

Linkages Across SZ4D



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Cross-Cutting Themes in the SZ4D Implementation Plan



CROSSCUTTING SCIENCE THEMES

AN INTEGRATED VISION FOR
SUBDUCTION ZONE HAZARDS



Cross-Cutting Themes in the SZ4D Implementation Plan

- Forecasting
- Mass & Energy Balance
- Rheology & Stress
- Fluids & Fluid Migration
- Climate Variability
- Cascading Hazards

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SUBDUCTION ZONE HAZARDS



Fluids & Fluid Migration



Fluids & Fluid Migration



Phreatic Eruptions



Lahars



Cold Springs



Sand Boils



Scaly Clay Melange



Mud Volcano

- *High Level Conceptual Link, But a Practical One?*

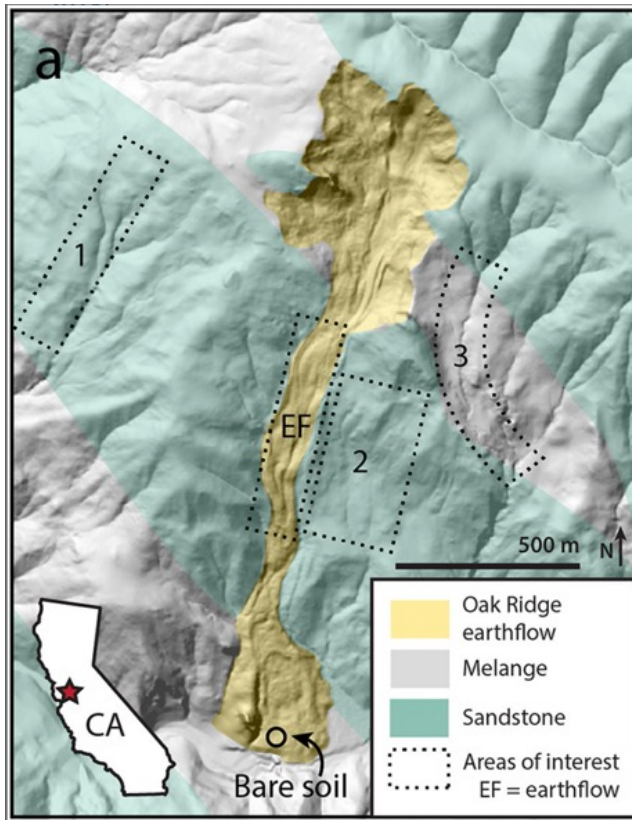
- *What are fertile areas for actual cross-cutting research?*



Nugget 1: Landslides and Fault Mechanics

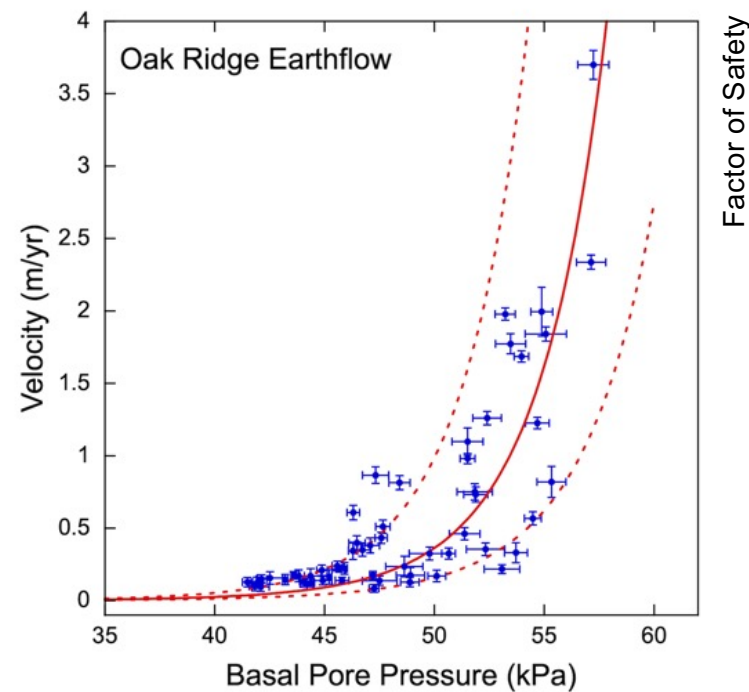


Oak Ridge Earthflow: Natural Lab



Nereson et al. 2018

Earthflow velocity explained by friction theory and pore fluid pressure fluctuations



