Elastoplastic Deformation in a Wedge-Shaped Plate Caused by a Subducting Seamount

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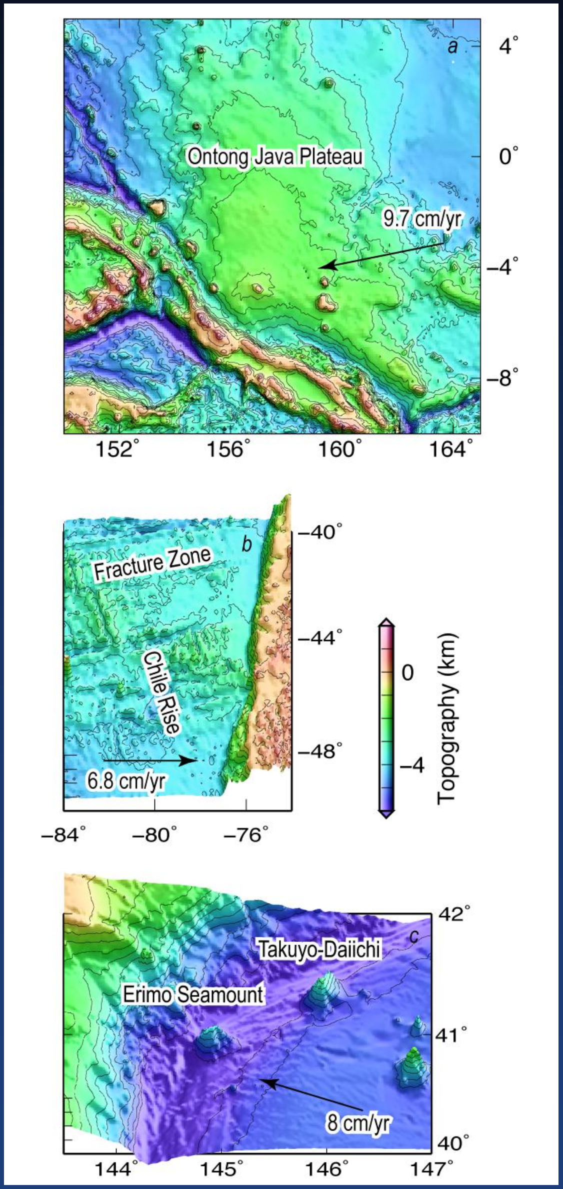
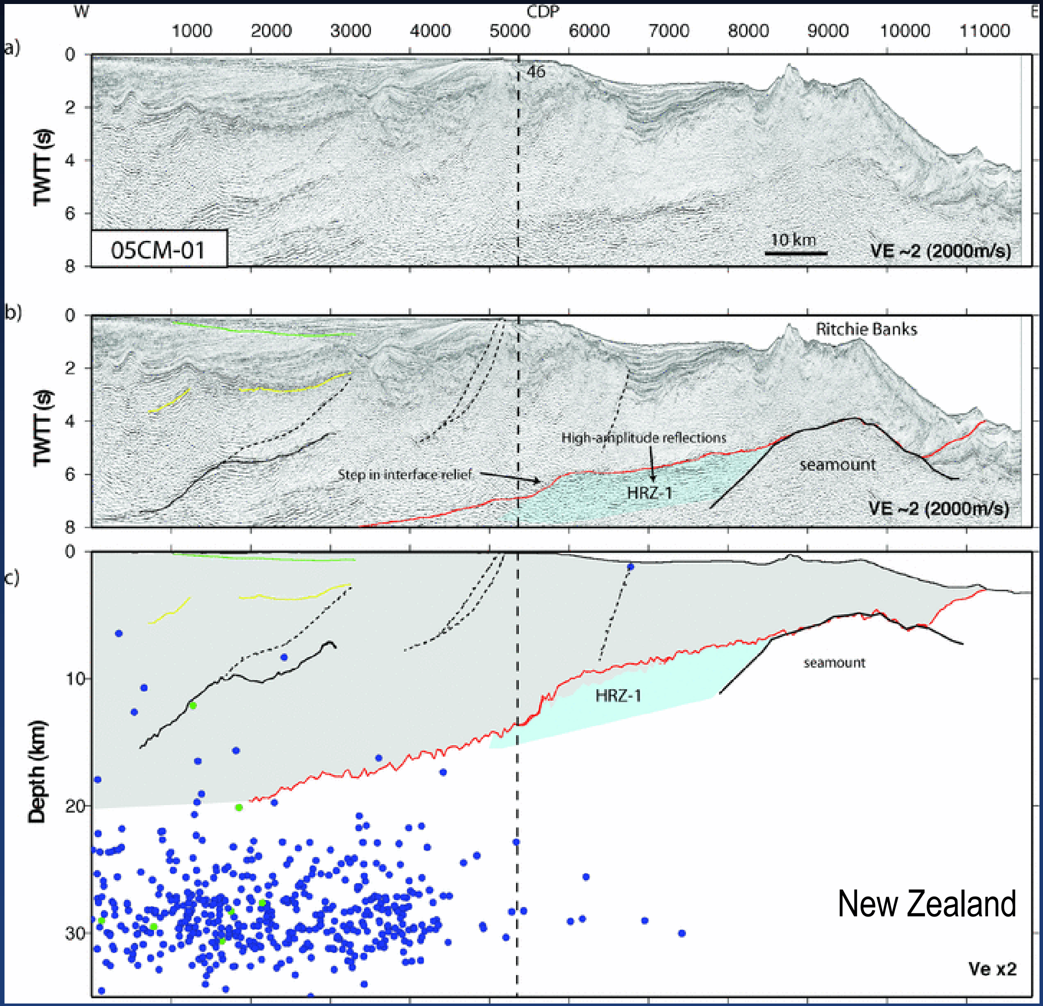
Observation of Subducting Topographic Features

