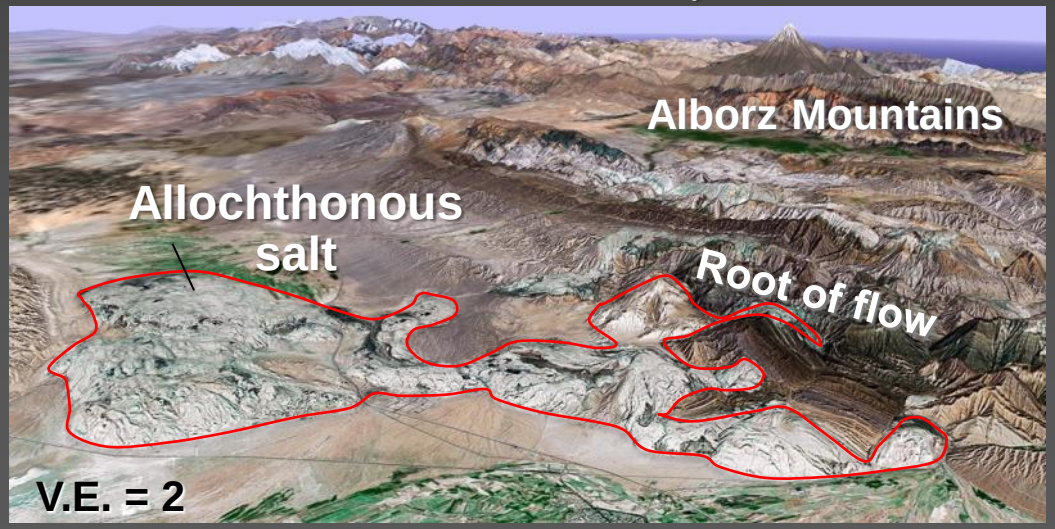


Hudec & Jackson 2006

Kuqa basin, China



Great Kavir basin, Iran



Google Earth

Form

Point source: extrusion from plug-shaped diapir

Zagros fold belt, Iran

V.E. = 2

Google Earth

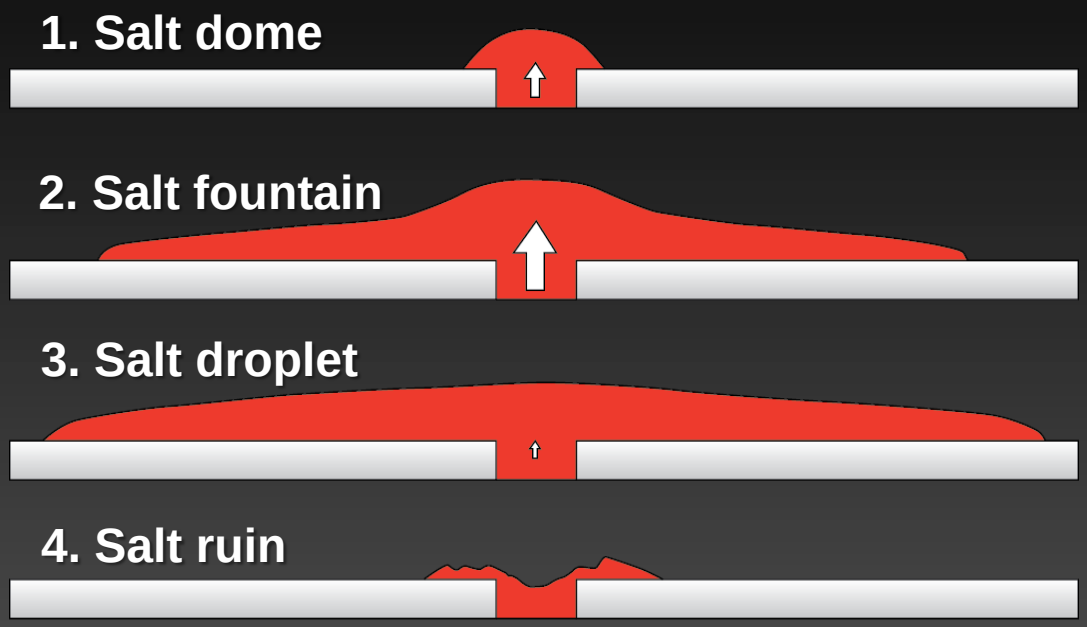
Evolution

1. Salt dome

2. Salt fountain

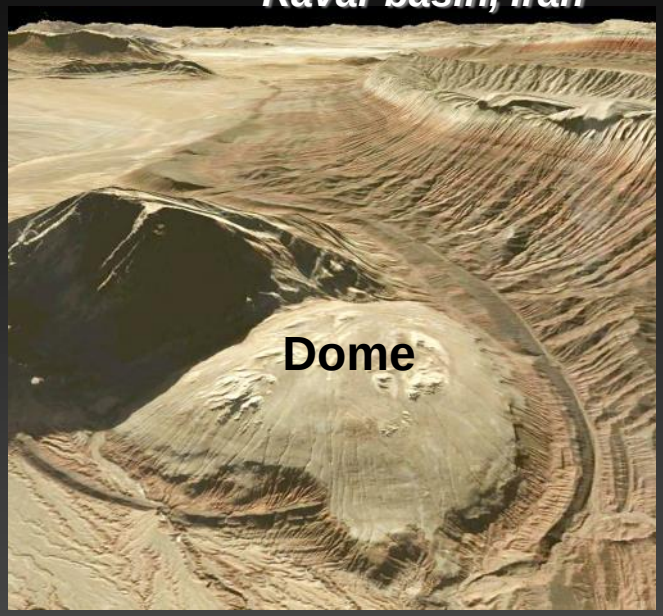
3. Salt droplet

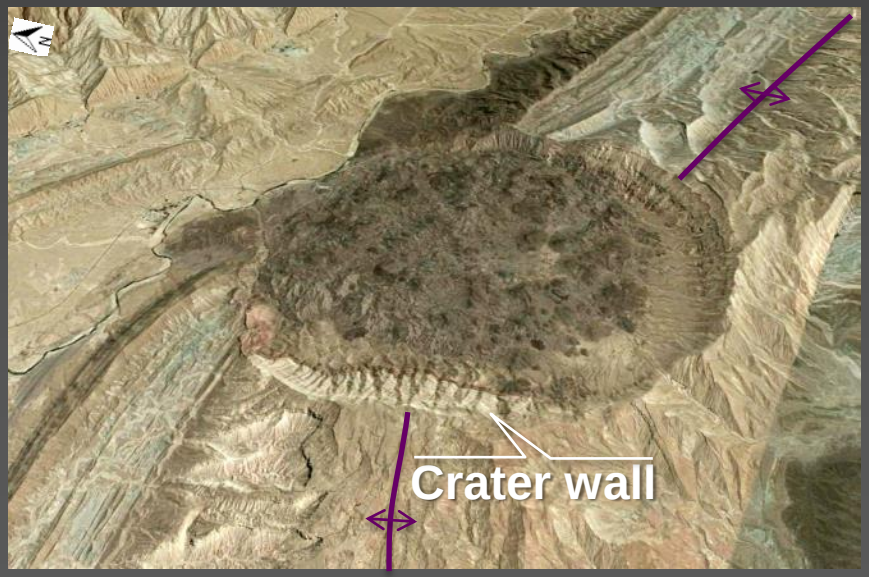
4. Salt ruin



C. Talbot

Ravar basin, Iran





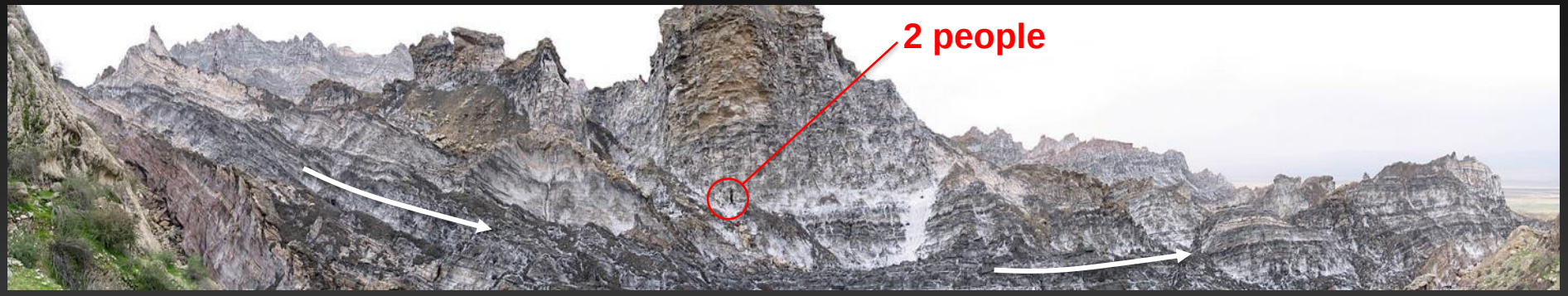
Zagros fold belt, Iran

Google Earth

Rate

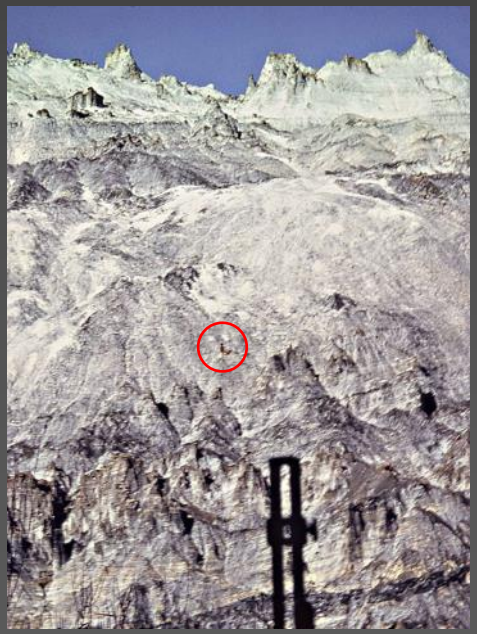
180º panorama

Kuh-e-Namak (Bushehr)

