



Why Melts Differ Across the Azores Triple Junction:

Lithospheric and Source Controls on Basalt Geochemistry

Angel Doran, Gary Michelfelder
Graduate | School of Earth, Environment & Sustainability | Missouri State University
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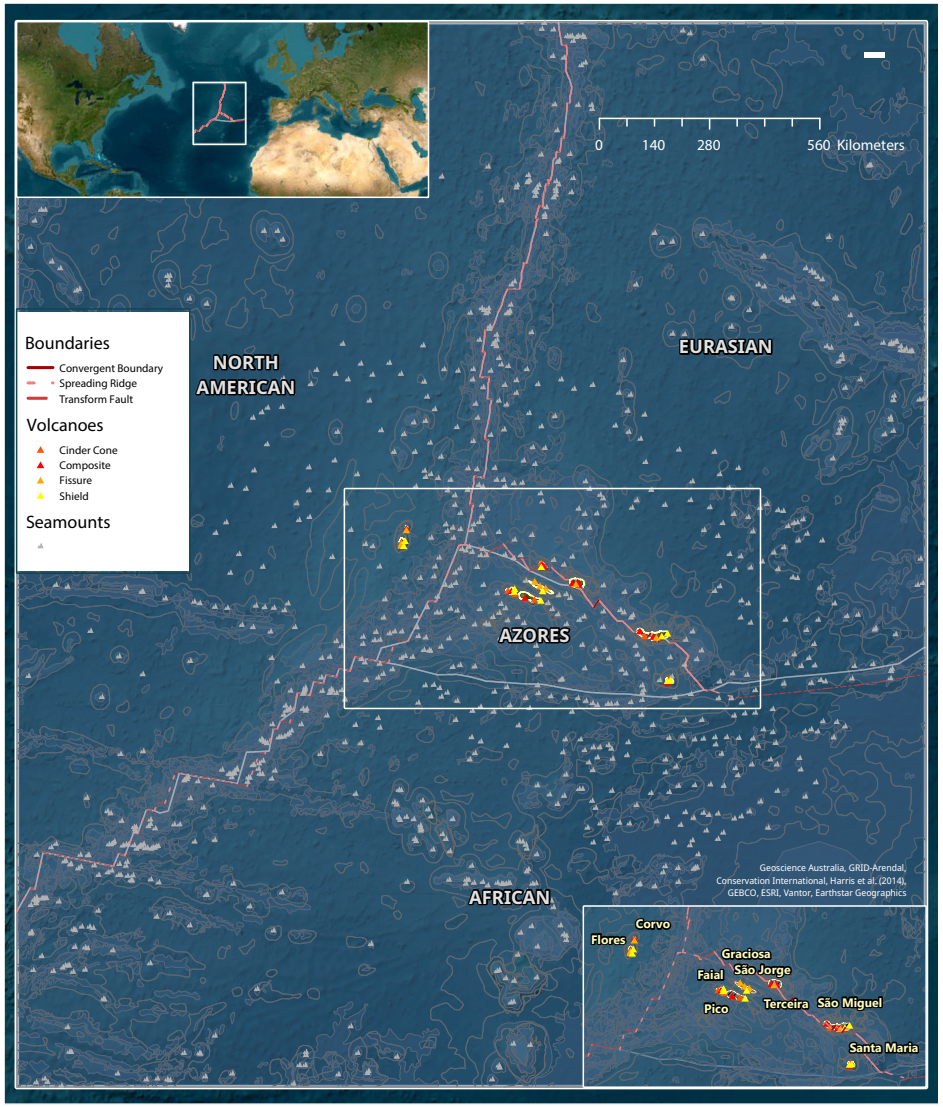
THE QUESTION



