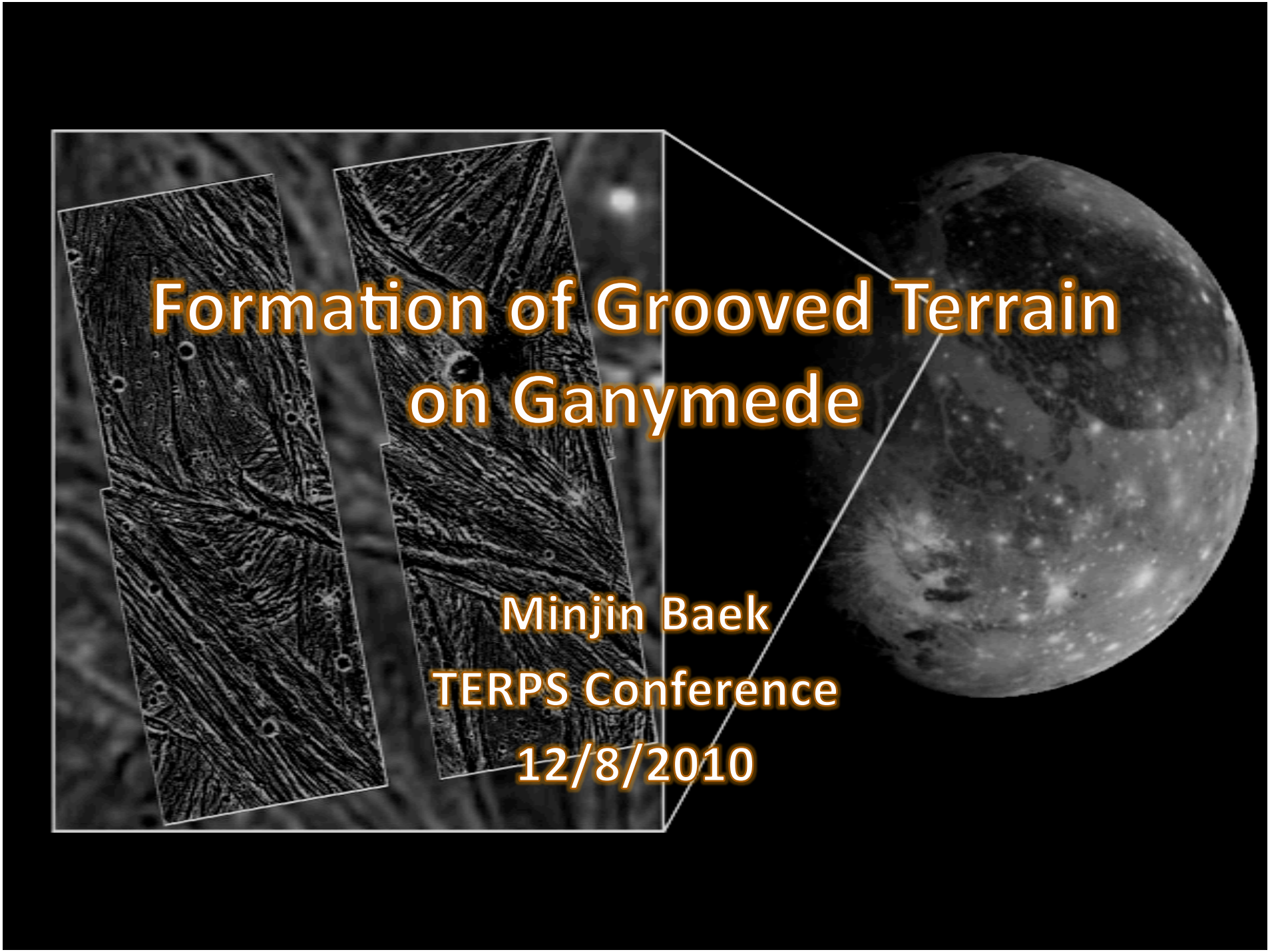
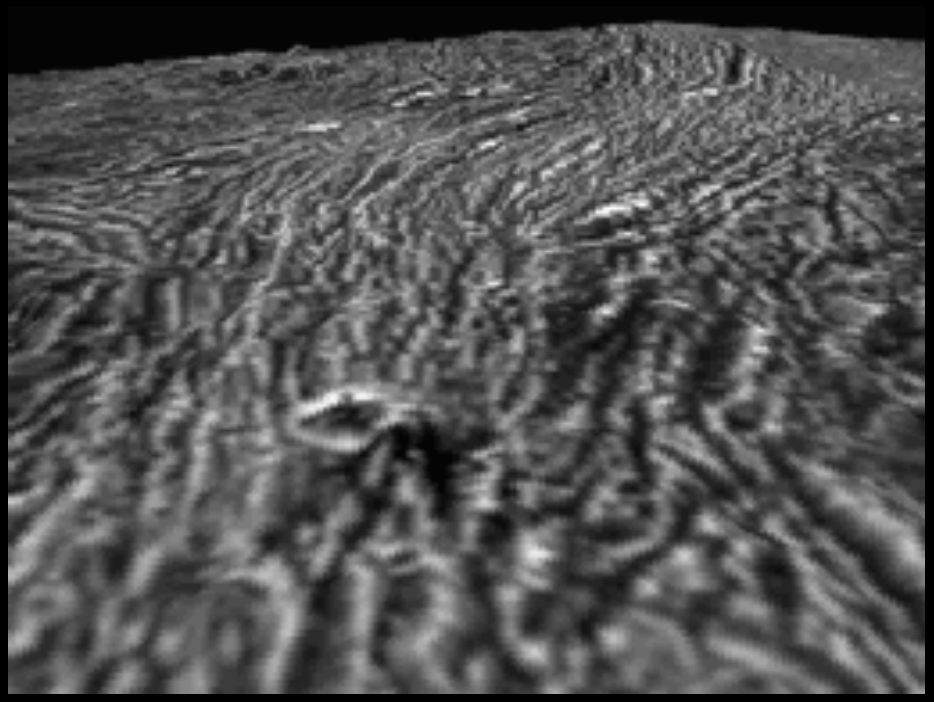