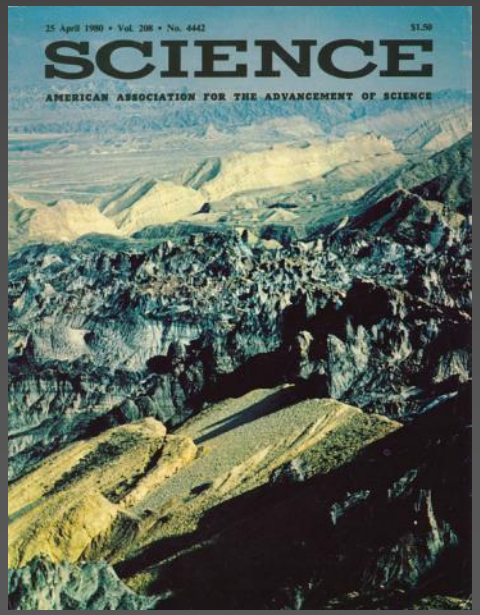


M. Jackson

Damp salt glaciers surge at m/yr at differential stresses <0.25 MPa.
Followed by years of no advance (Talbot & Rodgers 1980)



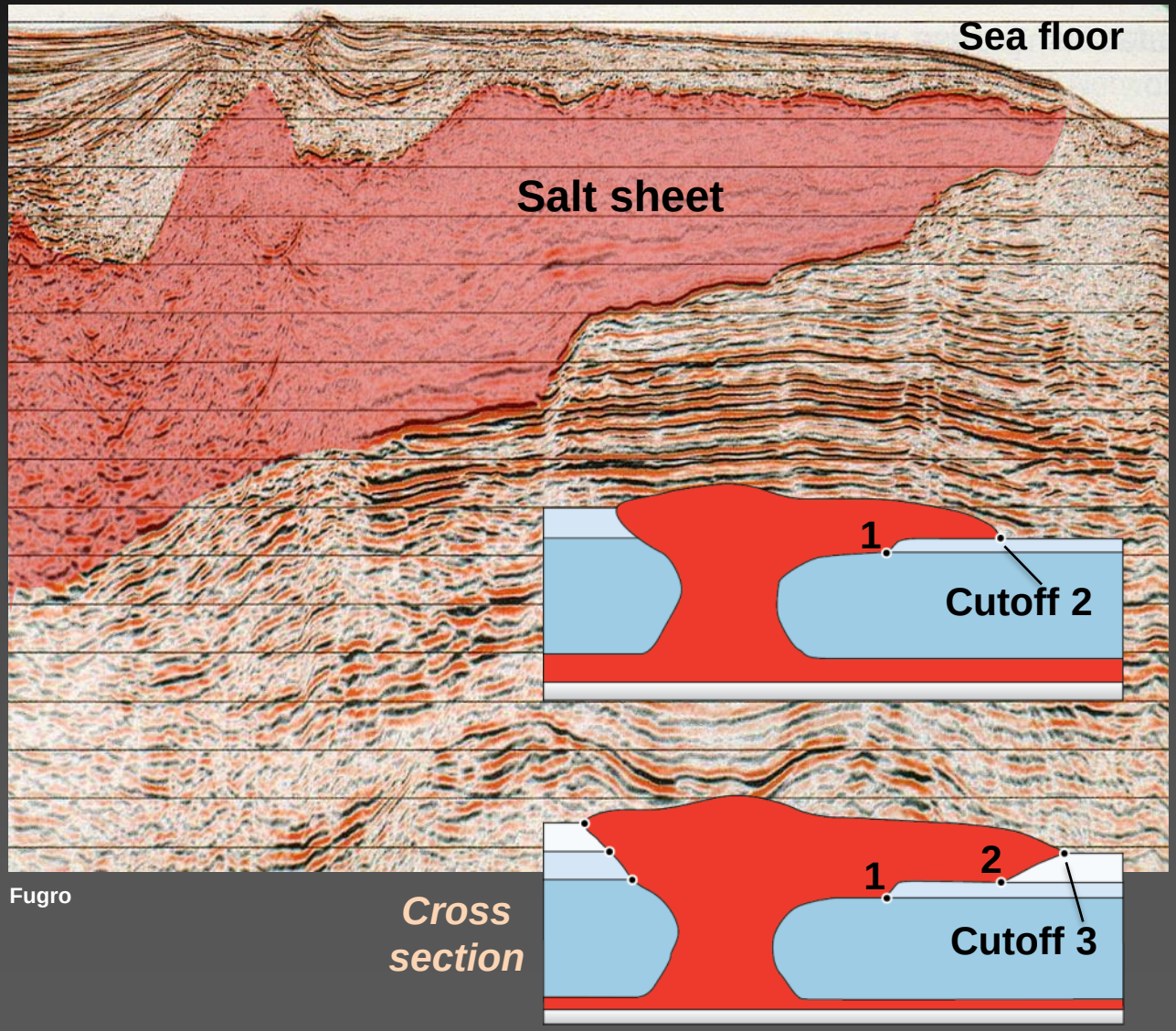
C. Talbot



J. Letouzey

Extrusive Advance

Gulf of Mexico

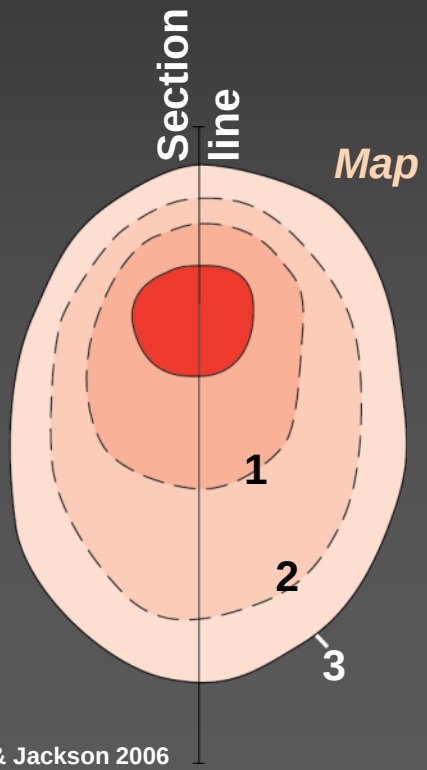


Fugro

Cross section

Growth history recorded by stratal cutoffs.