Topography



Seismic reflection



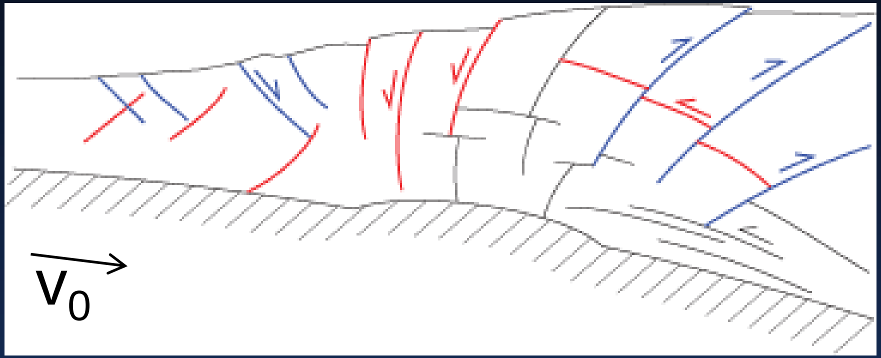
Bell et al. [2010]

Key Science Questions

- What is the effect of the subduction of a seamount on deformation and faulting of the upper plate?
- How to parameterize the seamount geometry, upper plate rheology, and induced faulting characteristics?

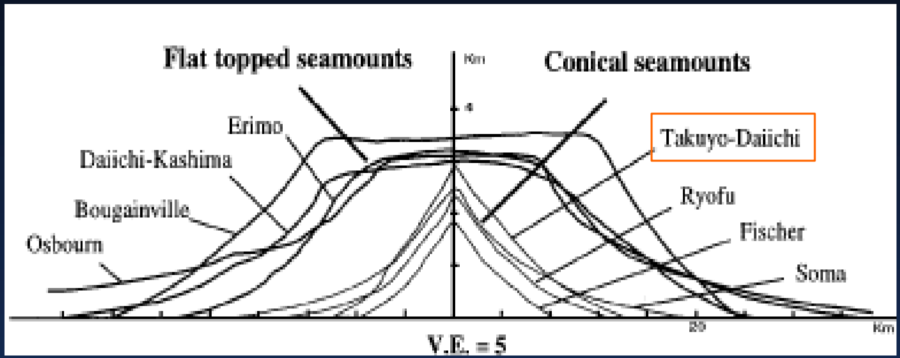
COMSOL Model Set-up

Expected Fractural Network



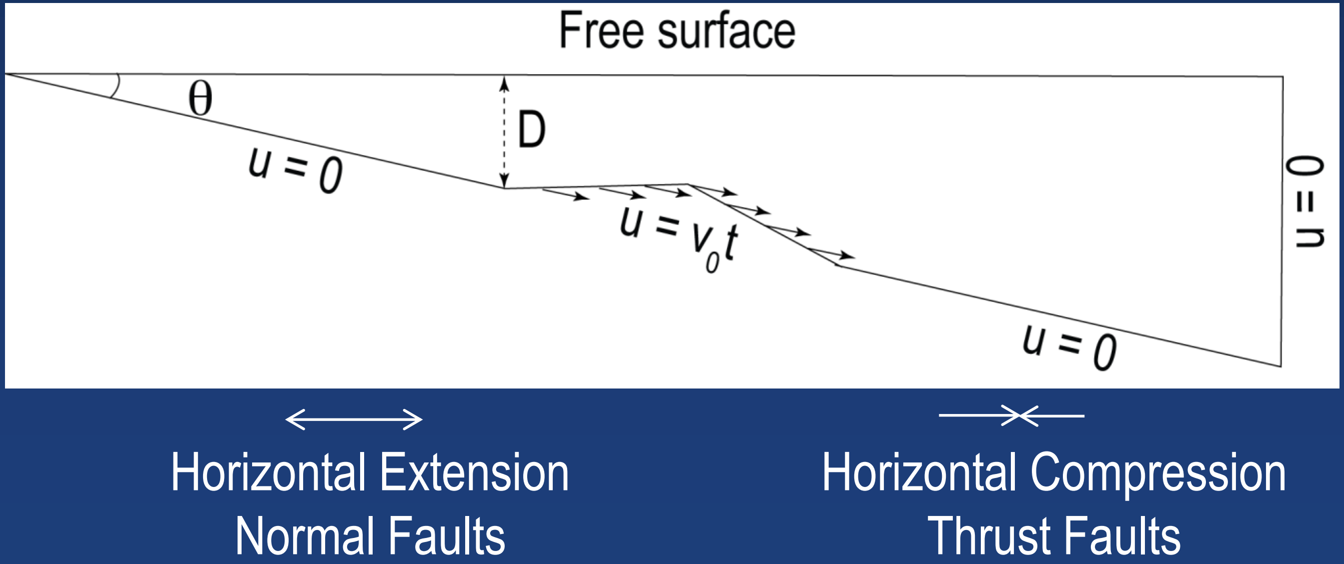
Wang and Bilek [2011]

Seamount Shape

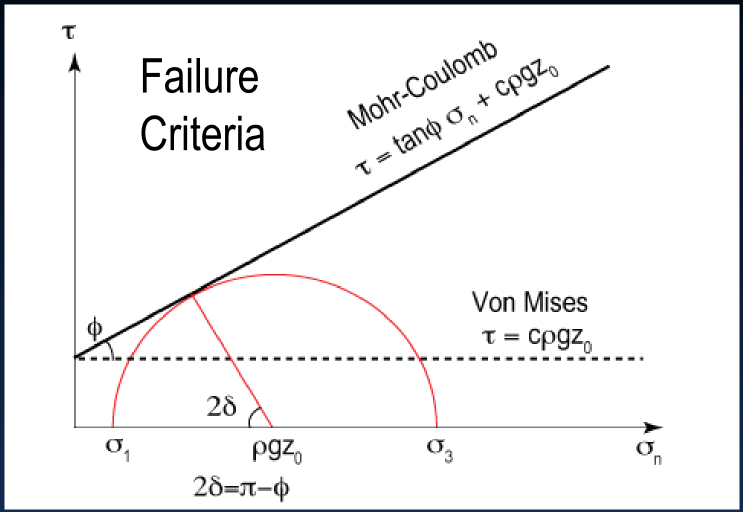


Dominguez et al. [1988]