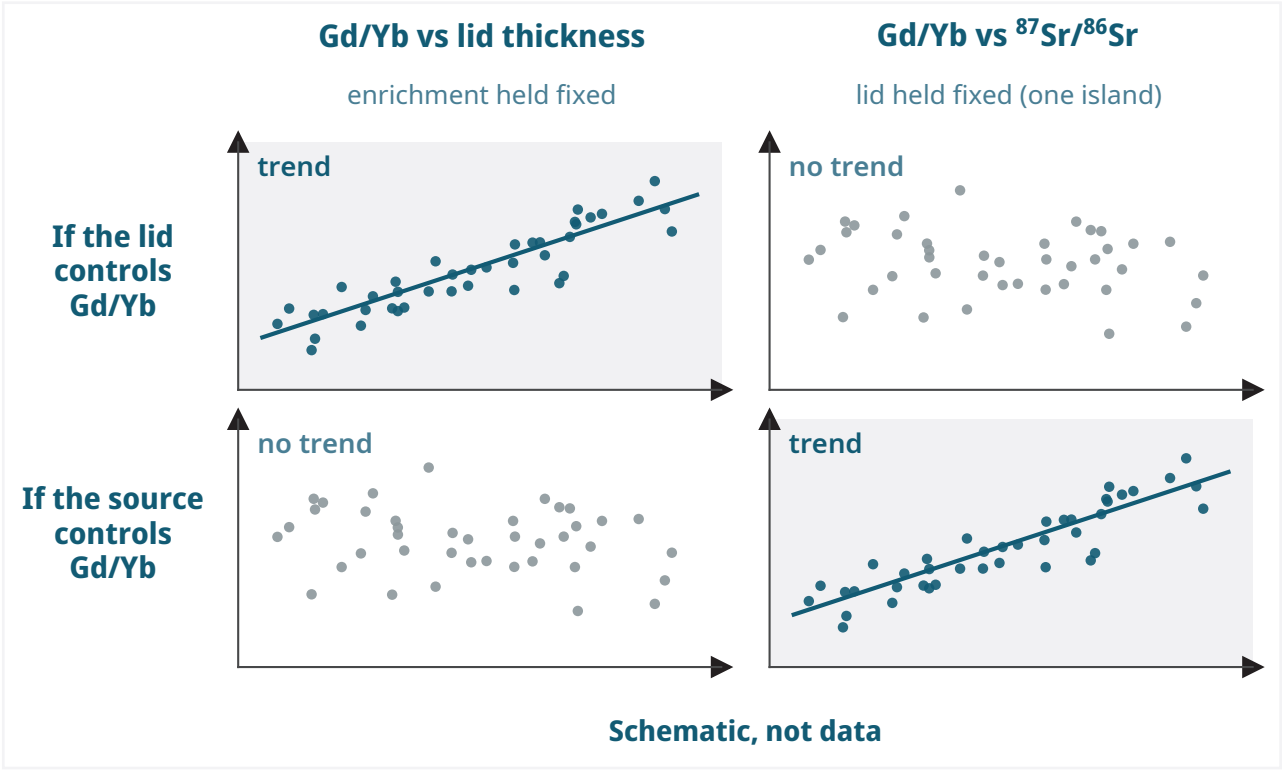
Introduction

Why do basalts differ from island to island across the Azores?

- Mantle source heterogeneity
- Lithospheric thickness
- Melting conditions and processes
- Magma storage and evolution

Can we separate source from lid?

Introduction



HYPOTHESES

- Lid control: Gd/Yb follows thickness
- Source control: Gd/Yb follows isotopes
- Combined control: Both gradients matter

