Chevron folds are special folding phenomena featuring (Figure 1):

- Narrow and sharp hinges
- Hinge collapse (some folds)

Common hypotheses to form chevron folds:

1. Material anisotropy
   - Effective anisotropic viscosity
   - Kinematic anisotropy

2. Narrow and sharp hinges
   - Stress distribution around hinges
   - Zero – hinge zone

3. Flexural slip:
   - No viscous coupling
   - Distributed amount of slip variable
   - Initial perturbations
   - With / without slip

Model Features:

- 2D sublayers separated by frictional interfaces
- Kinematic anisotropy
- Effective anisotropic viscosity
- Initial hydrostatic pore pressure
- 50% of horizontal shortening applied using strain rate of 10−6/sec
- Various initial perturbations

Results:

- Chevron folds: Later stages (Bastida et al., 2007)
- Systematic & symmetric chevron folds
- Hinge collapse
- Systematic & symmetric chevron folds

Methodology: 2D Finite Element Analysis

- Material properties:
- Young’s modulus (GPa)
- Poisson’s ratio
- Permeability (m²)
- Initial hydrostatic pore pressure
- Elastic modulus
- Bond strength

Model Setup:

- Investigate the conditions and folding mechanisms for chevron folds to form.
- Quantify the slip evolution during chevron folding.

Series #1:

- Sinusoidal initial perturbation: \( \sigma_0 \)
- Anisotropic folding layers, i.e. true multilayer
- With / without slip
- Results:
  - Systematic & symmetric chevron folds with hinge collapse.
  - Flexural slip cannot change folding shapes in true multilayer model

Series #2:

- Sinusoidal initial perturbation: \( \lambda=0.51\sigma_0, 0.1\sigma_0 \)
- Effective single layer with slip
- High friction coefficient (\( \mu=0.6 \))
- Results:
  - 10% of dominant wavelength with \( \mu=0.6 \).
  - Chevron folds with out hinge collapse.

Series #3:

- Sinusoidal initial perturbation: \( \lambda=0.51\sigma_0, 0.1\sigma_0 \)
- Effective single layer with slip
- Low friction coefficient (\( \mu=0.2 \))
- Results:
  - 10% of dominant wavelength with \( \mu=0.2 \).
  - Onset of hinge collapse.
  - Chevron folds: larger amplitudes & sharper inter-limb angle compared to Series #2.

Series #4:

- White noise initial perturbation
- True multilayer setup/elastic single layer
- High/low friction coefficient (\( \mu=0.2 / 0.6 \))
- Results:
  - Non-symmetric chevon folds are generated when lower friction coefficient is applied.

Conclusion:

- The slip tendency parameter is chosen to indicate the temporal evolution of slip.
- Slip tendency, \( \gamma \) is defined by:
  \[ \gamma = \frac{\text{slip rate}}{\text{strain rate}} \]
  For \( \gamma>1 \) slip occurs.

Discussion

- For all chevron folds models, slip is initiated at the early stages of folding, i.e. ~1% - ~5% of shortening. This is in contrast to field observations of chevon folds (Bastida et al., 2007), where slip is observed during the later stages of folding.

- The initial perturbation affects slip occurrence:
  - For sinusoidal perturbations slip occurs ~50% of shortening.
  - For white noise perturbations, slip is initiated later and ceases after ~15% of shortening.

Outlook

- According to Series #4, the relationship between friction coefficient and dominant wavelength needs to be expressed quantitatively.
- Investigate the discrepancy of timing of slip during chevron folding.

References