Finnegan & Saffer, 2024

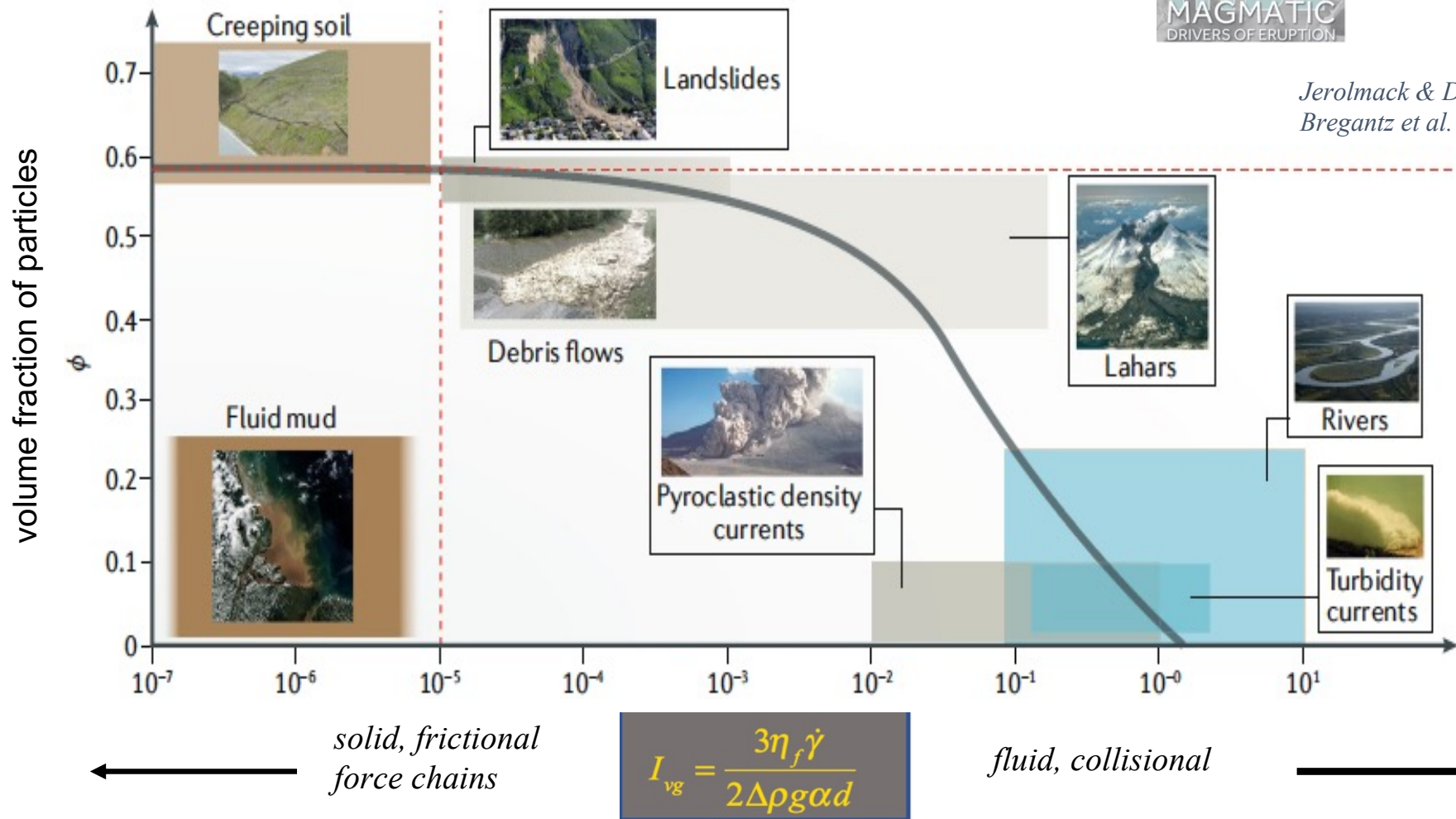
Cohesion explains LS depth

Schaible et al. 2026 (in prep.)