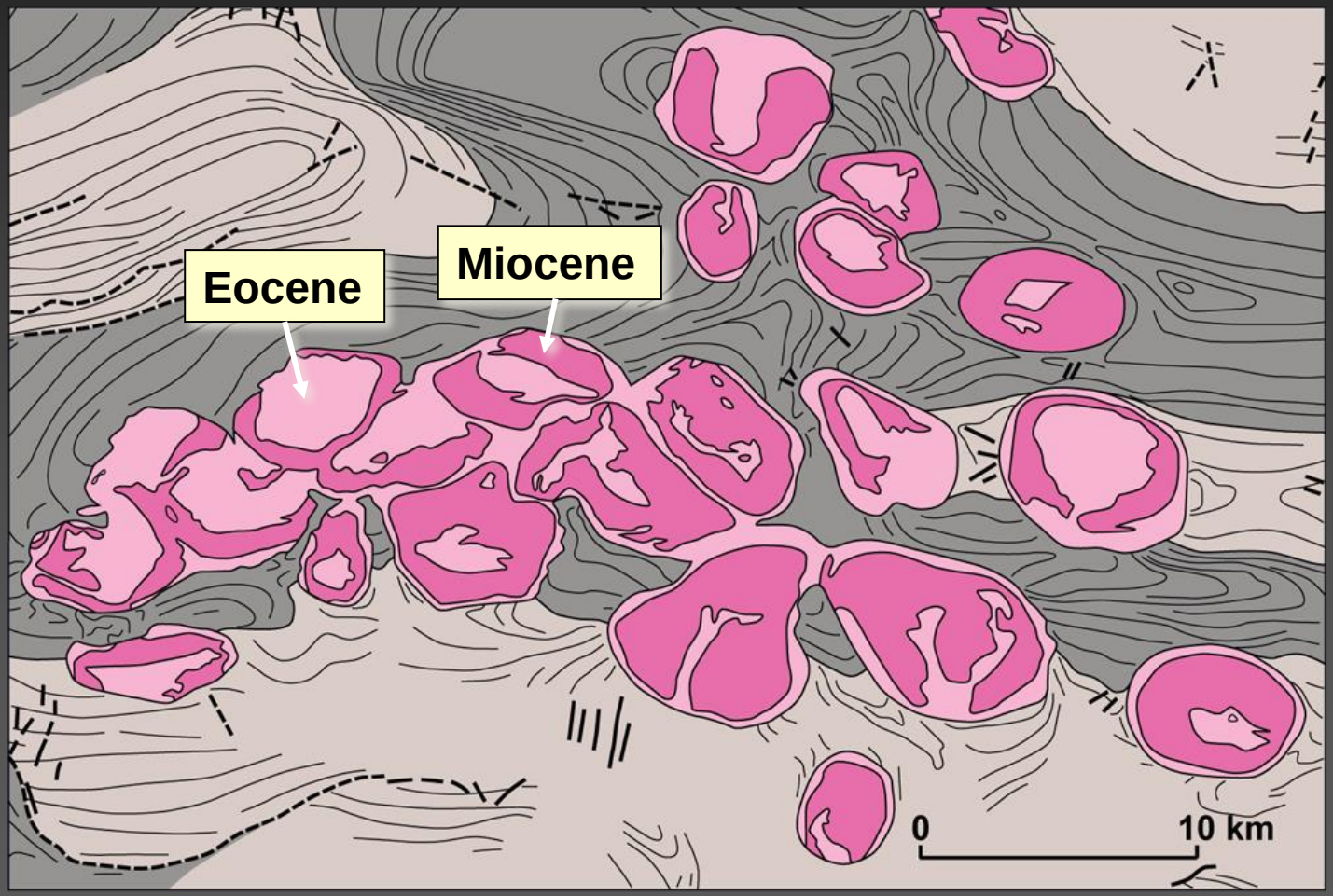
Advance rate = mm/yr



Hudec & Jackson 2006

Coalescence

- 12 diapirs (~4 km wide) coalesced to form salt canopy
- Two ages of evaporite: Eocene (marine) and Miocene (continental)



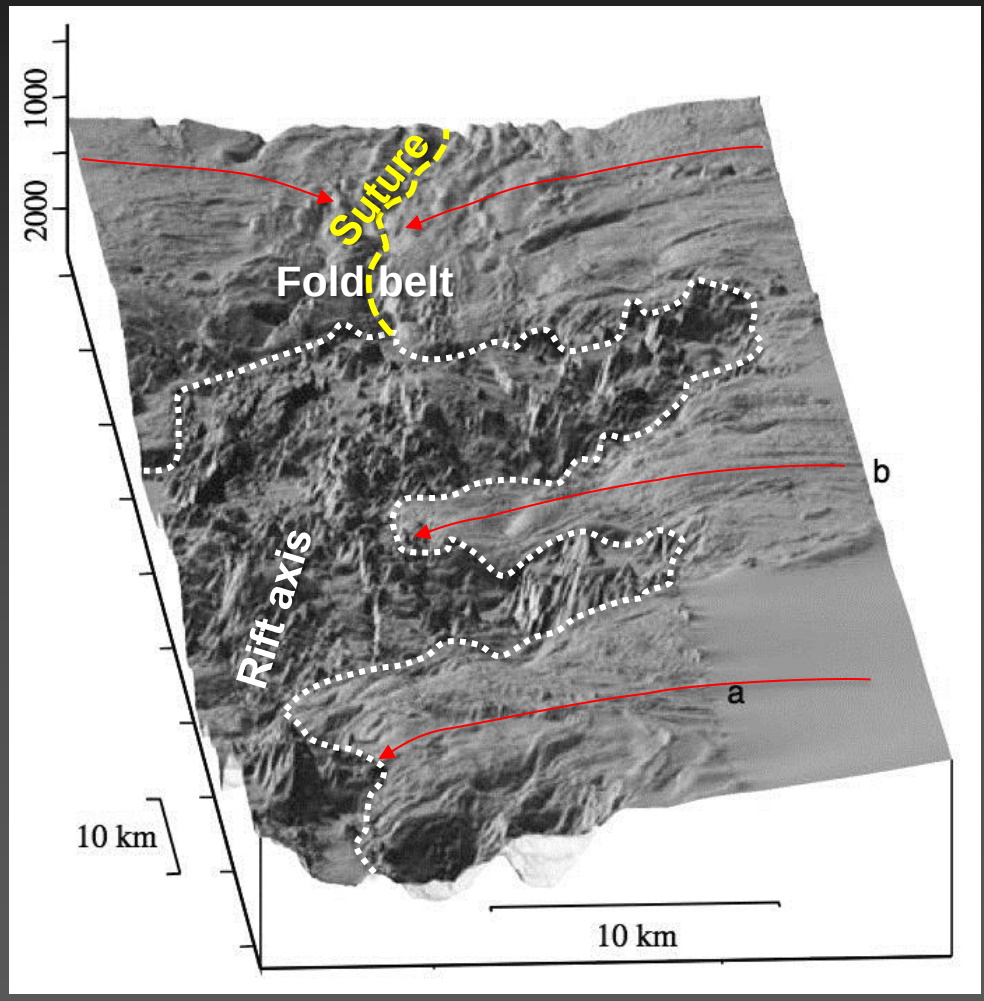
Great Kavir, Iran

Jackson et al. 1990

Coalescence

- Miocene allochthonous salt below pelagic mantle
- Lateral flow down continental slope
- Flow into axial rift
- Flow across extended oceanic crust (0.7 Ma) and its thin cover
- 4 salt lobes
- Flow-parallel streaks
- At toe-of-slope:
  - Fold belt
  - Salt suture

Central Red Sea



Mitchell et al. 2009

V.E. = 4

Coalescence

- Continental slope is shallow mega-canopy of salt
- Hundreds of coalesced diapirs. Largest near-surface salt structure on Earth

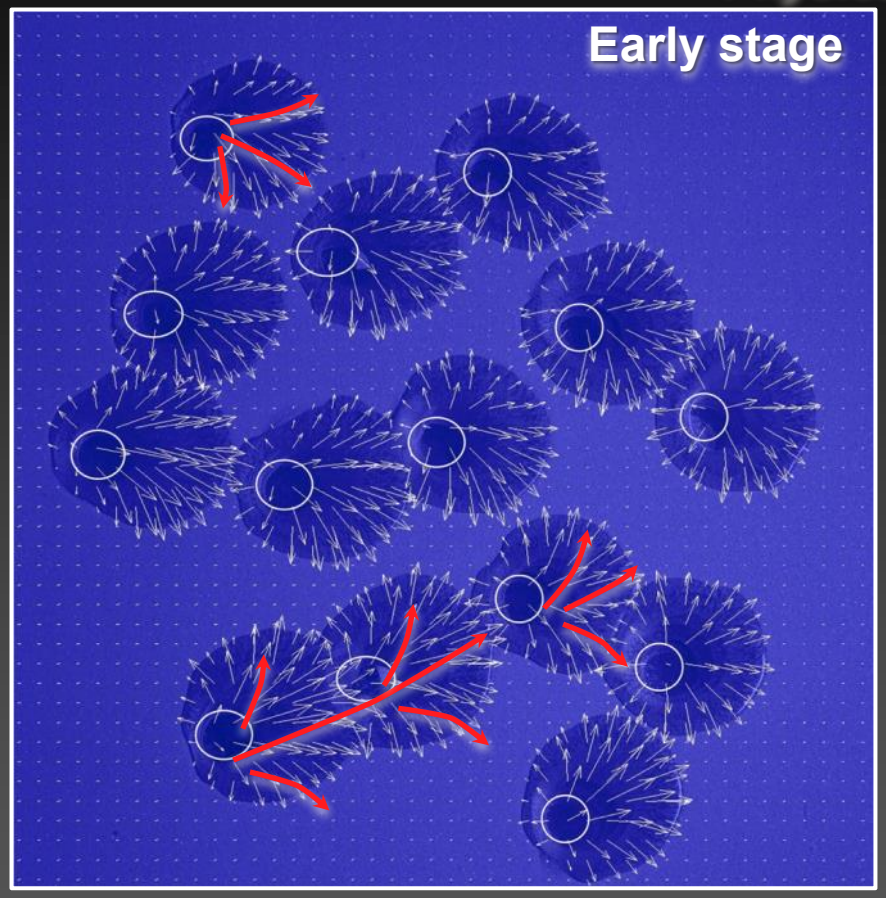
3

Northern Gulf of Mexico sea floor

- Sigsbee Escarpment = front of mega-canopy.
- Great-circle length >560 km
- Sinuous length >1000 km
- Average height ~800 m