Formation of Grooved Terrain
on Ganymede
Minjin Baek
TERPS Conference
12/8/2010

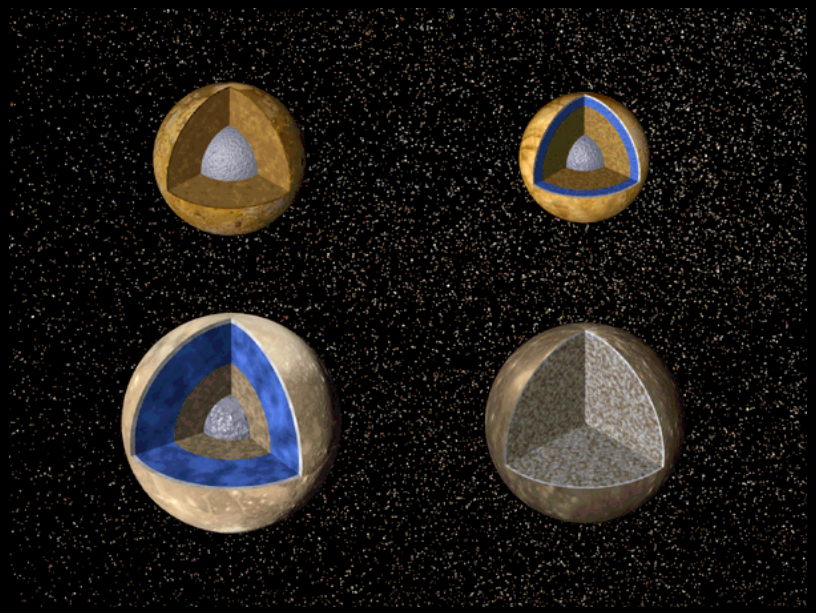
Grooved Terrain on Ganymede



Galileo flyover of Arbela Sulcus
(NASA/JPL/DLR)

- Groove sets - ridges and troughs
  - Covers nearly 2/3 of surface
  - Periodically spaced (3-17km)
  - Amplitude of 200-500m (peak-to-trough)
  - Shallow slopes of ~5°
  - Continuous for 100-1000km
- Likely formed during extension of lithosphere
  - Epoch of global expansion by differentiation
  - Melting during resonance passage

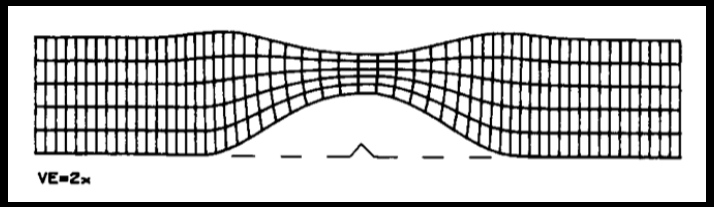
Tectonic Deformation - Why Study?