Model Set-up

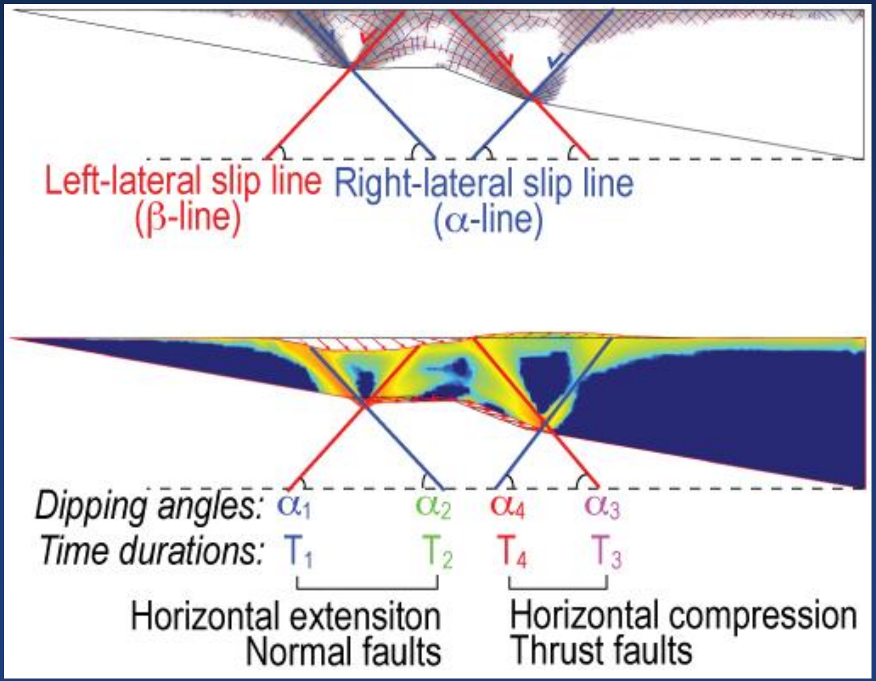


- V_0 = 5 cm/yr
- Conical Seamount shape
- Quasistatic time-dependent deformation



Tested Parameters

- Angle of internal friction: Φ
- Dipping angle of the subducting slab: θ
- Distance from the left side of the seamount base to the ground surface: D

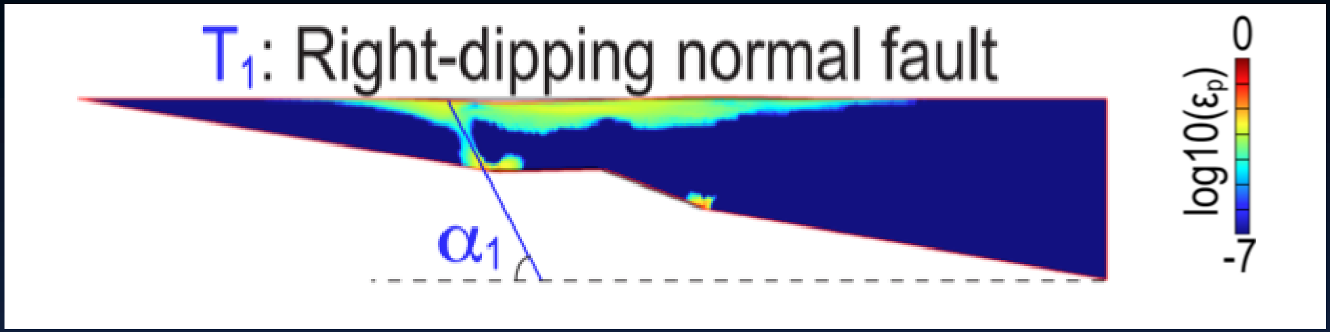


Disp. Exag. = 50

Output

- Surface displacement: U_x, U_z
- Slip lines: α, β-lines
- Time durations of seamount movement required for a sequence of faults to cut through the upper plate: T_l to T_4
- Dipping angles of the through-going faults: α_1 to α_4