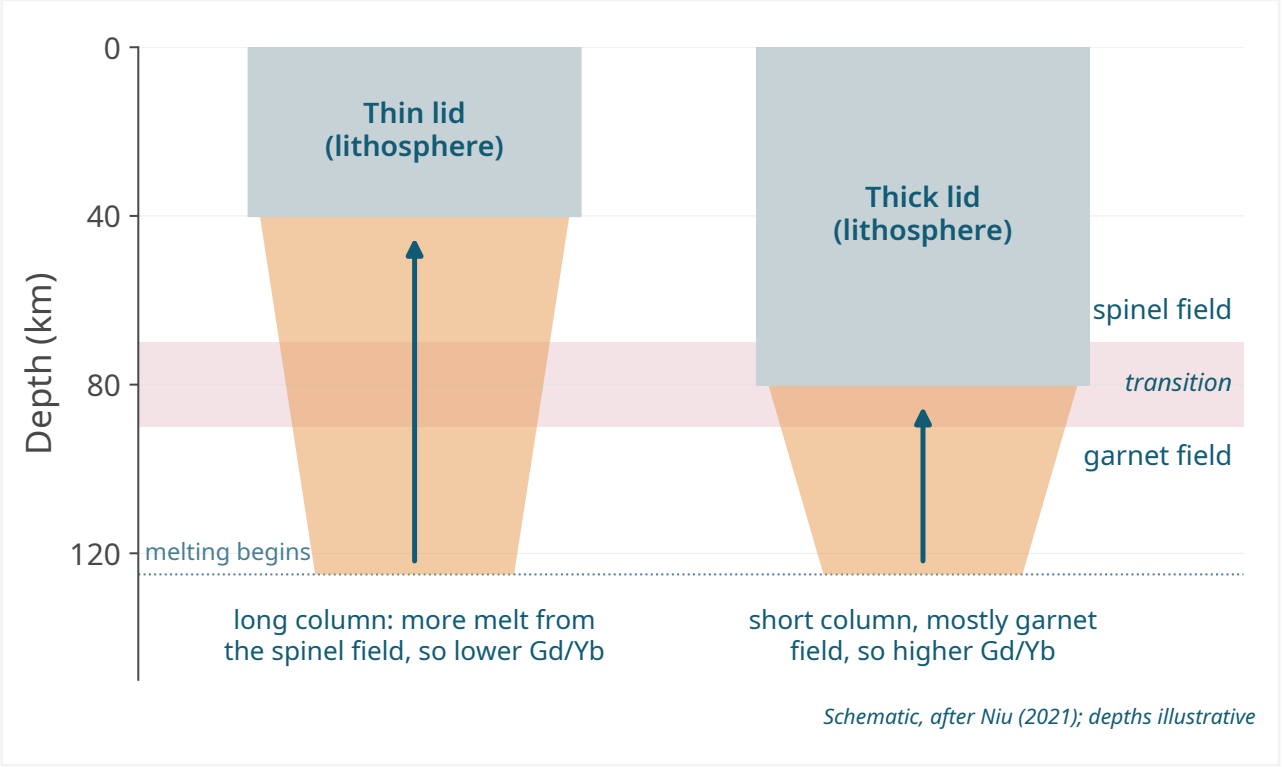
Where do gradients diverge?

LID EFFECT

Beneath ocean islands, the lithosphere limits decompression melting

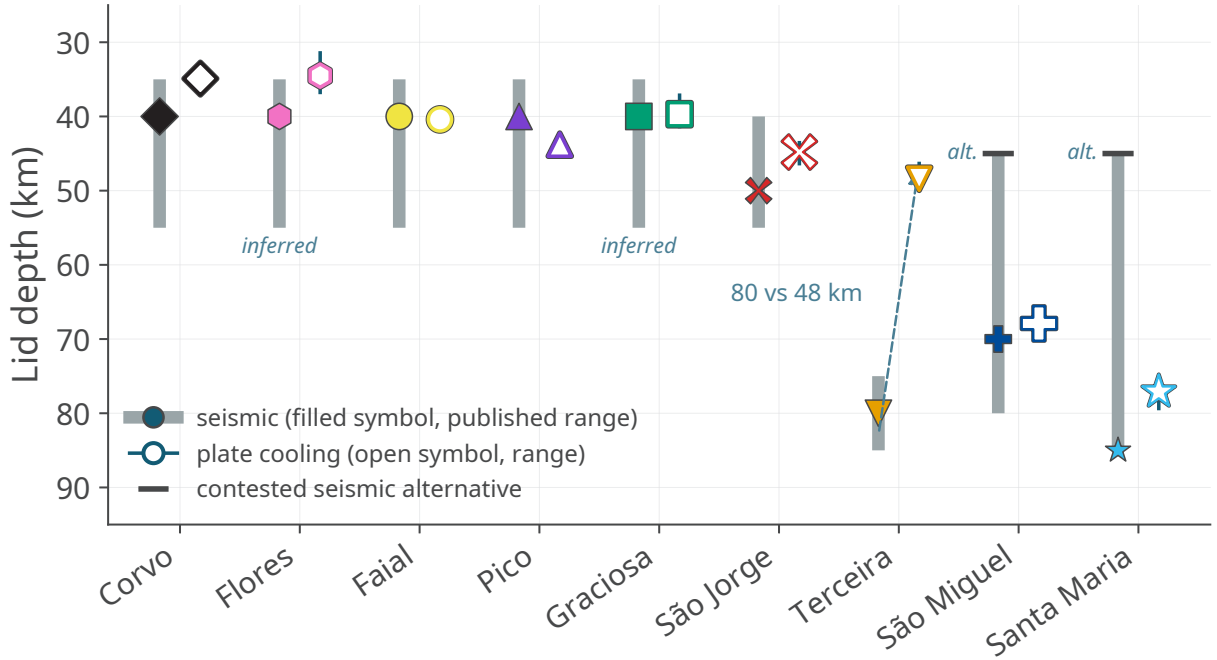
- Thicker lid → shorter column
- Garnet retains Yb > Gd
- Residual garnet → higher Gd/Yb

Background



Schematic, after Niu (2021); depths illustrative

Prediction: with the source held constant, a thicker lid means higher Gd/Yb



Seismic: Spieker et al. 2018. Plate cooling: lid = 11 × square root of seafloor age in Myr (Seton et al. 2020), at each island's centre.