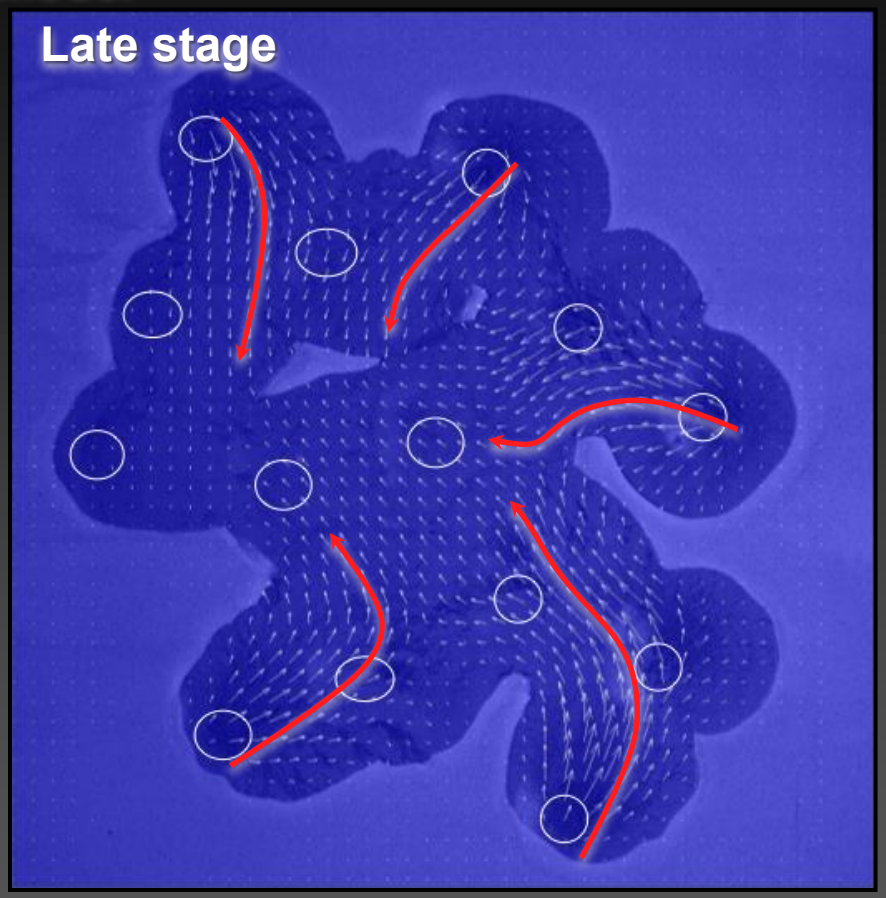
Coalescence

Physical model



T. Dooley

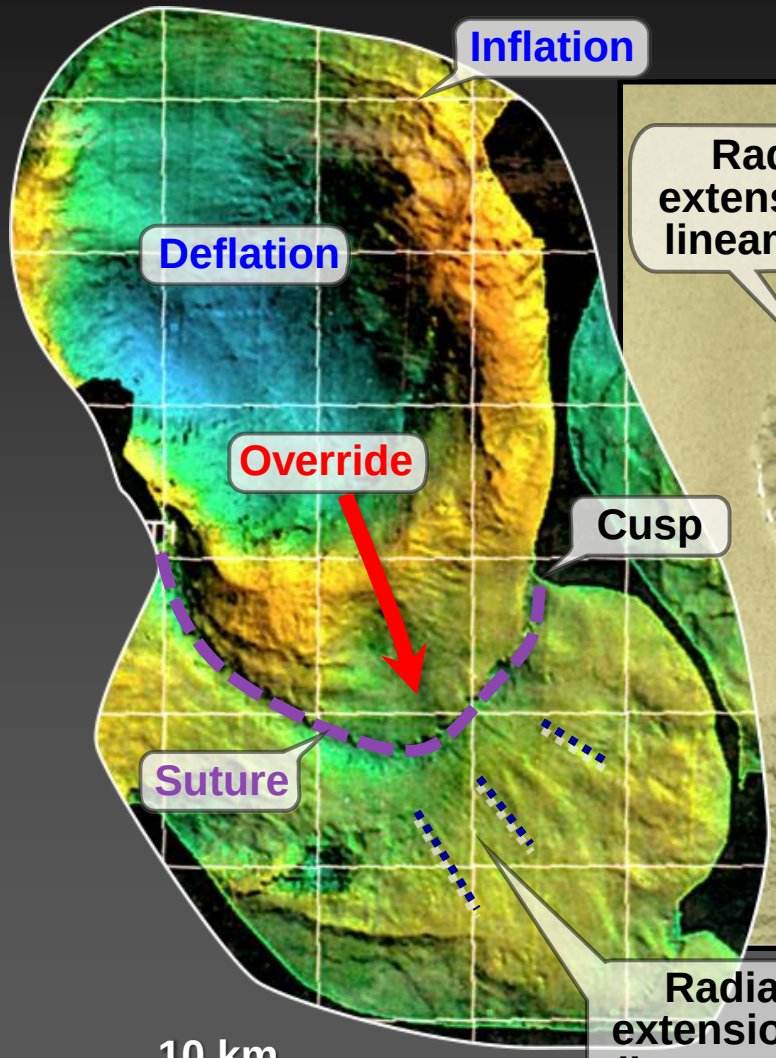
- Initially salt sheets spread subradially



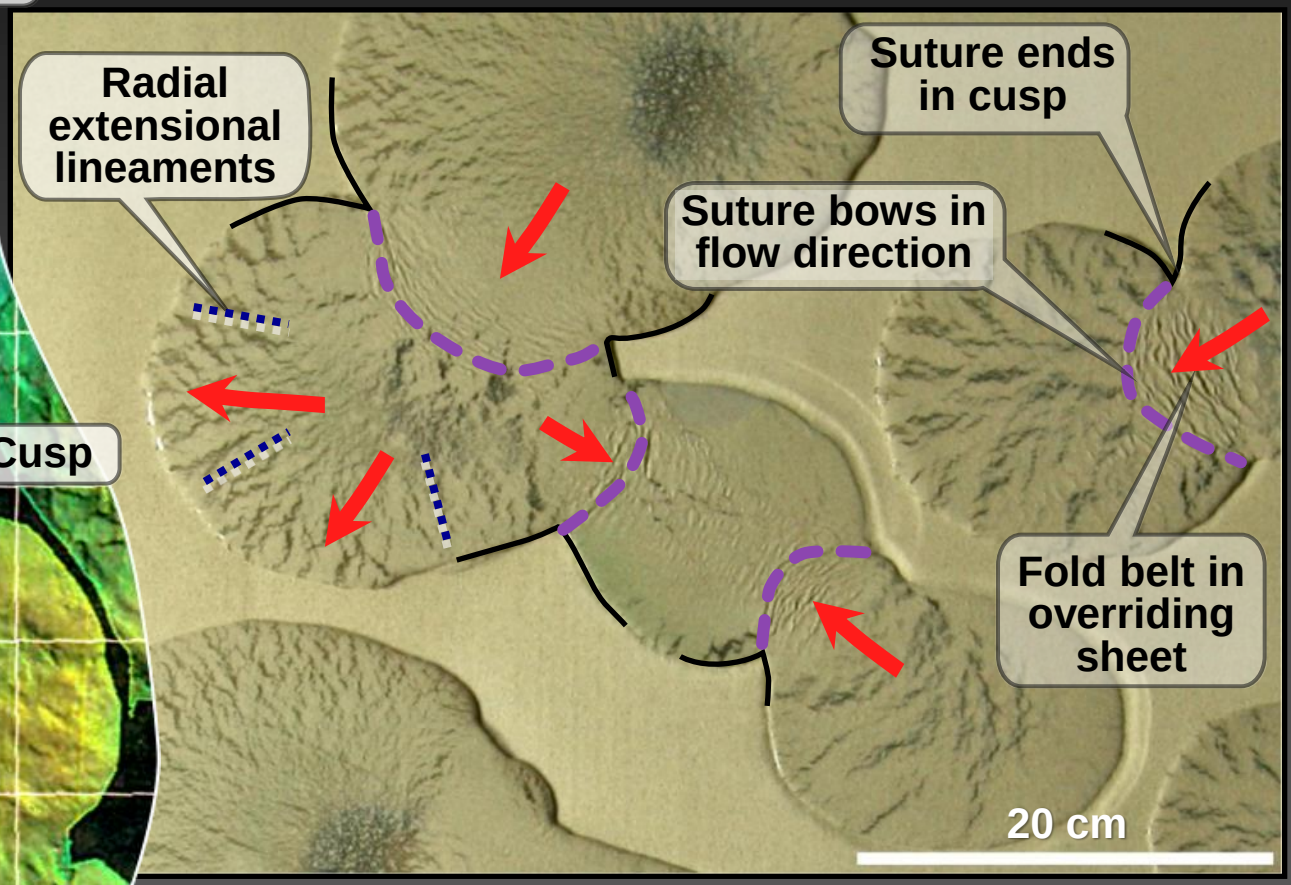
- After canopy coalesces, salt sheets spread inward
- Most-active feeders at canopy margin