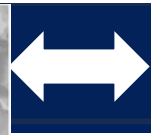
Nugget 2: Granular Flow – Soft Physics



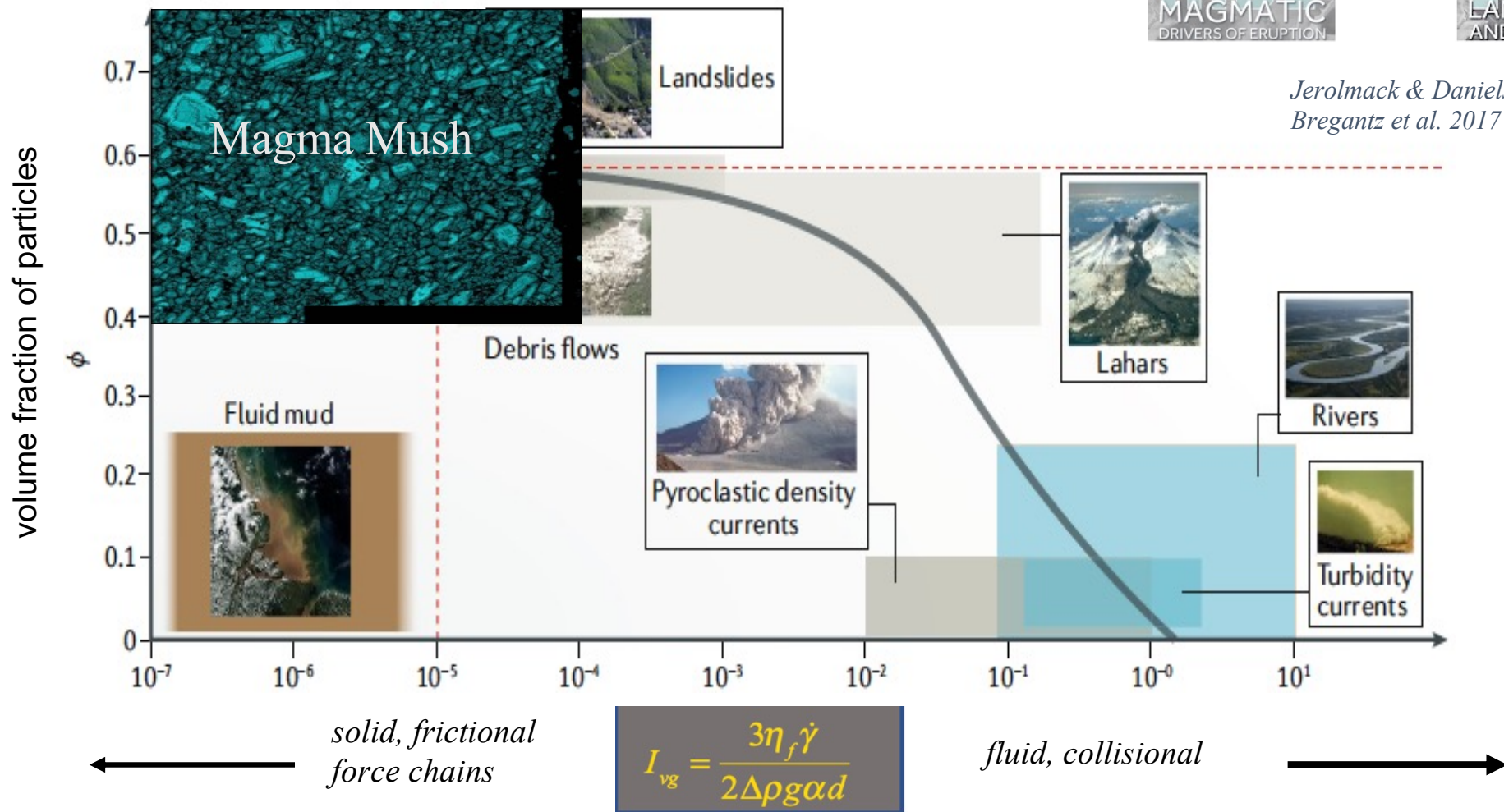
*Jerolmack & Daniels, 2019
Bregantz et al. 2017*