The two methods disagree only at Terceira

LID DEPTHS

Lid depths are estimated independent of geochemistry

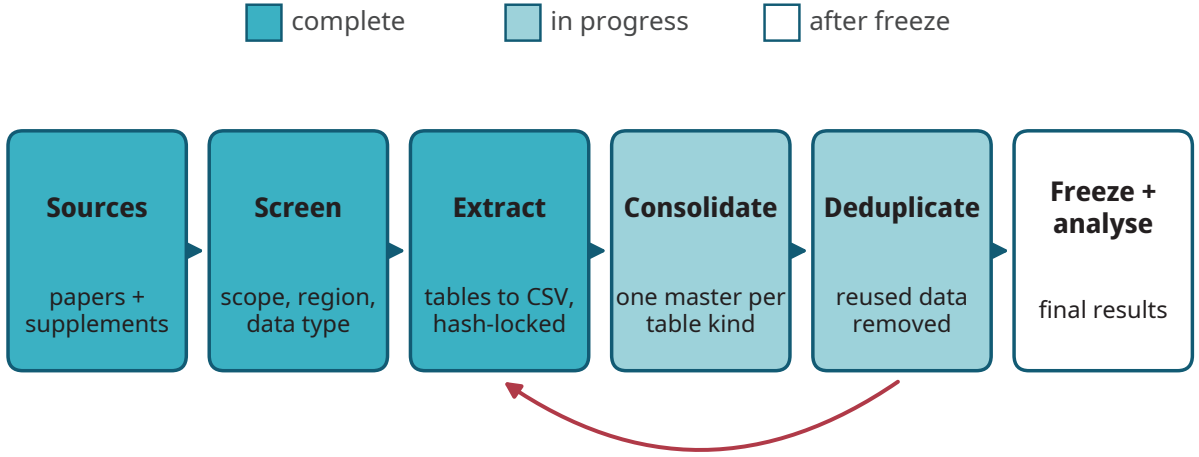
- Seismic: receiver functions
- Plate cooling: seafloor age
- Differ by ≤8 km at eight of nine islands

THE DATASET

Literature → reproducible dataset

- 782 papers screened (1860-2026)
  - 495 with data
  - 309 with geochemical data
  - 229 with new geochemical data
- 3,196 valid whole-rock samples

Methods



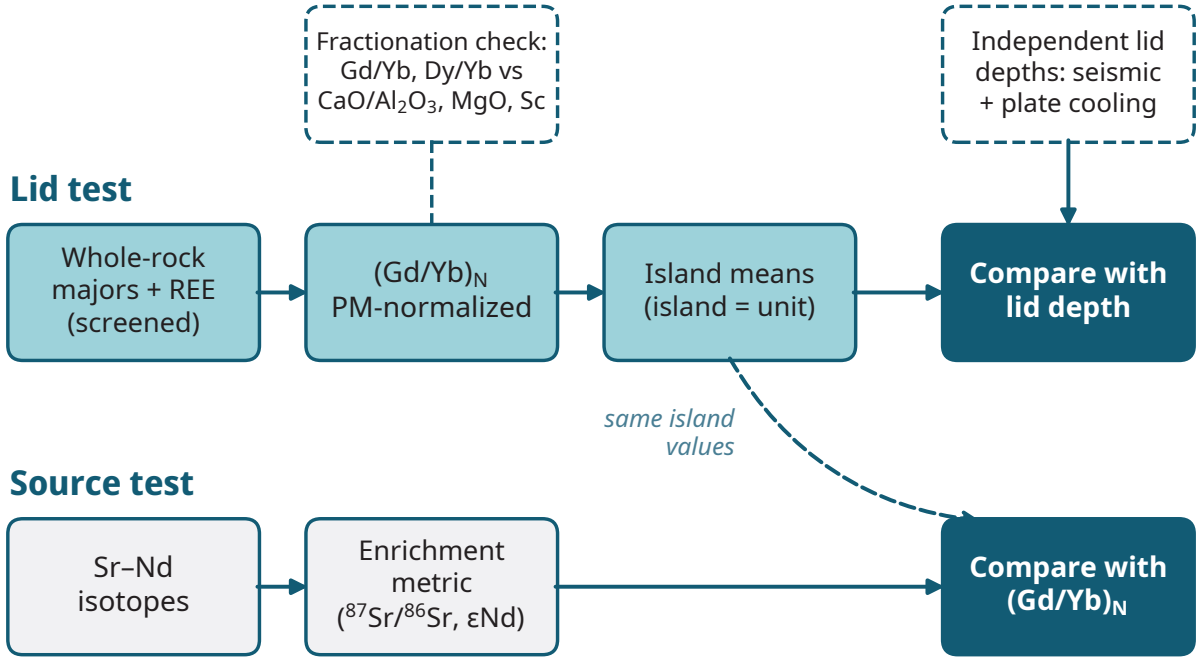
independent QA/QC: every value checked against the source page; deviations flagged in qaqc_ columns, never overwritten