A Sequence of Faults Cutting Through the Entire Plate



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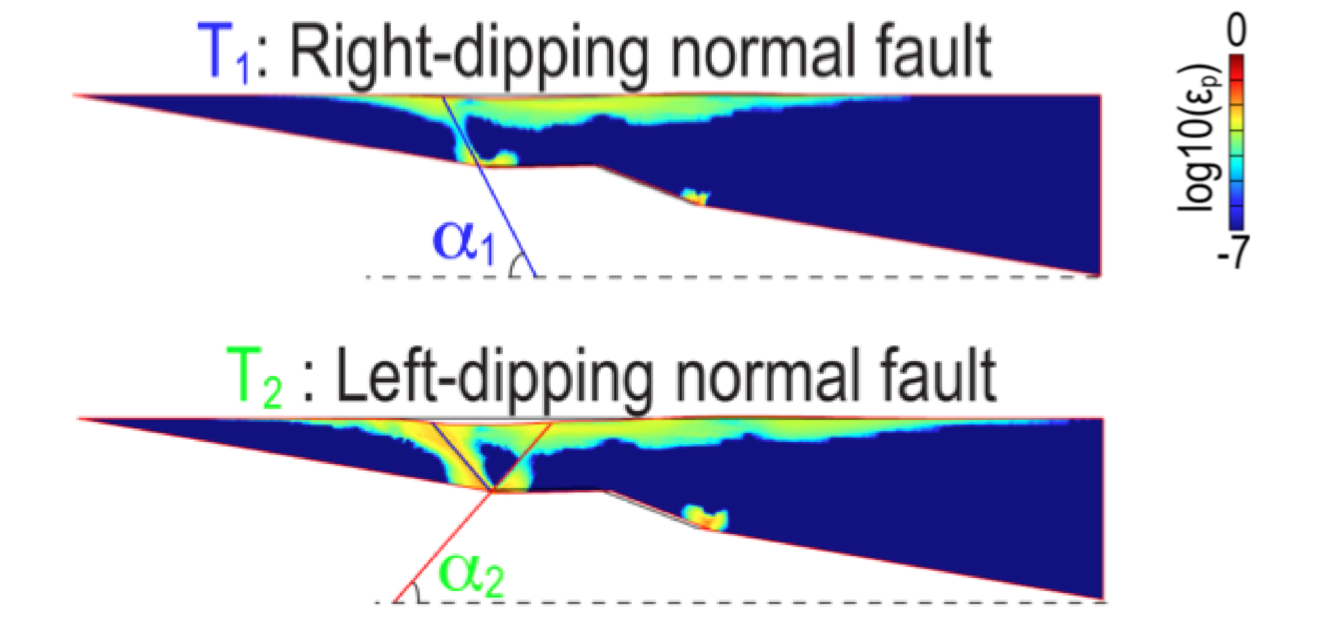

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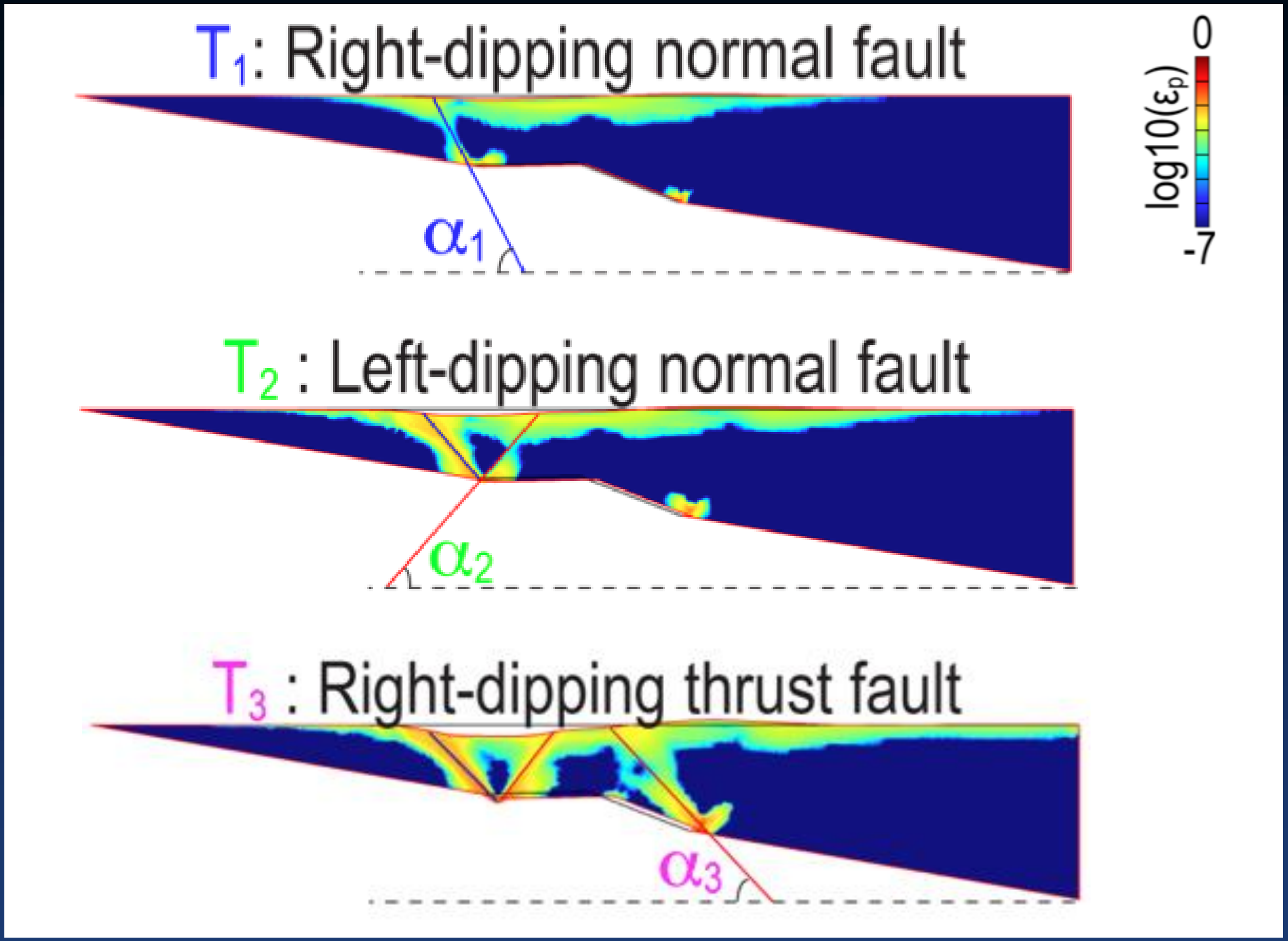