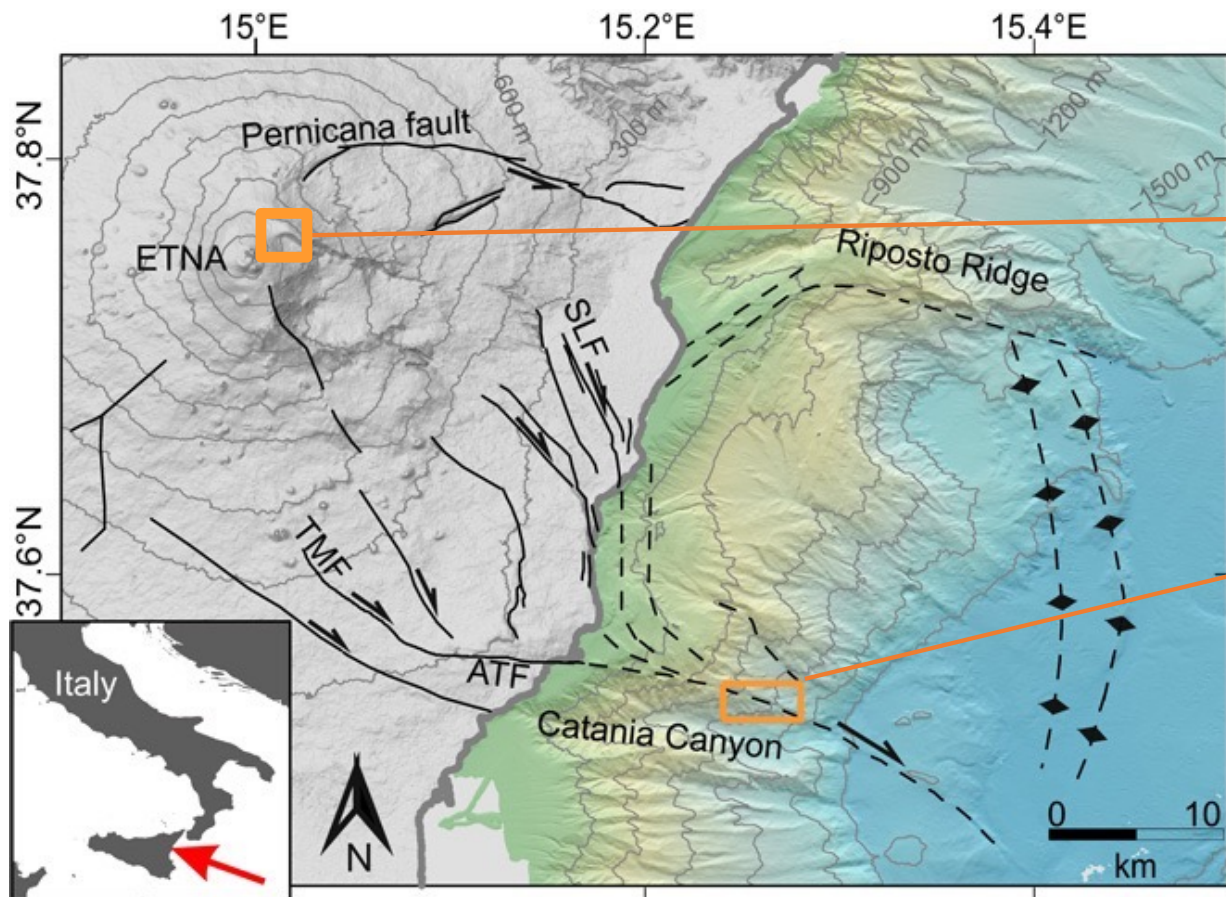
Nugget 2: Granular Flow – Soft Physics



*Jerolmack & Daniels, 2019
Bregantz et al. 2017*



Nugget 3: Volcano Fiber Optic for Monitoring Volcanic Unrest and Slope Stability



GFZ
