Weak, Seismogenic Faults in the Lower Crust

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Session: TS4.5

1. *Demonstrate that faults are seismogenic in the Andean foreland lower crust.*
2. *Calculate the forces needed to break these faults in earthquakes.*
3. *Discuss the implications for the controls on fault strength and its links with water.*

COMET

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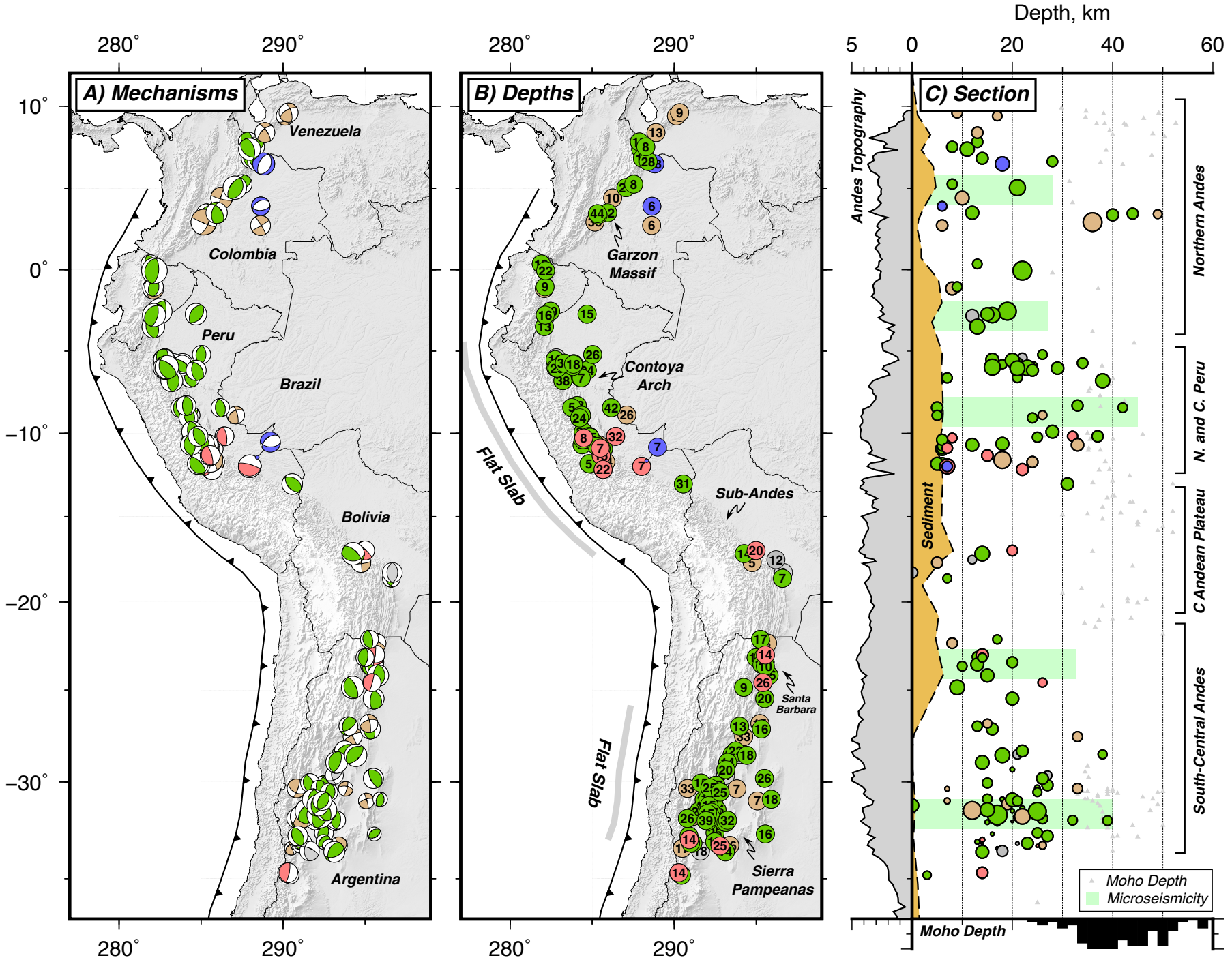
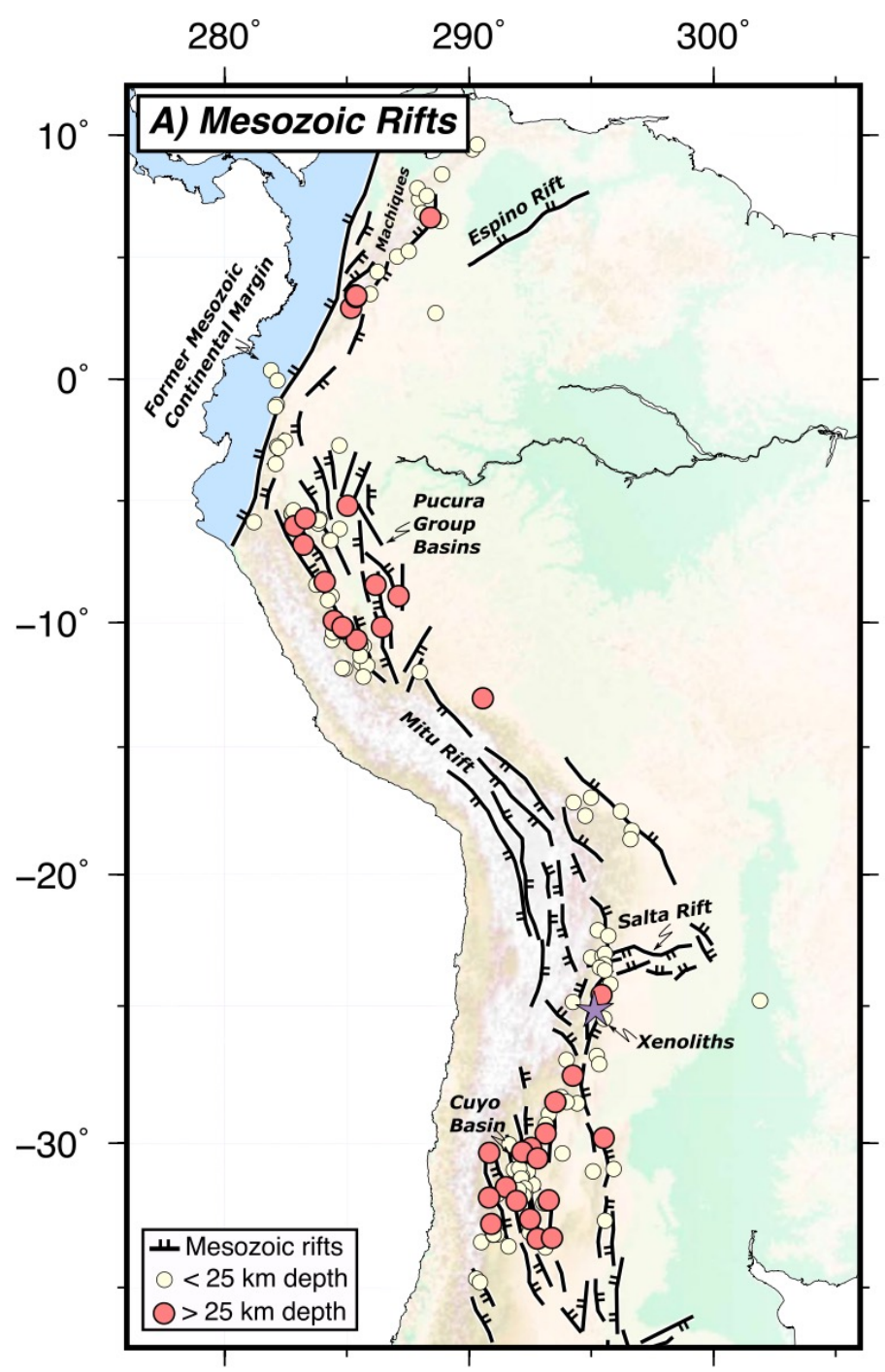
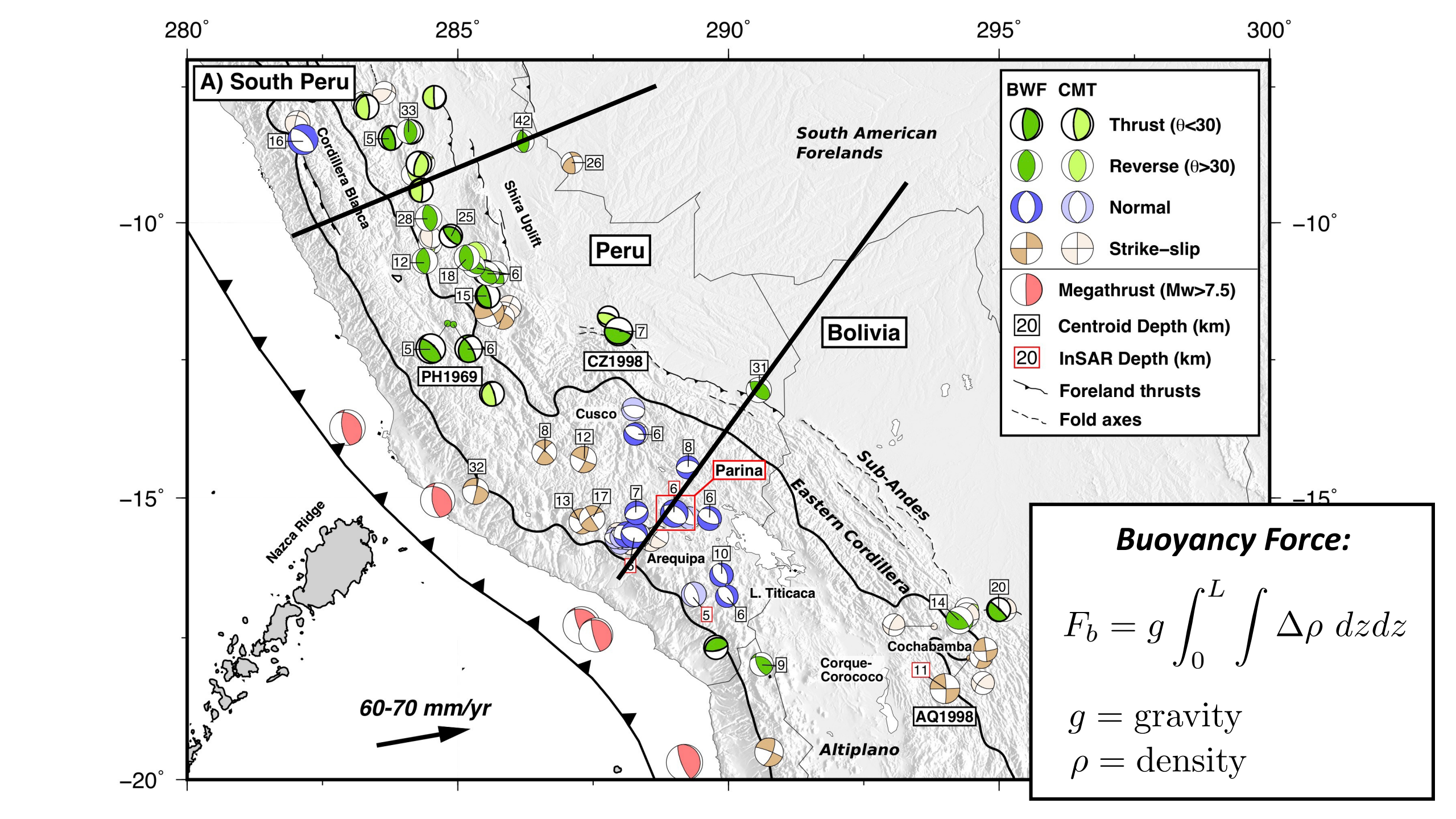