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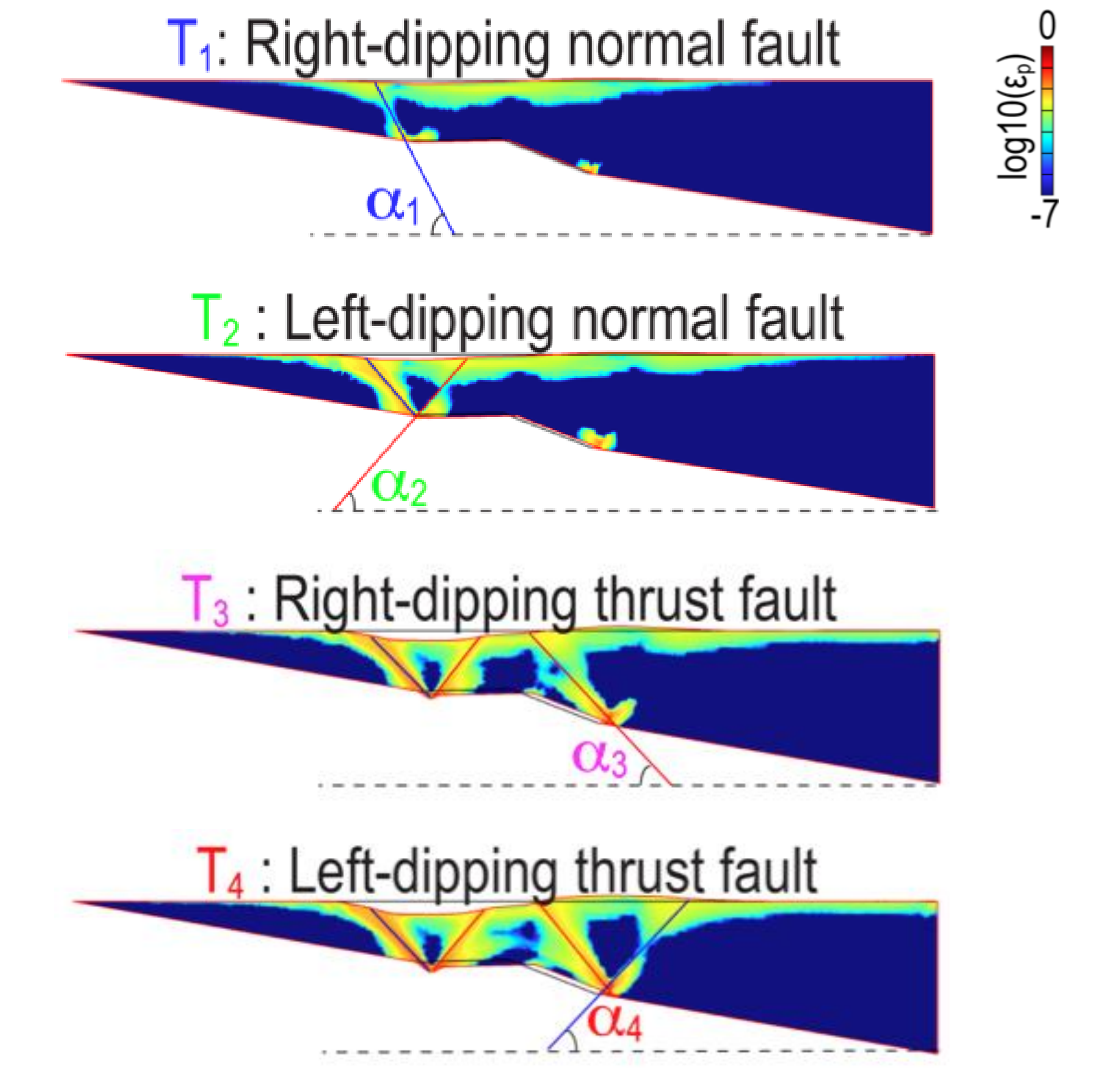

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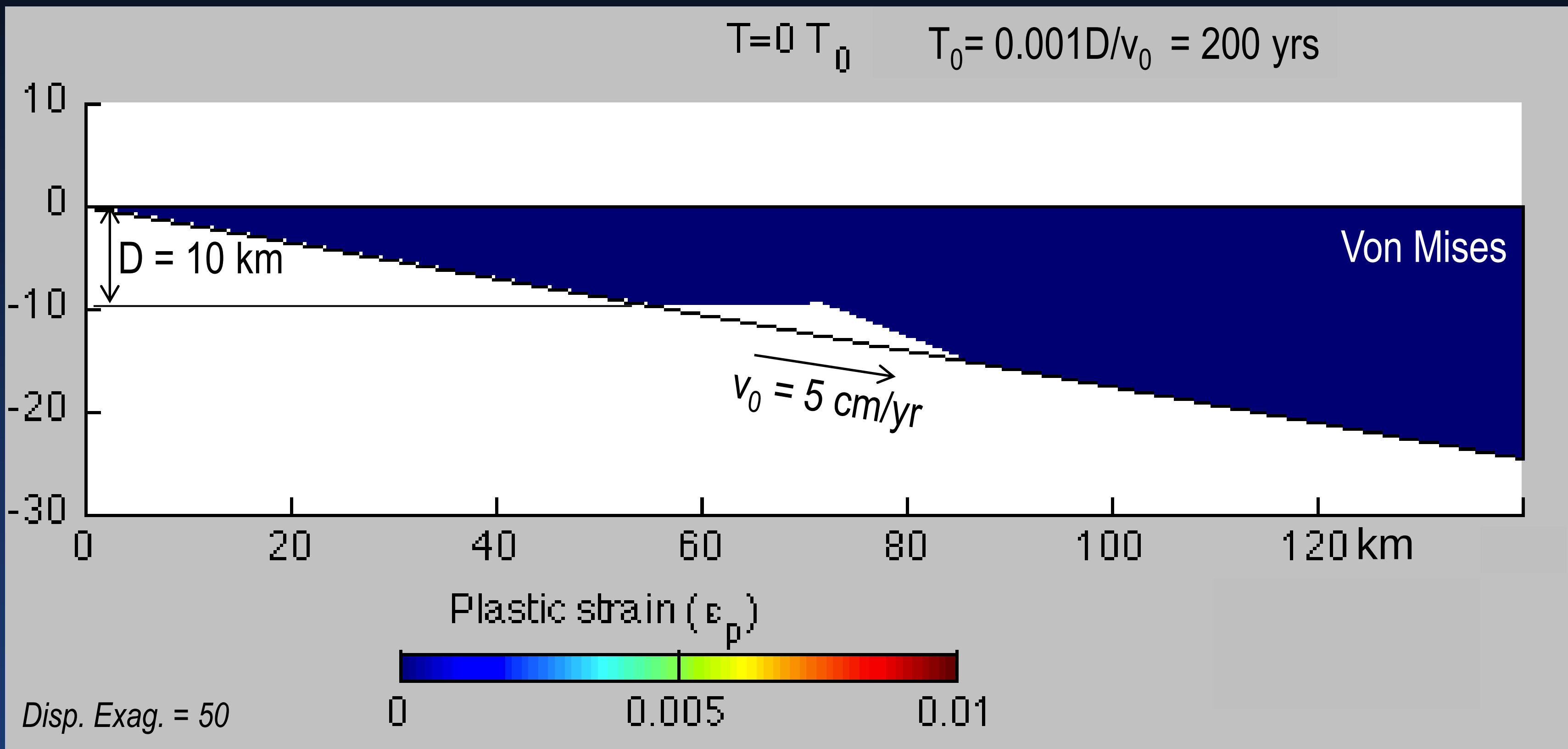