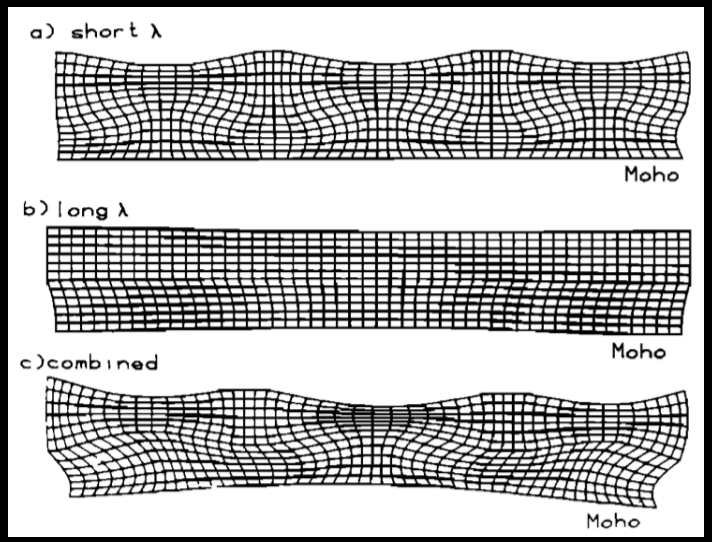
Studies of surface deformation on Ganymede provide

- Constrains for the geophysical conditions
  - Required strains
  - Heat flow estimate (dT/dz)
- Thermal and orbital evolution
  - Thermal-orbital coupling
    - Melting from tidal heating
      - » Global expansion
      - » Differentiation
      - » Magnetic field

Extensional Necking



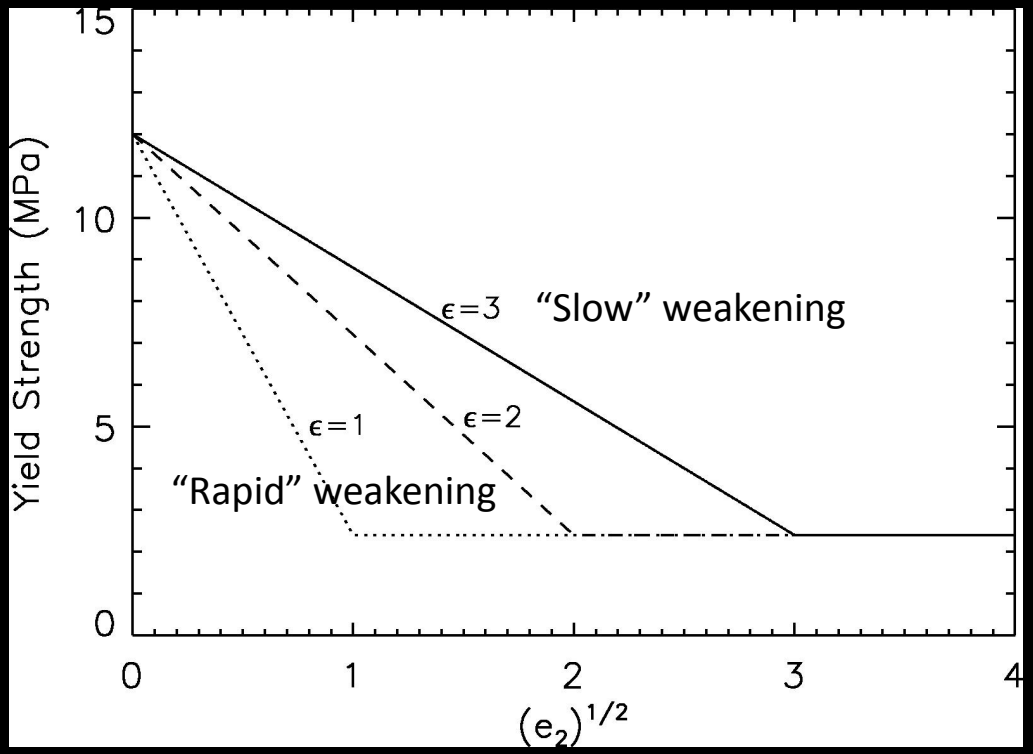
Zuber and Parmentier (1986)



Zuber et al. (1986)