Status as of 9 Oct 2026

Extracted ≠ validated ≠ complete

Today's test uses an unfrozen dataset

Methods



Which one explains the island-to-island pattern?

ANALYSIS

Analytical Methods

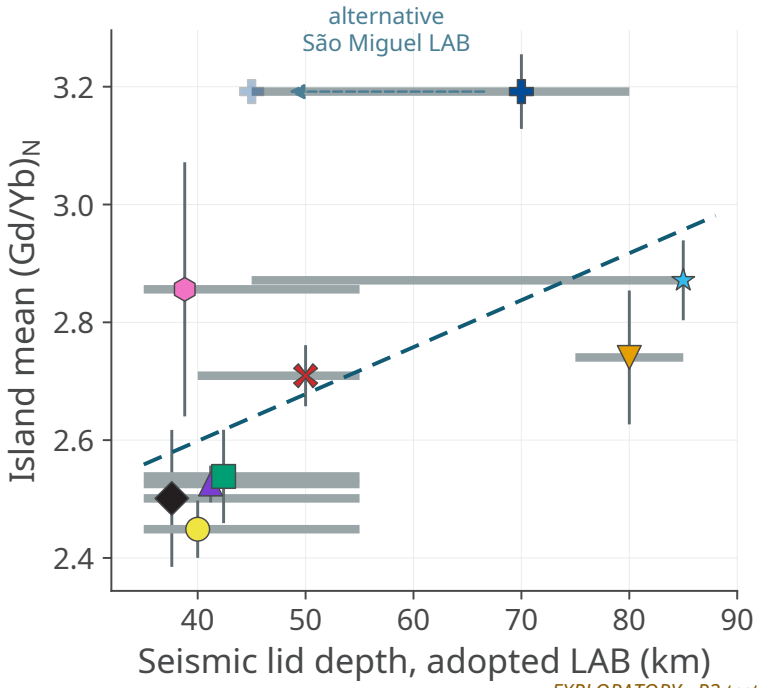
- Screen for mafic samples
  - 532 samples from 45 papers
- Summarize Gd/Yb by island
- Assign independent LAB depths
- Compare Gd/Yb with lid depth
- Compare Gd/Yb with source proxies

TEST RESULTS

Preliminary test

- Mafic basalts only
- PM-normalized Gd/Yb
- Island-level test
- Contrast holds; regression marginal

Results



Island-level test

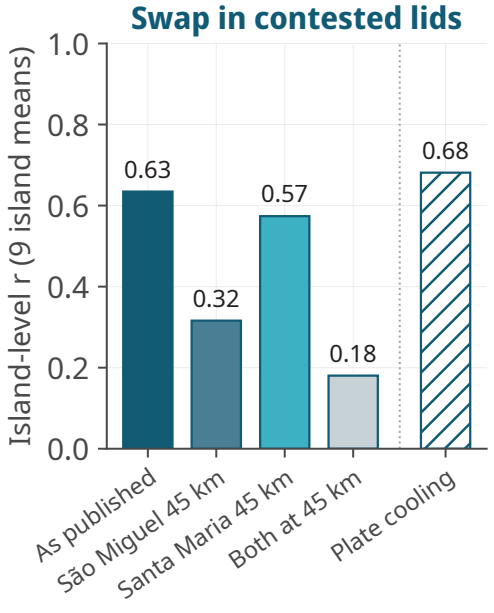
Unit	9 island means
Samples	532 (n 17–102 per island)
Pearson r	0.63 (p = 0.066)
Spearman ρ	0.71 (p = 0.031)
Slope	0.08 per 10 km
r with LAB uncertainty	0.28 to 0.72 (95% of draws)
Plate-cooling lid	r 0.68 (p = 0.043)
Permutation	p = 0.024, one-sided (84 island splits)