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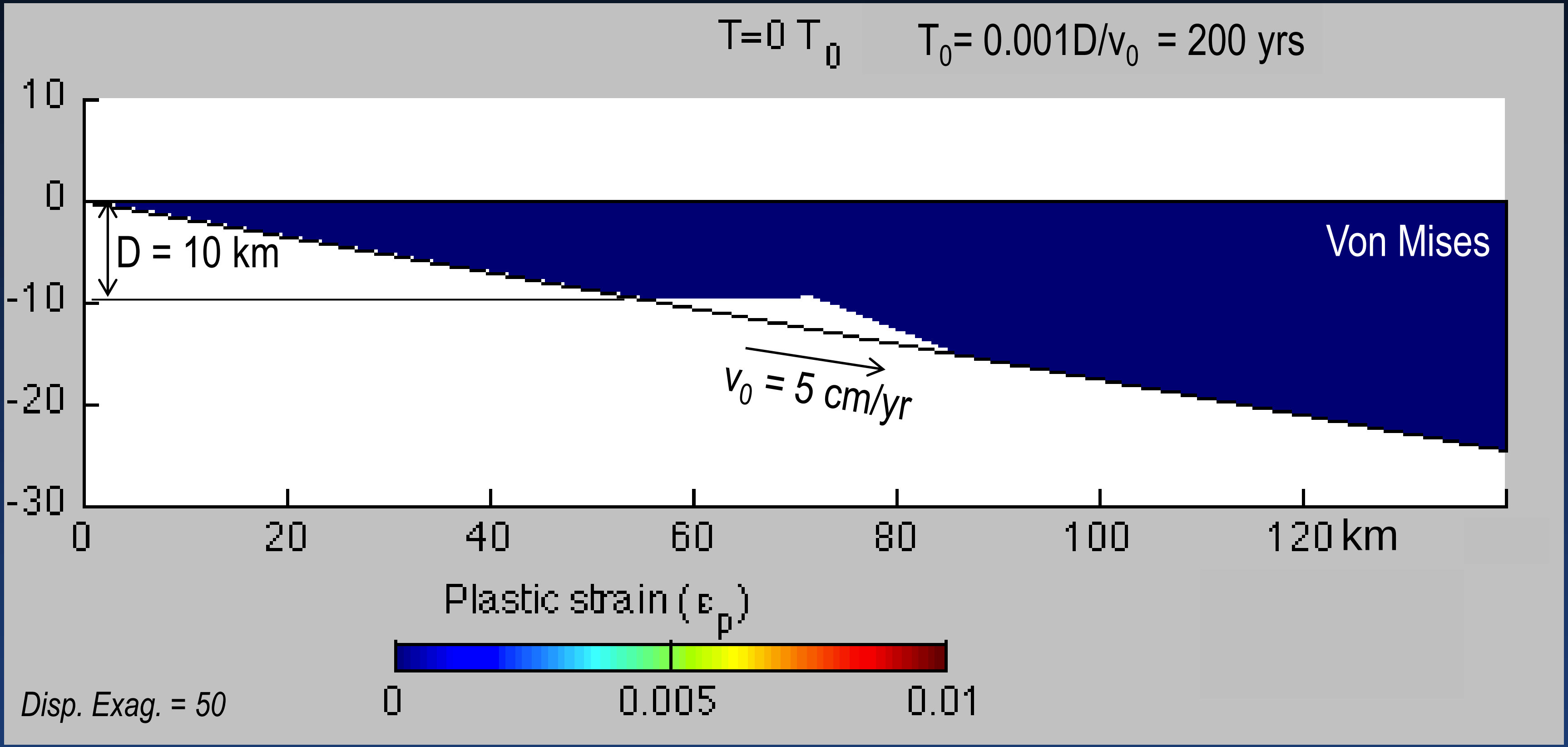