Coalescence

Gulf of Mexico top of salt canopy

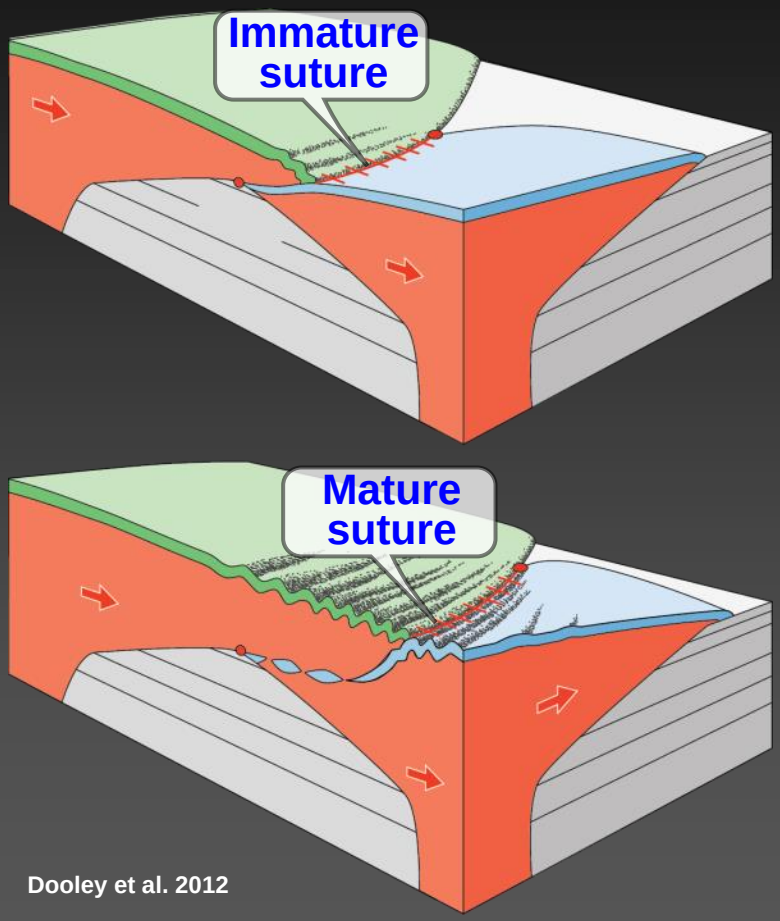


Physical model

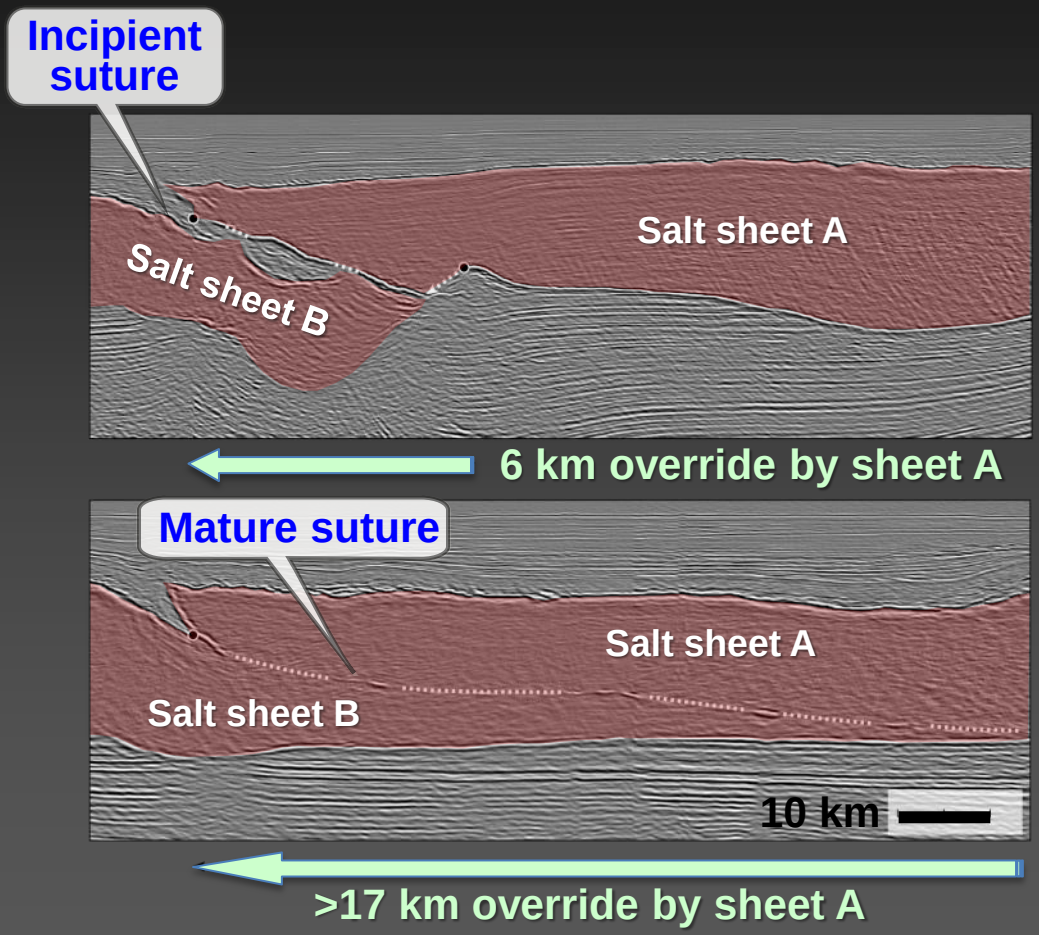


T. Dooley

Coalescence



Dooley et al. 2012



Dooley et al. 2012

Recycling

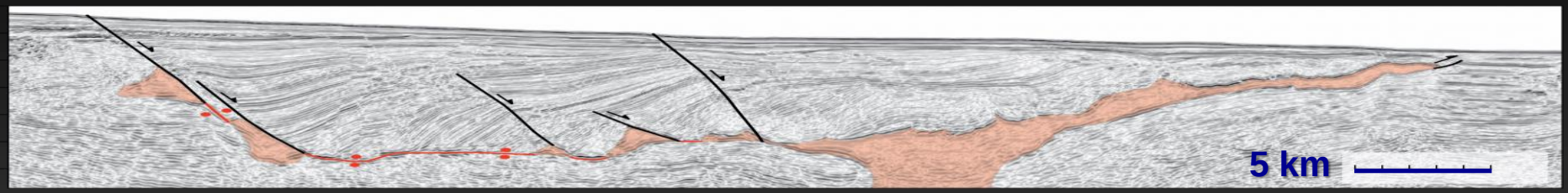
T. Dooley

- As it is buried, salt inside canopy is recycled
- Salt sheets deflate below thickest overburden
- Allochthonous salt expelled from deflating zone inflates canopy below thinnest overburden