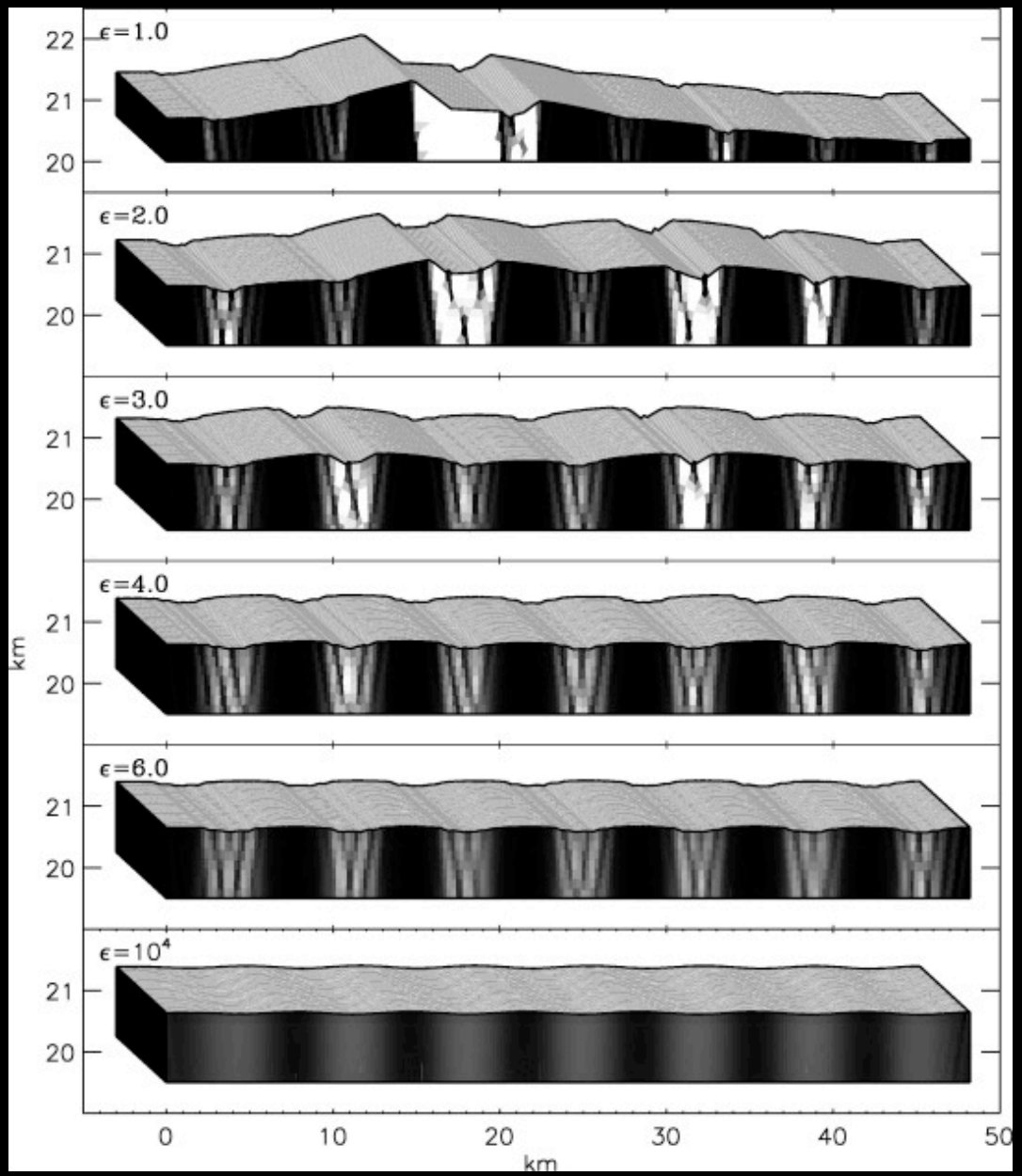
- Considered as *primary mechanism* for grooved terrain
- Necking of lithosphere
  - Rift morphology modeled with localized crust extension
- Layered structure
  - Strong plastic surface layer
  - Weak viscous substrate