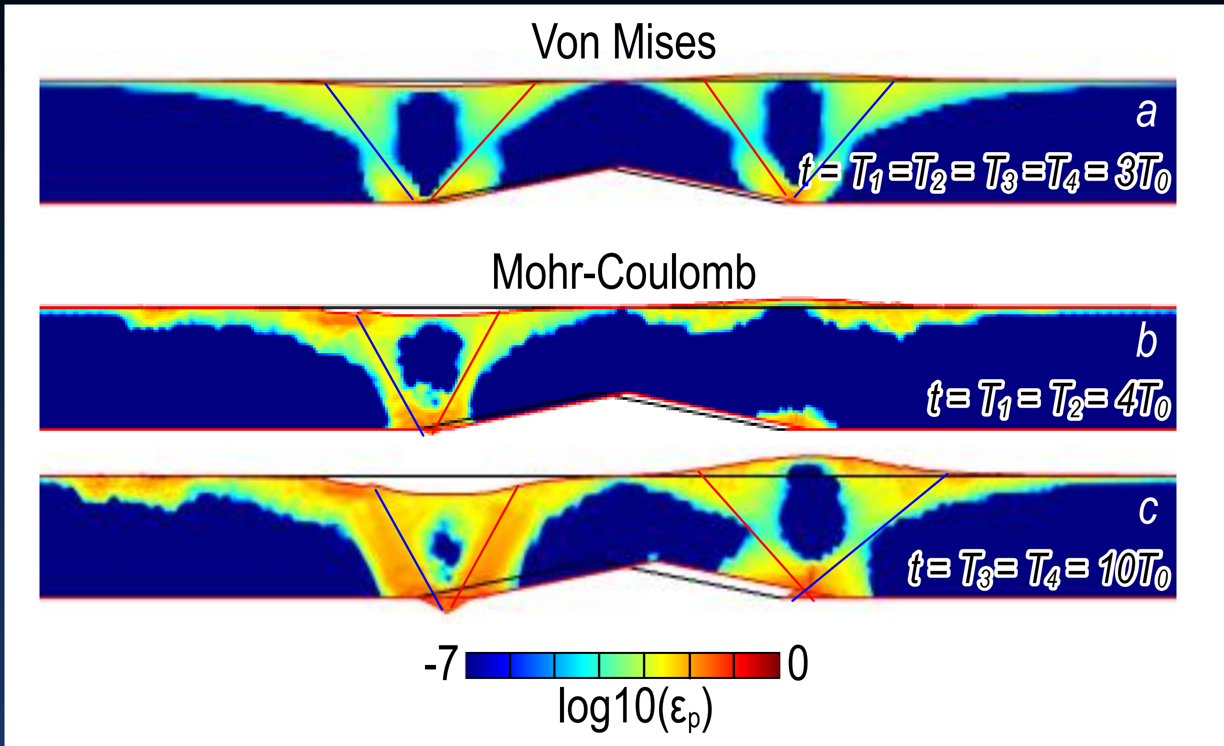
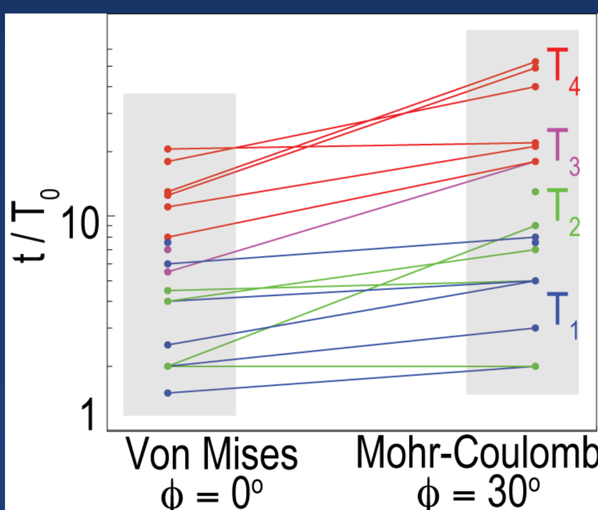
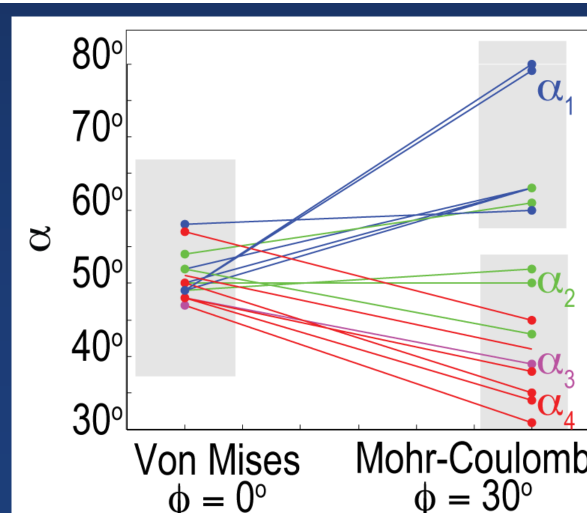