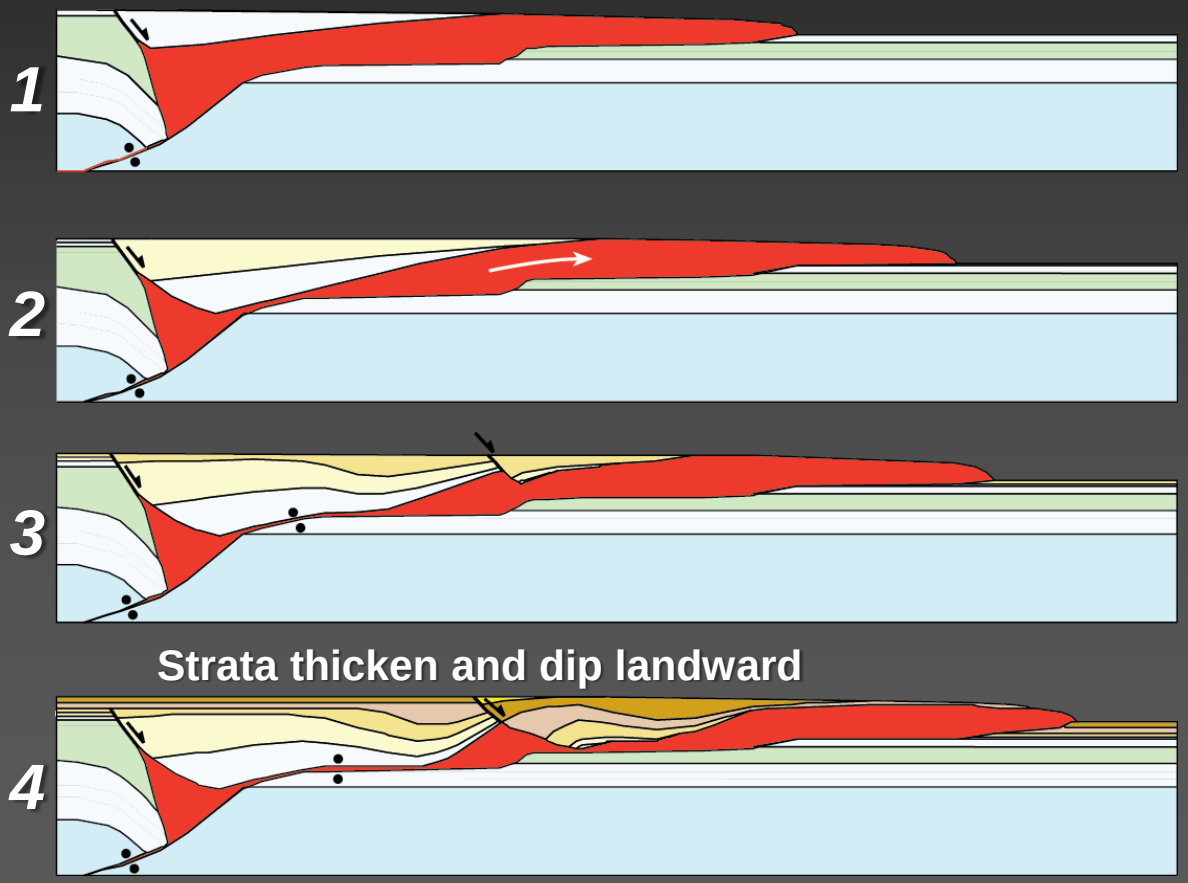
Recycling

Seaward →

Gulf of Mexico



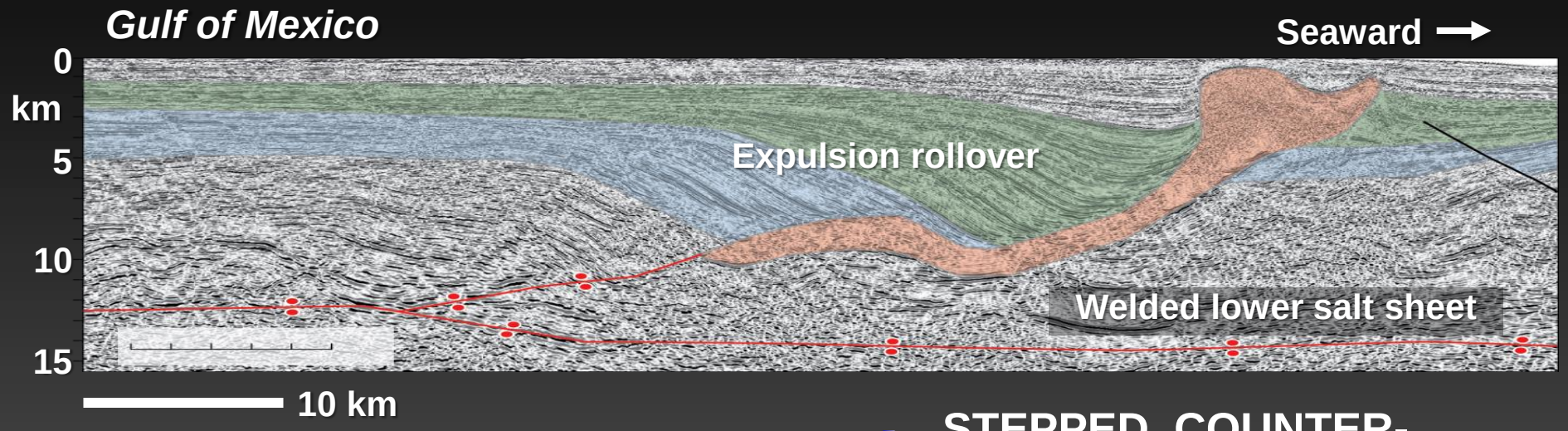
V.E. = 1

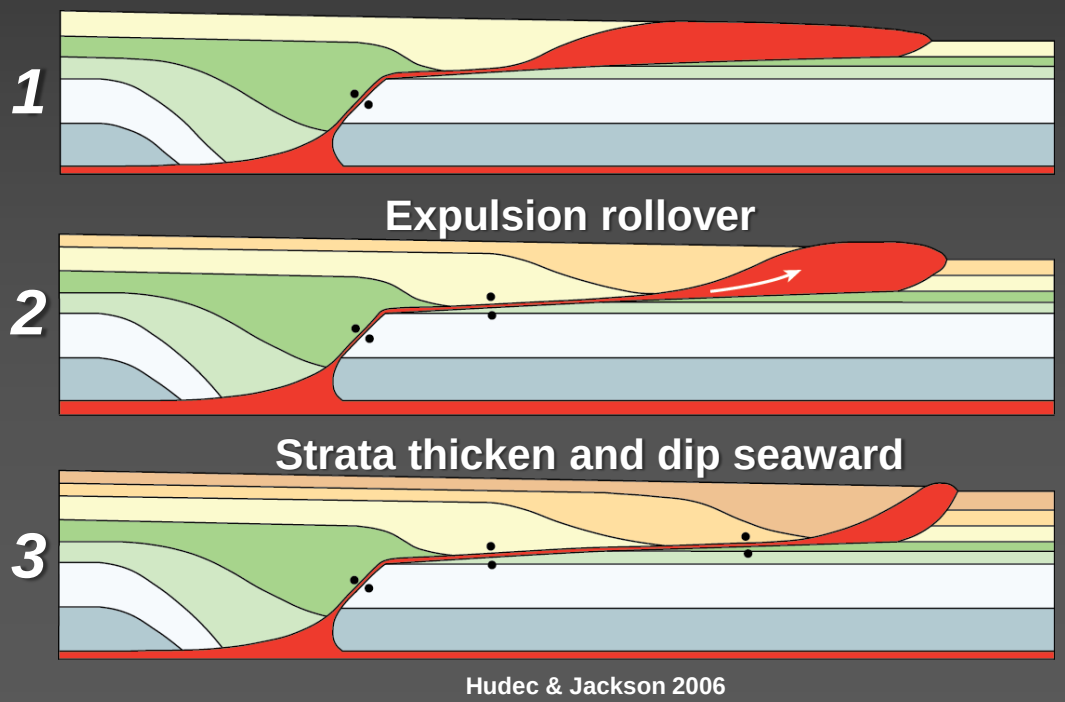


Hudec & Jackson 2006

- ROHO SYSTEM
- Highly extensional (tens of km)
- Overburden wedges expel salt seaward
- Proximal salt sheet deflates and welds
- Distal salt sheet inflates and advances

Recycling

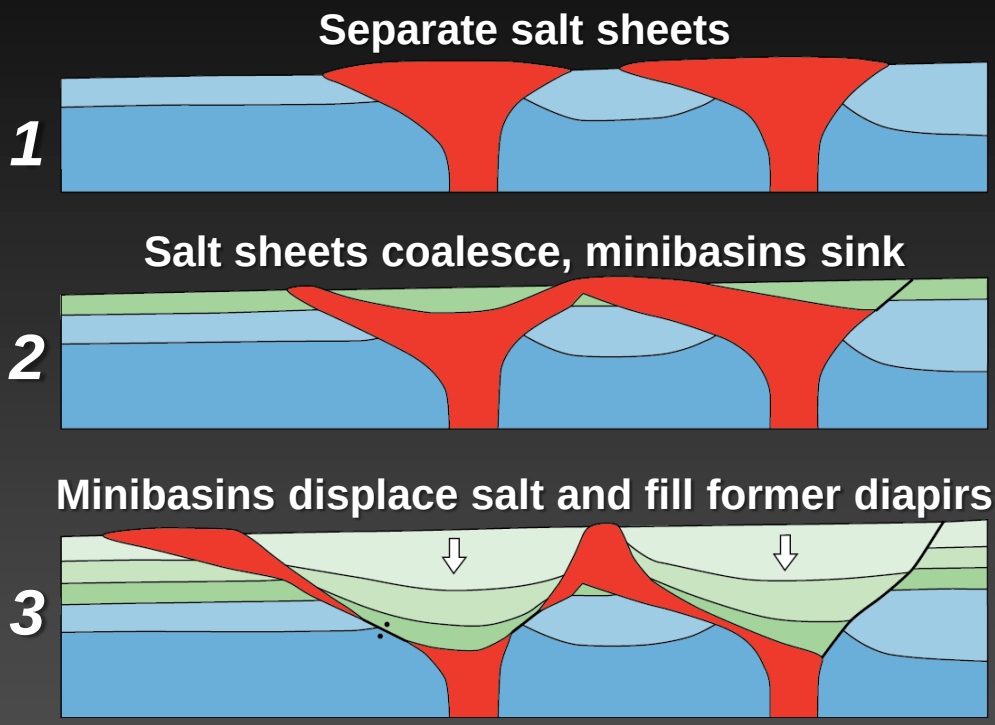


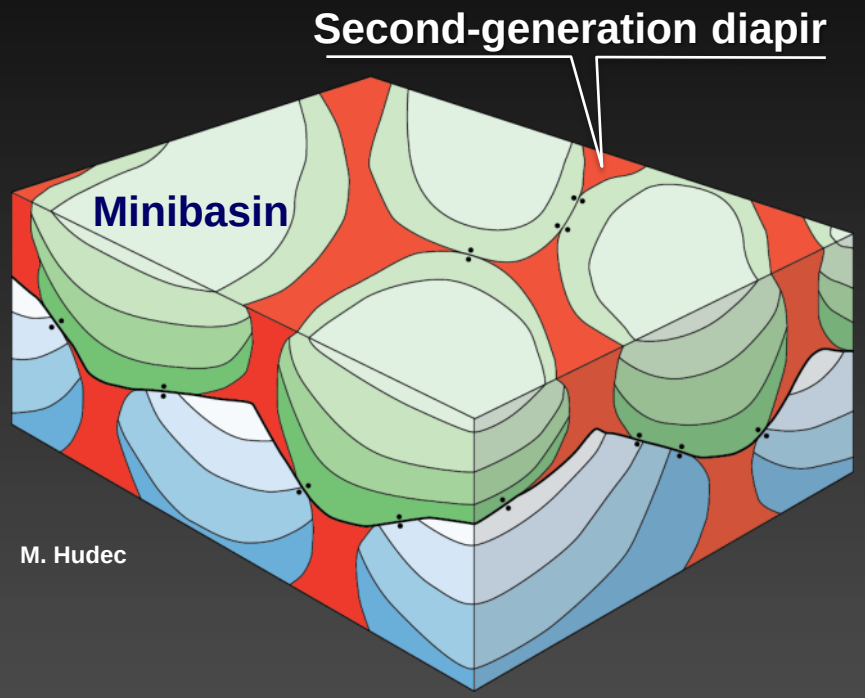


Hudec & Jackson 2006

- STEPPED COUNTER-REGIONAL SYSTEM
- Little extension, massive salt expulsion seaward
- Overburden wedges thicken seaward
- Proximal salt sheet deflates and welds
- Distal salt sheet inflates and advances