Pearson and Spearman p two-sided. Bars: published LAB range (x); ±2 SE of mean (y). Dashed: least squares on island means; 40 km islands offset for visibility.

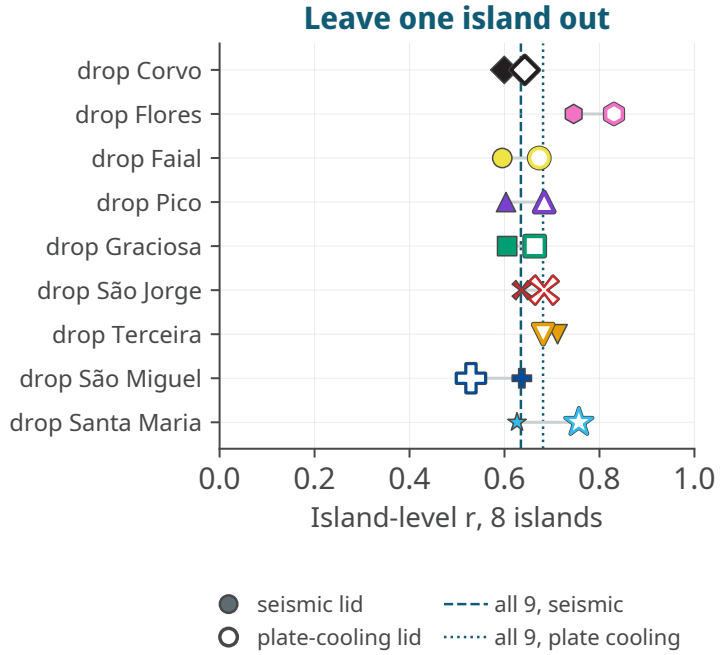
EXPLORATORY · P3 test population (9 Oct 2026) · dataset not yet frozen

Thick-lid islands carry higher Gd/Yb

SENSITIVITY



Pearson r of island-mean $(Gd/Yb)_N$ against lid depth.
Contested: São Miguel model M9, Santa Maria PSMA.



EXPLORATORY · P3 test population (9 Oct 2026) · dataset not yet frozen

Result depends on lid depths

- São Miguel's lid drives the result
- Contested 45 km lids weaken it
- Plate-cooling lids give a similar trend
- Fractionation: not detected

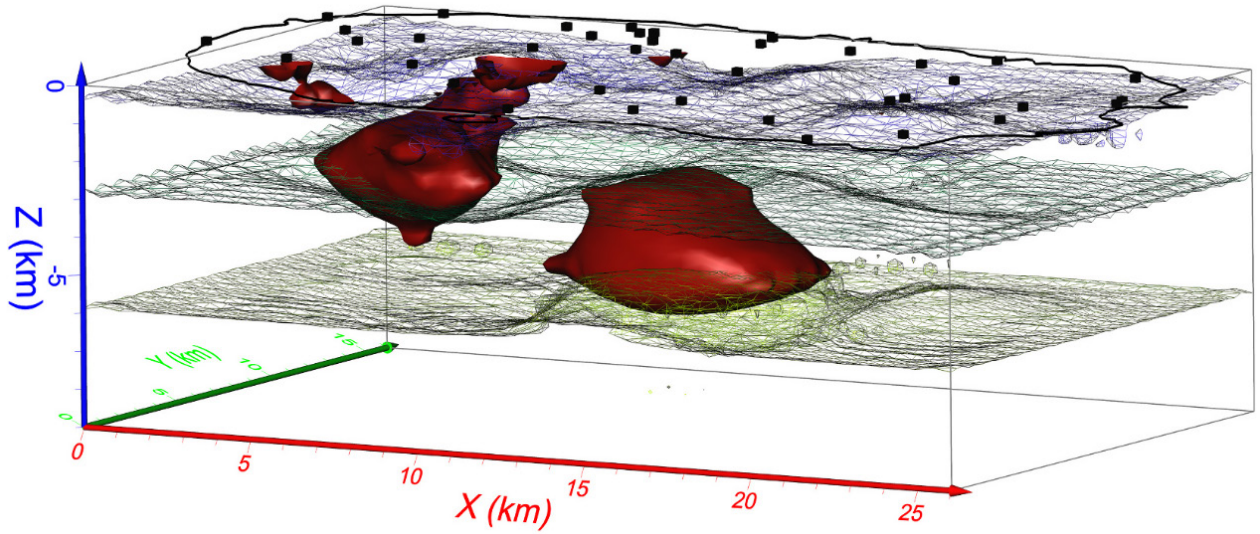
A key constraint is geophysical: the lithosphere beneath São Miguel