Strain Localization

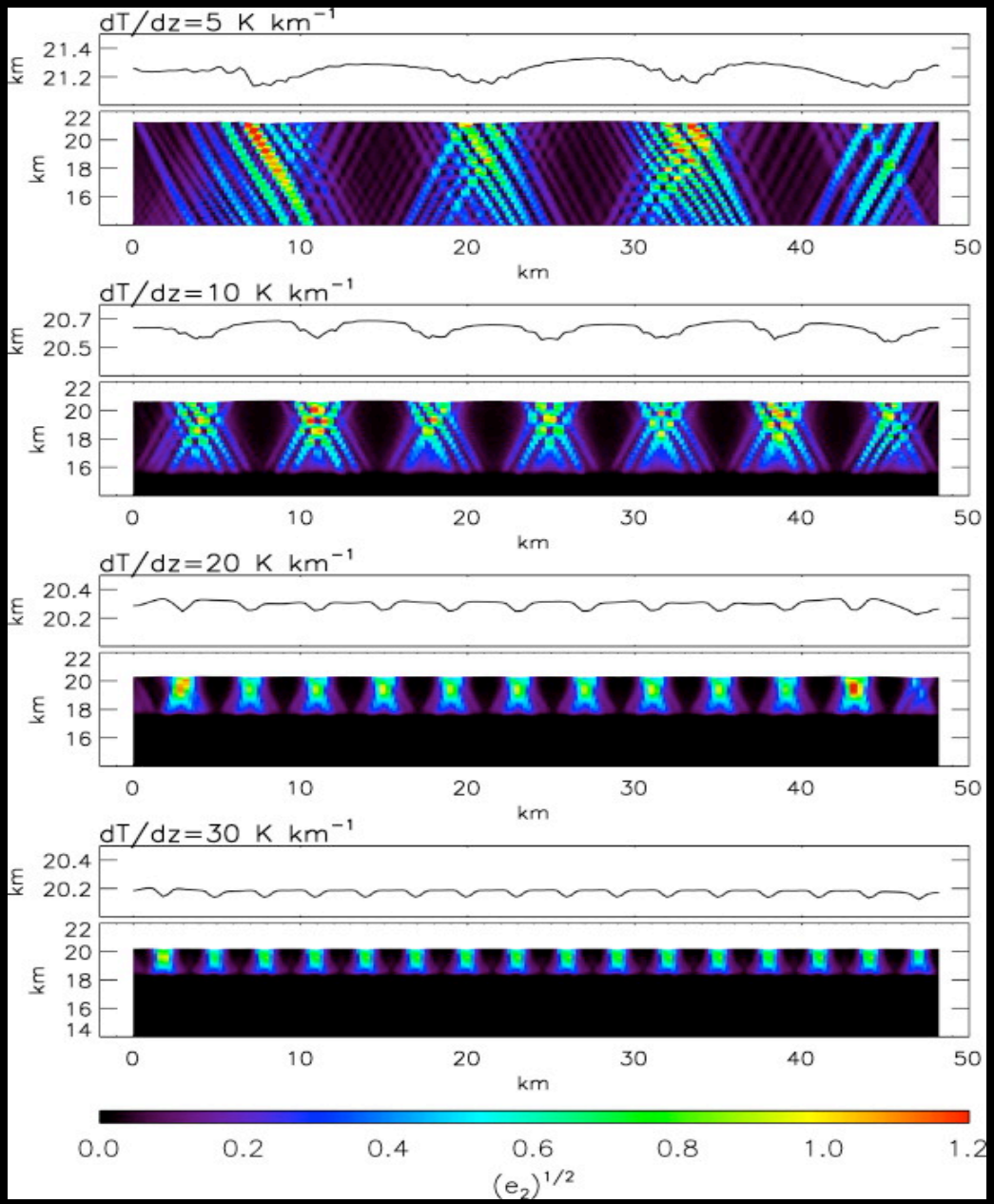


Bland et al. (2010)

- Strain localization requires strain rate weakening in the crust
- Yield strength decrease rapidly for small ε
- Slow decrease for large ε



- Thermal gradient constant (dT/dz=10 K/km)
- Varying weakening parameter



- Thermal gradient varying
- Constant weakening parameter (ε=4)

Conclusions

- Understanding groove formation
  - Model of extensional necking with inclusion of strain weakening
  - Results in grooves with amplitudes of 200-500m (well match to the observed value)
- Surface deformation not only depends on thermal gradient – also on weakening rates
- Thermal gradient of 10 K/km sufficient to produce grooves with observed amplitude

References

- Bland, M.T., McKinnon, W.B., Showman, A.P., 2010. The effects of strain localization on the formation of Ganymede's grooved terrain. *Icarus* 210, 396-410.
- Zuber, M.T., Parmentier, E.M., 1986. Lithospheric necking: a dynamic model for rift morphology. *EPSL* 77, 373-383.
- Zuber, M.T., Parmentier, E.M., Fletcher, R.C., 1986. Extension of continental lithosphere: a model for two scales of basin and range deformation, *JGR* 91, 4826-4838.