Distributed Acoustic Sensors
on Volcanic Events
Jousset et al. (2022) Nature Comm.

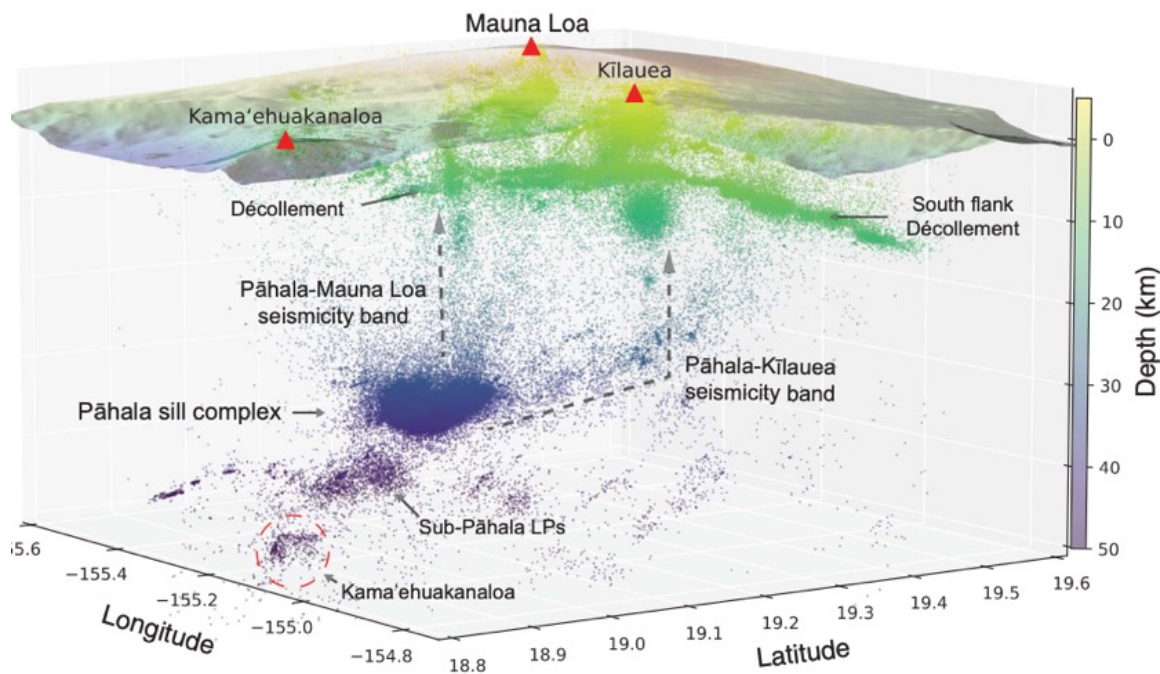
IFREMER-GEOMAR
Fiber Optic on Seafloor
to Detect Strain
Gutscher et al. (2023) EPSL

Urlaub et al. (2018)