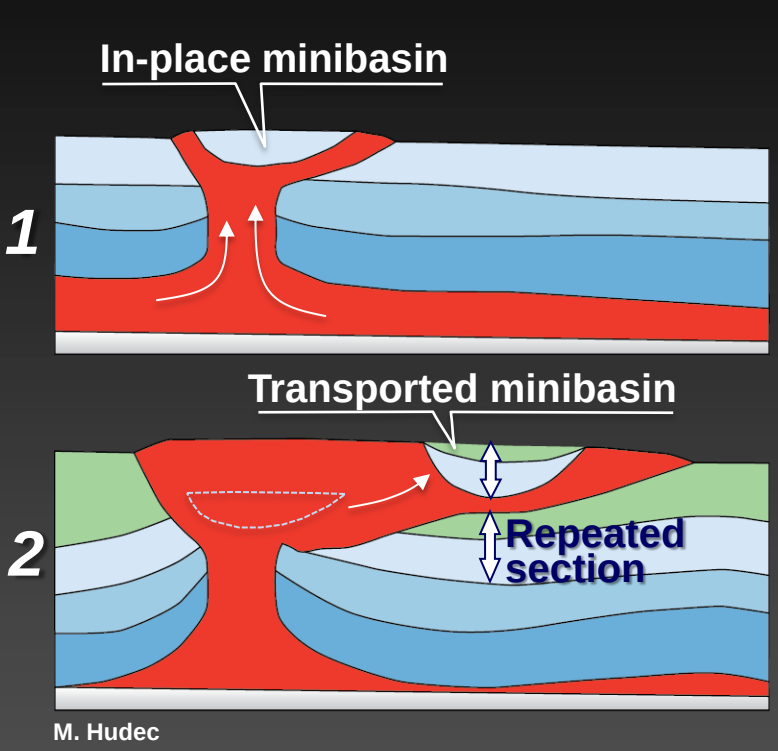
Recycling

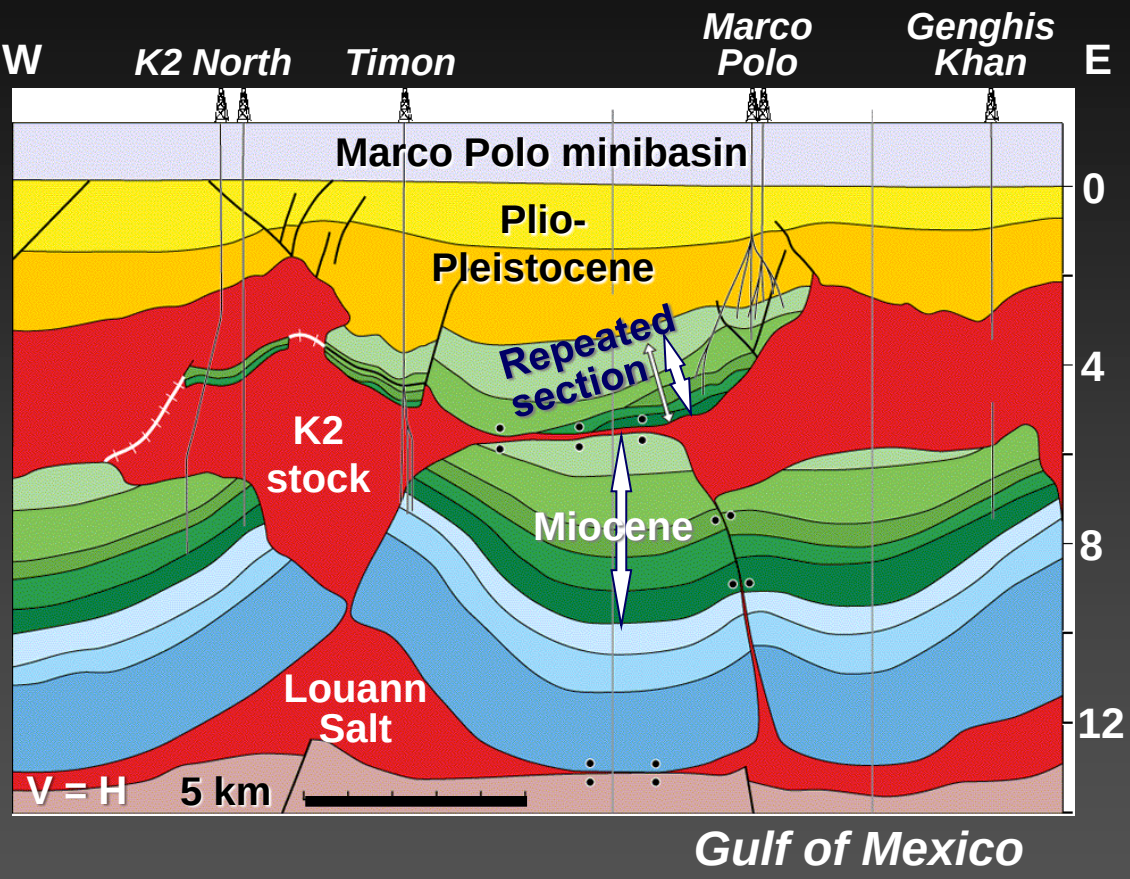




- SALT-STOCK CANOPY
- Salt stocks coalesce as canopy
- Minibasins sink into stocks, displace salt to margins
- Salt rises as second-generation diapirs to form polygonal ridges encircling minibasins

Recycling

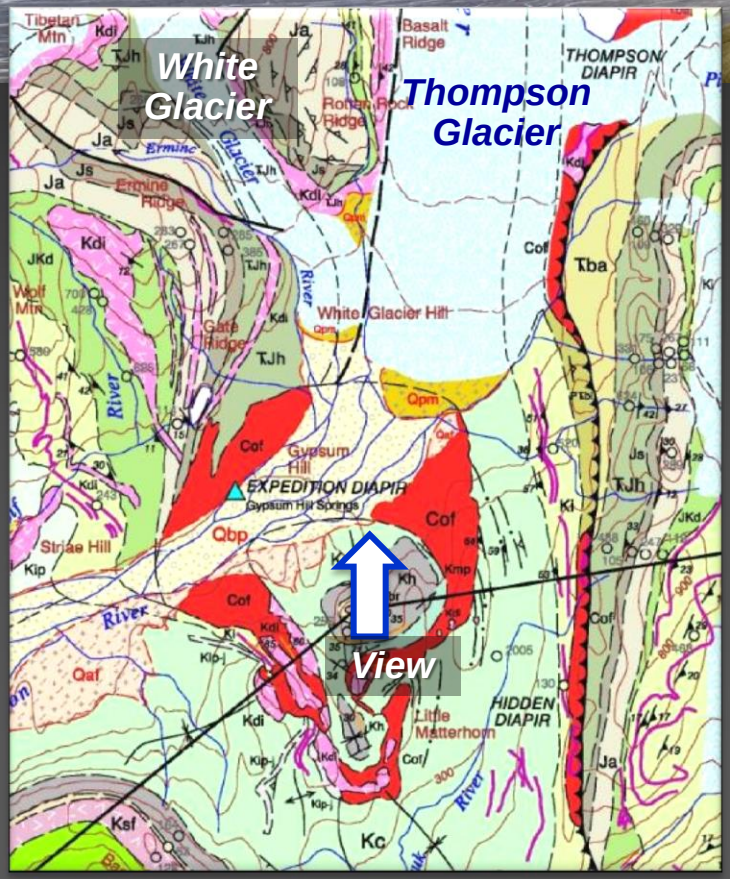




- Salt sheets can carry minibasins tens of km
- Transported minibasin repeats subsalt stratigraphy
- Example: 2-km of Miocene strata repeated in Marco Polo minibasin

Whimsy

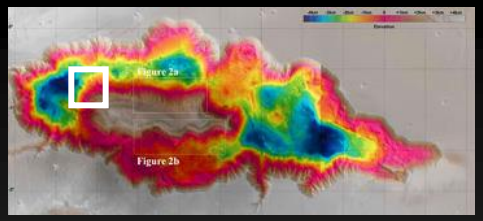
M. Jackson



Harrison & Jackson 2009

Axel Heiberg Island, Canadian High Arctic

- World's only example of ice glacier crossing salt glacier
- Salt glacier of salt (red) ~315 Ma
- Salt glacier emplaced above ~110 Ma strata
- Salt sheet is part of Expedition diapir