Von Mises vs. Mohr-Coulomb Failure Criterion







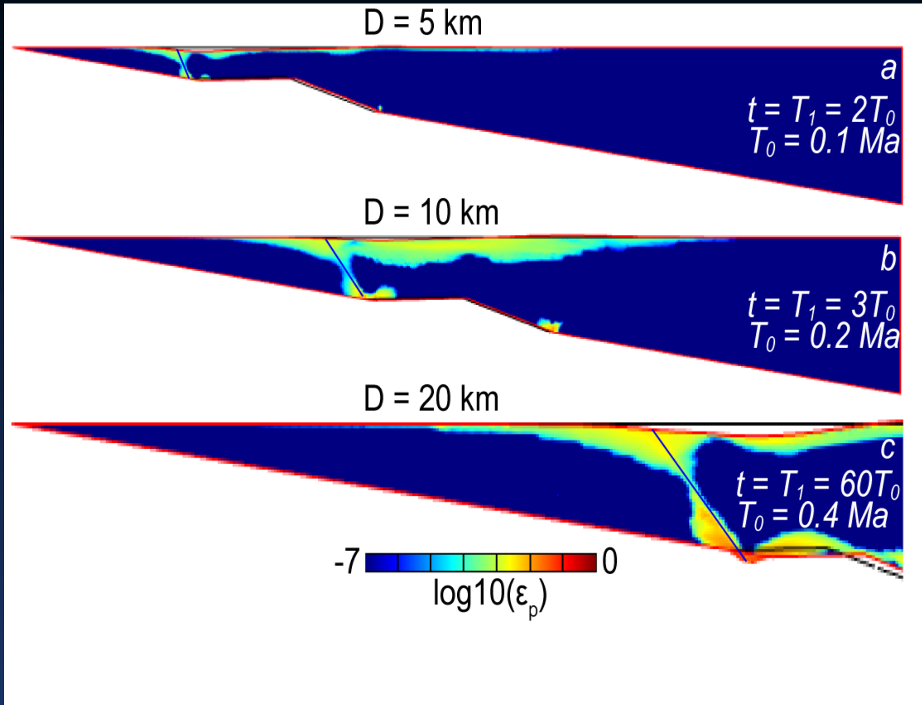
Von Mises

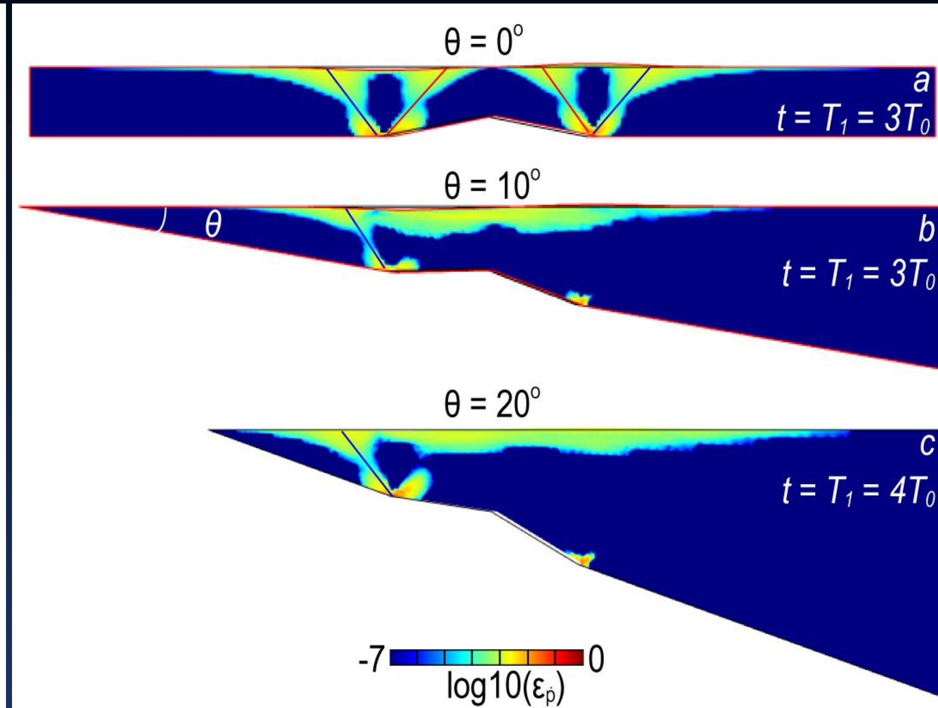
- Symmetry failure zones
- Normal and thrust faults appear at the same time

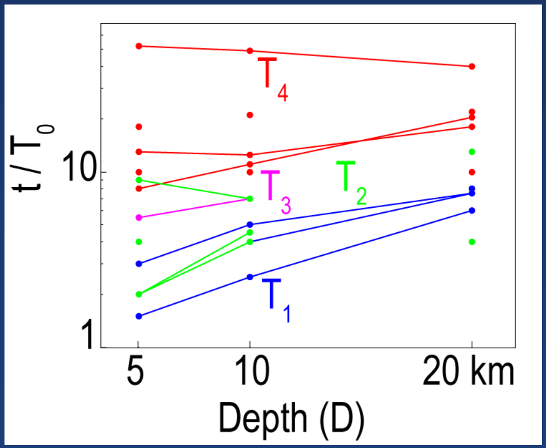
Mohr-Coulomb

- Asymmetry
- Normal faults appear prior to thrust faults

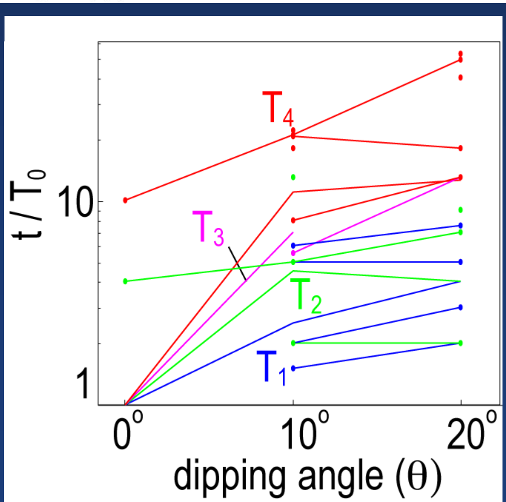
Influence of Seamount Depth, D, and Dipping Angle, θ







- Longer durations of seamount movement are required for faults to cut through plates of deeper seamounts greater dipping angles.



Conclusions

1. A pair of conjugate normal faults first appeared in the thinner part of the upper plate, followed by another pair of conjugate thrust faults in the thicker part of the plate.

2. The durations of the seamount movement required for faults to cut through the entire plate are longer for deeper seamounts, greater dipping angles of the plate, and for the Mohr-Coulomb than the Von Mises criterion.

Acknowledgements

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