Nugget 4: Enhanced EQ Catalogs for Faults & Volcanoes

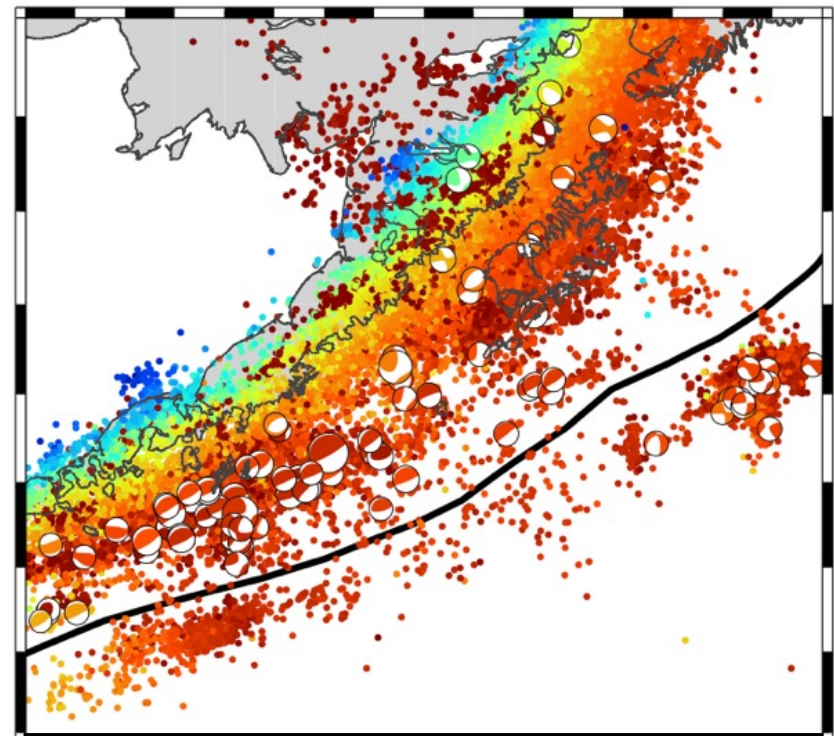


Deep Learning EQ Catalog: Post 2018 Eruption Kilauea, Hawaii



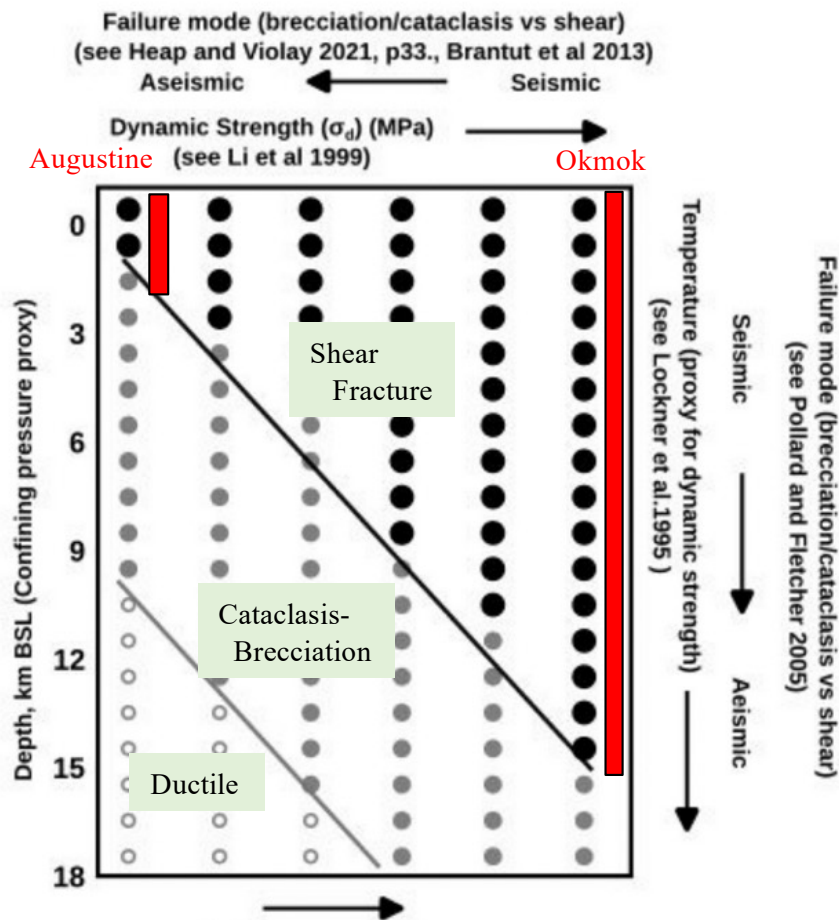
Wilding, *Science*, 2023