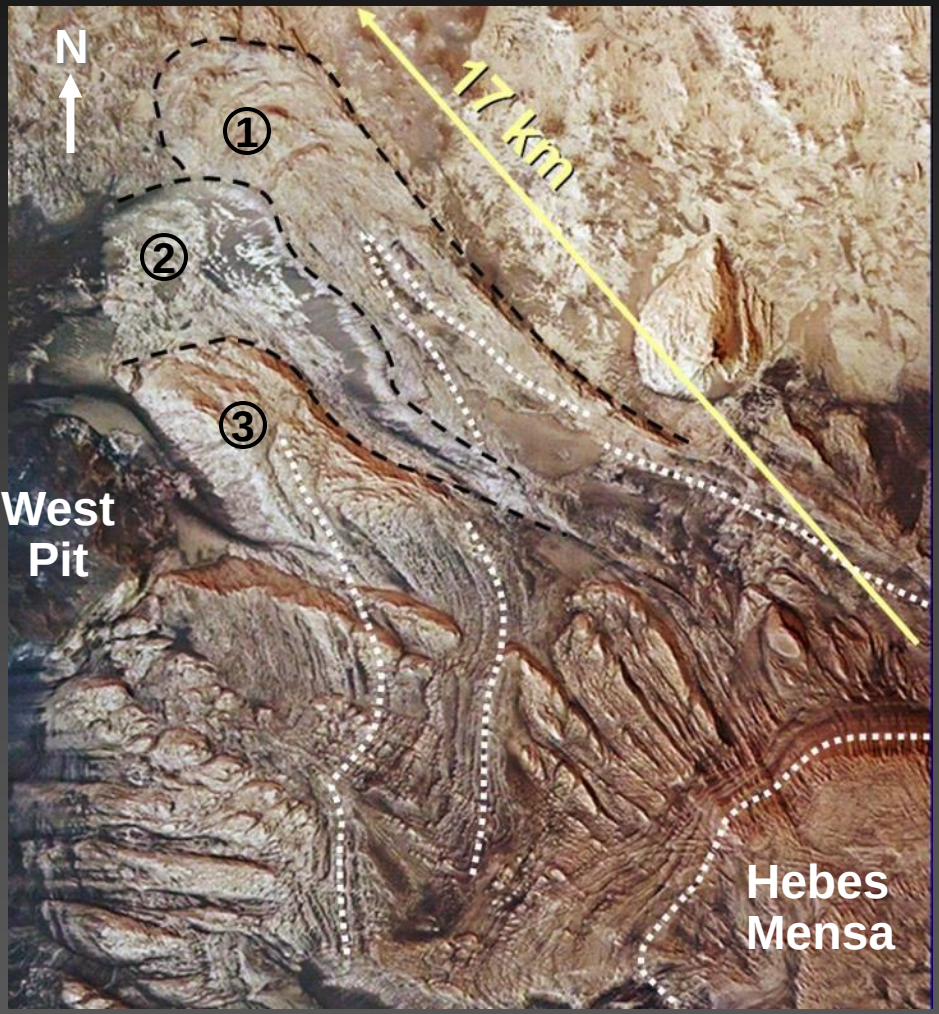


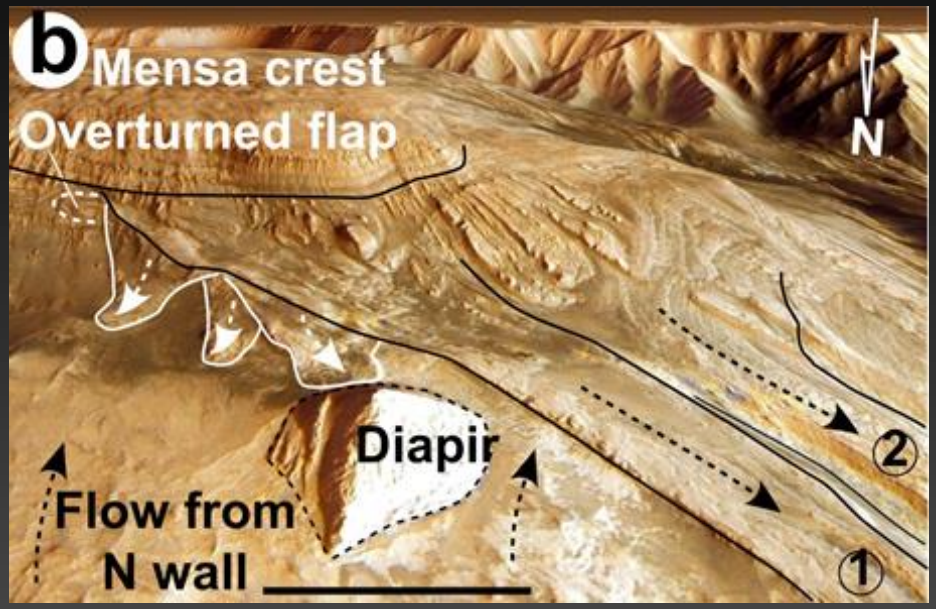
Hebes Chasma

Mars

AGL APPLIED GEODYNAMICS LABORATORY

V.E = 2

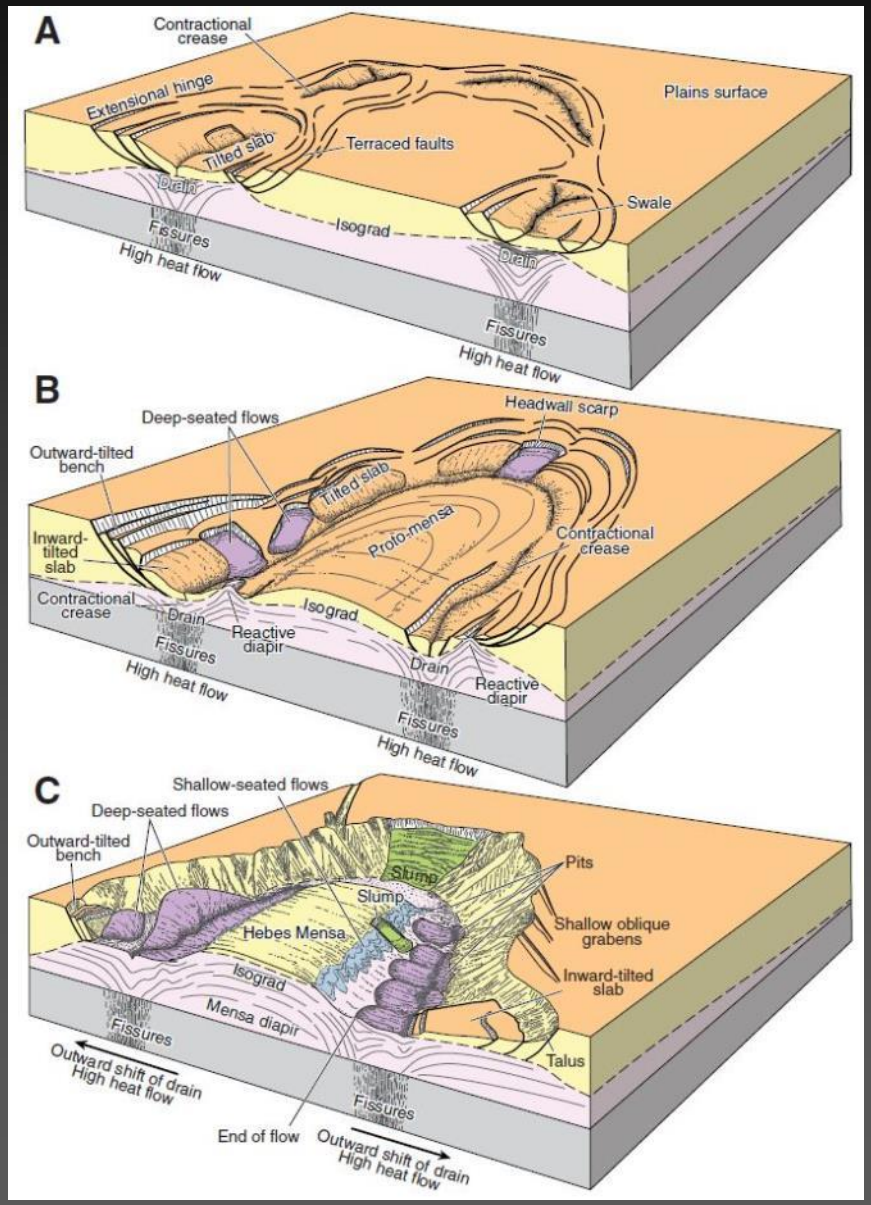


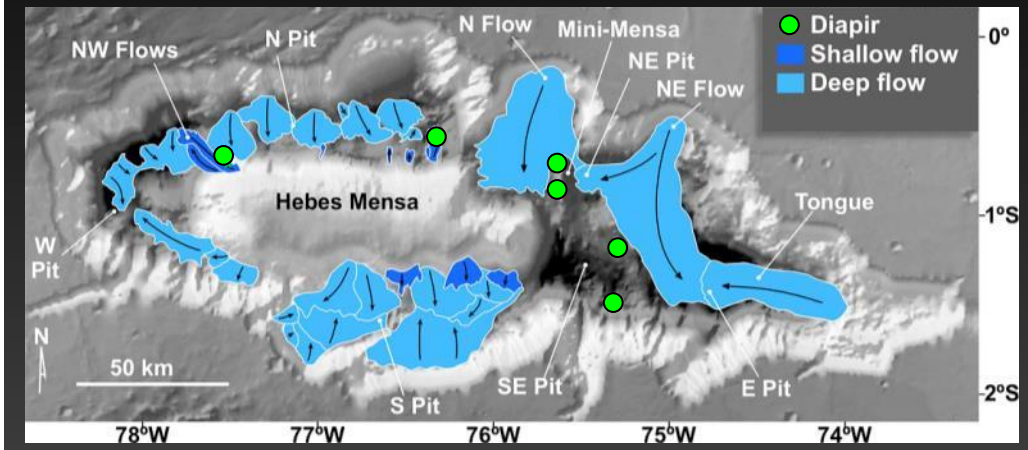


- 3 allochthonous flows from one stratigraphic level in Hebes Mensa
- Flows end in pits
- Diapir

Jackson et al. 2011

Mars





Jackson et al. 2011

New Worlds to Explore