A) Mechanisms
B) Depths
C) Section
Depth, km
5
0
20
40
60
280˚
290˚
10˚
0˚
−10˚
−20˚
−30˚
Venezuela
Colombia
Peru
Brazil
Bolivia
Argentina
Garzon Massif
Contoya Arch
Flat Slab
Flat Slab
Sub-Andes
Santa Barbara
Sierra Pampeanas
Andes Topography
Sediment
Moho Depth
Northern Andes
N. and C. Peru
C Andean Plateau
South-Central Andes
Moho Depth
Microseismicity



1. Most lower-crustal earthquakes occur in reactivated Mesozoic rift systems.

Faults remain seismogenic in the lower crust after protracted periods of reactivation over ~Myr time-scales.

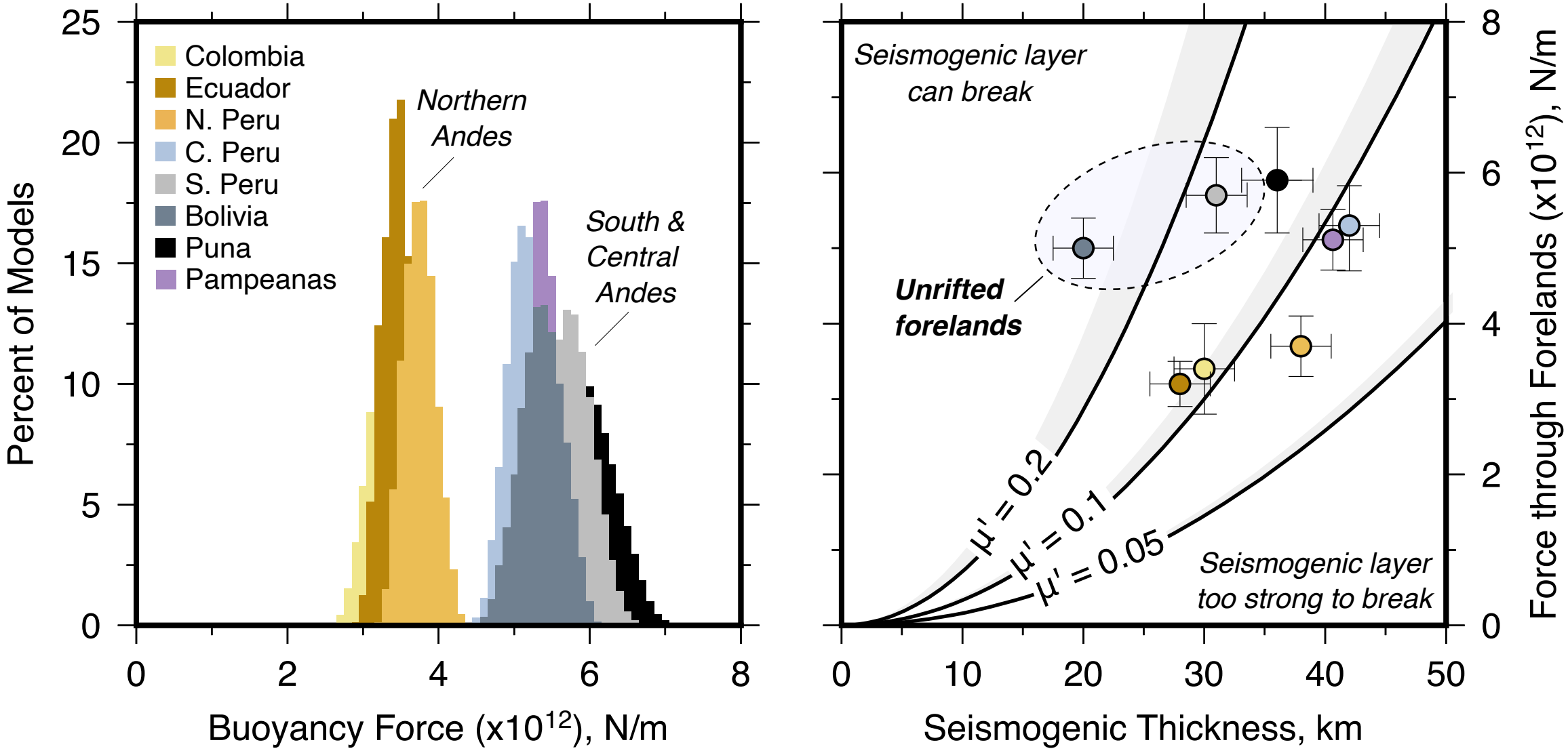


Buoyancy Force:

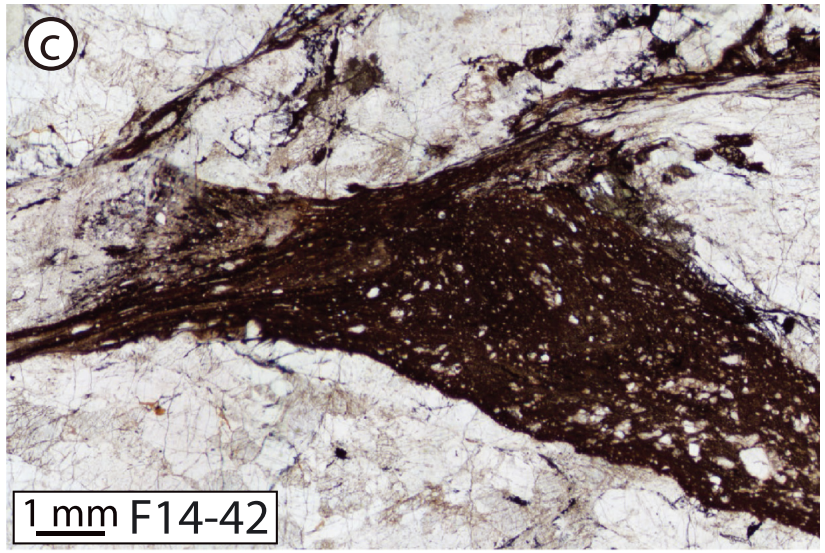
$$F_b = g \int_0^L \int \Delta\rho \, dzdz$$

g = gravity

ρ = density

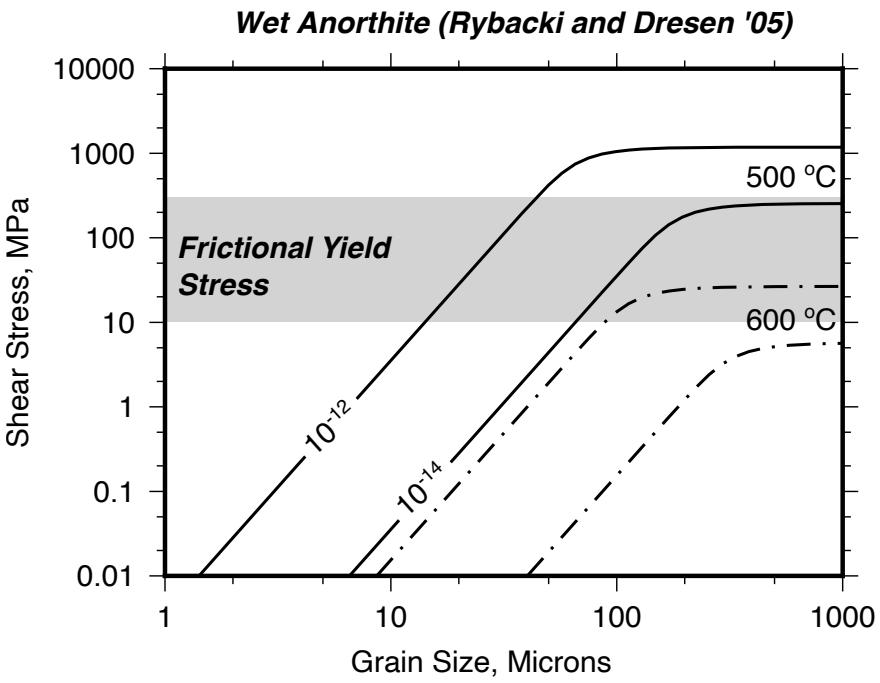


2. Earthquake-generating faults in the lower crust have a low effective friction of <0.2



Hawemann et al., 2019

Campbell et al., 2020



3. Geological observations of lower-crustal psuedotachylytes show that:

- Grain-size reduction leads to mylonitisation.
- Tiny amounts of fluid infiltration during fault slip causes mylonitisation.

A pervasive water phase in the lower crust unlikely to make faults both frictionally weak and seismogenic.

Conclusions

1. ***Seismogenic faults within the lower crust have low effective frictional strength (<0.2)***

2. ***These weak faults are reactivated and potentially have a protracted history of slip.***

3. ***A pervasive water phase on seismogenic lower-crustal faults is inconsistent geological evidence of the effects of water on deformation mechanisms at lower-crustal P-T.***

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Wimpenny et al., 2022, Weak, Seismogenic Faults Control Mountain Building in the Andean Forelands, G-cubed, 3, https://doi.org/10.1029/2021GC010270.