Deep Learning EQ Catalog: 2020-2021 Aftershocks Alaska

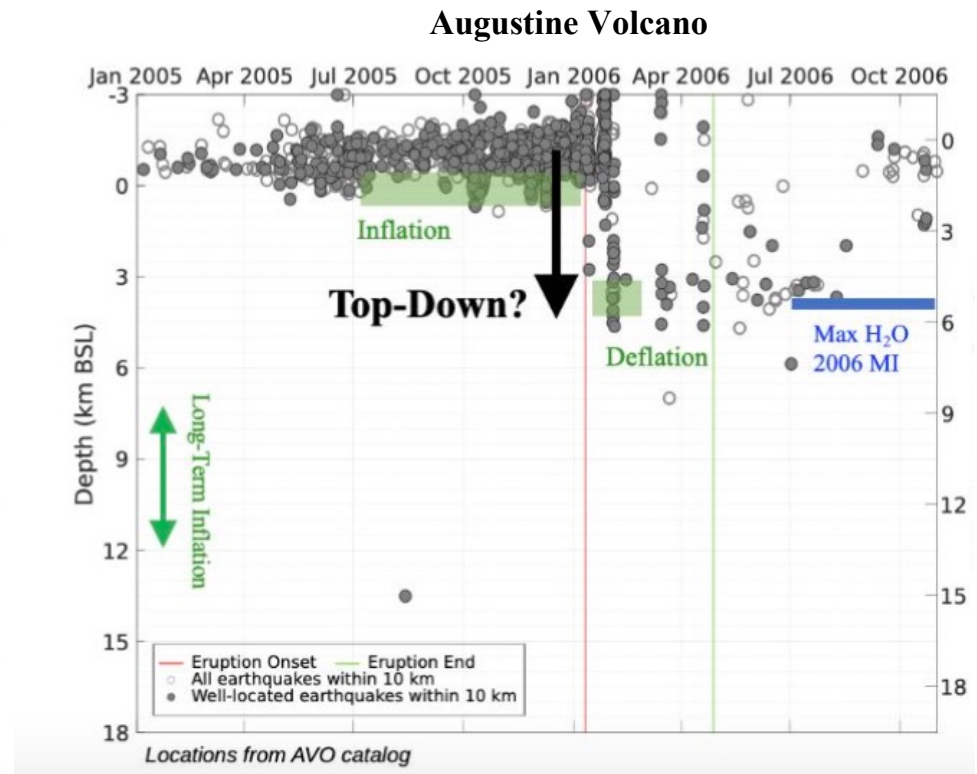


Jie, *SRL*, 2025

Nugget 5: Rock Mechanics and Volcano Seismicity



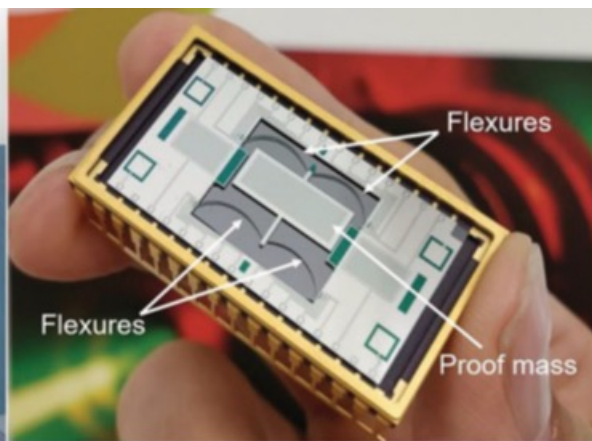
Magma Supply as a Proxy for Strain Rate?



Courtesy of Diana Roman

Nugget 6: MEMS Gravimeter

The “Wee-g”



Deployed on Poas
Volcano, Costa Rica



*Courtesy of Libby Passey, University of Glasgow
Prasad et al. (2025) IEEE Sensors*



Gravity (Gal)

Gravity (mGal)

Nugget 7: Phreatic Eruption



Lake max level

2024 Eruption



Poás Volcano,
Costa Rica



5.1 EQ 9 km

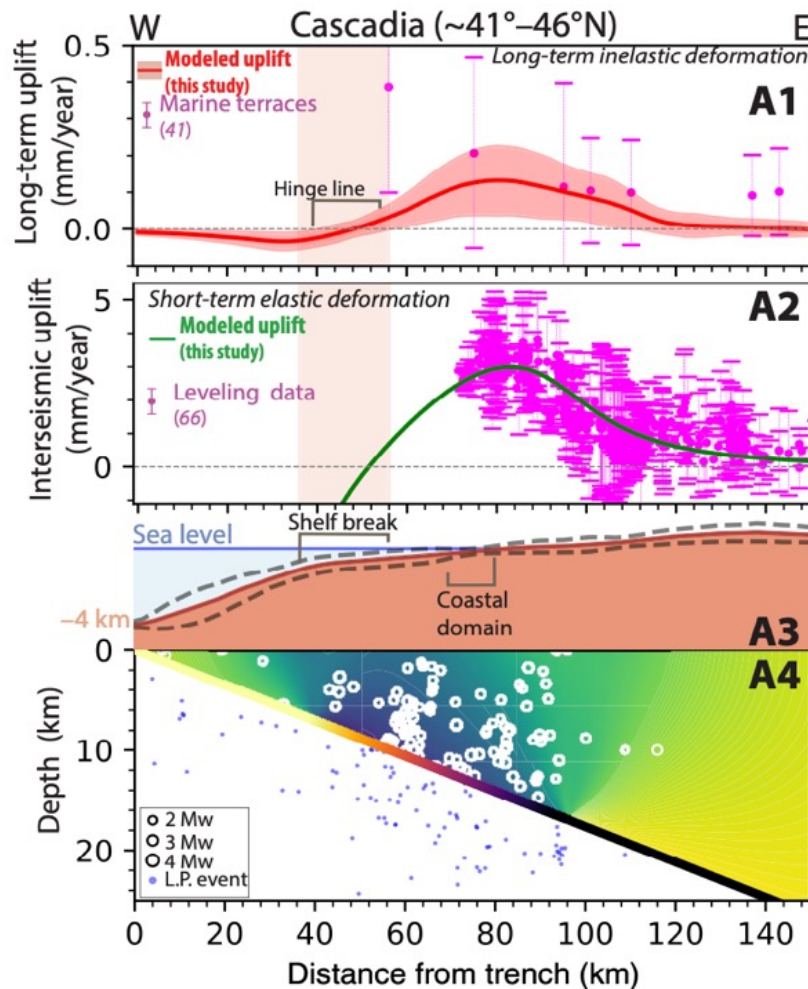


Crater Slope
Failure



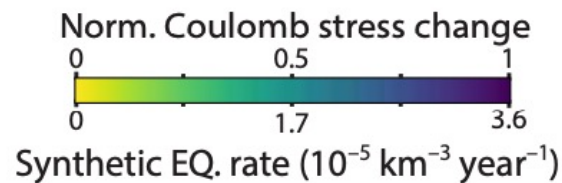
van der Laat et al. (2026) submitted to JVGR

Nugget 8: Landscape Records Megathrust Locking



Oryan et al. (2024) Sci. Adv.

- Models how the landscape records permanent deformation of many earthquake cycles
- Links short term locking state of megathrust to long term uplift of the fore-arc



What Can We Do Right Now? That is Novel and New?

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Your Ideas?



Nuggets:

- 1) Landslides & Fault Mechanics
- 2) Granular Flow & Magma Mush
- 3) Fiber Optic Volcano & Slope
- 4) Enhanced EQ Faults & Volcano
- 5) Magmatic EQ and Failure Mode
- 6) MEMs Gravimeter
- 7) Phreatic Eruptions
- 8) Megathrust Encloded in Landscape



Kavli Institute for
Theoretical Physics