DIVERGENCE

Terceira vs. São Miguel

- Similar seismic lids, different Gd/Yb
- Plate cooling puts Terceira near 48 km
- Terceira: segmented magma storage
- Rifting complicates lid control

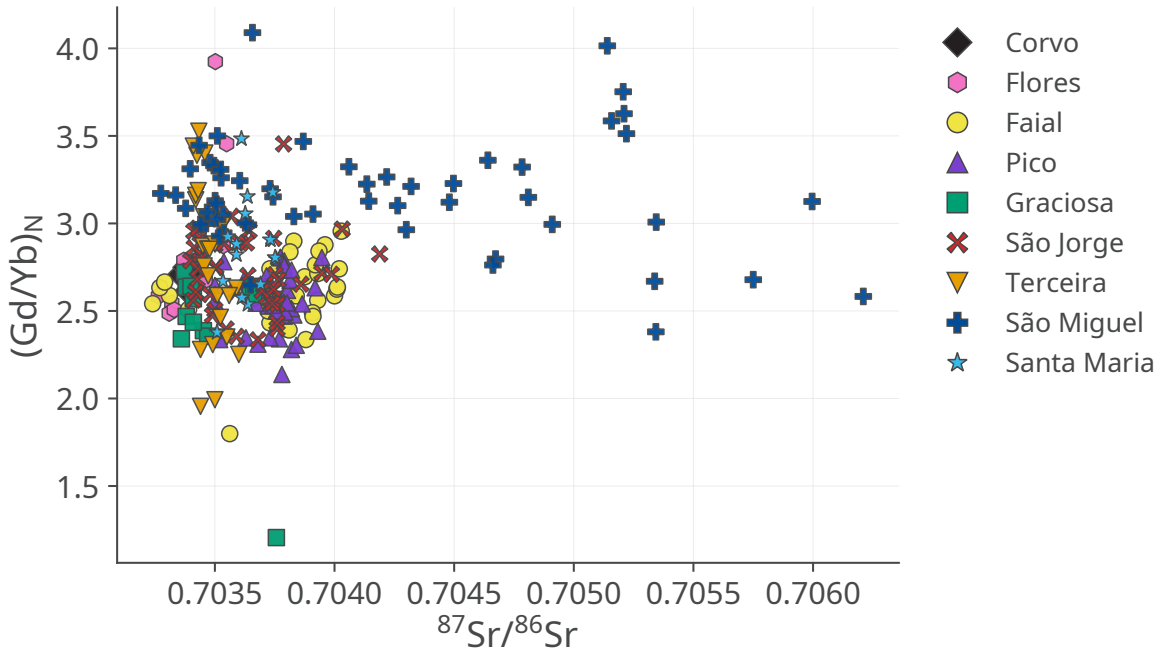
Discussion



High-Vp/Vs bodies beneath Terceira (Dias et al. 2026, Tectonophysics 929, Fig. 9)

Terceira: a thinner lid, or melts modified on the way up?

Discussion



EXPLORATORY · P3 test population (9 Oct 2026) · dataset not yet frozen

Source could still mimic the lid signal

SOURCE?

Source heterogeneity is real; which term is first-order?

- Sr–Nd shows source variation
- Enrichment alone ≠ high Gd/Yb
- Flores, Corvo: Nb-enriched at equal seismic lids
- Sr isotopes on 242 of 532 samples in today's test

SO FAR

What the evidence supports today

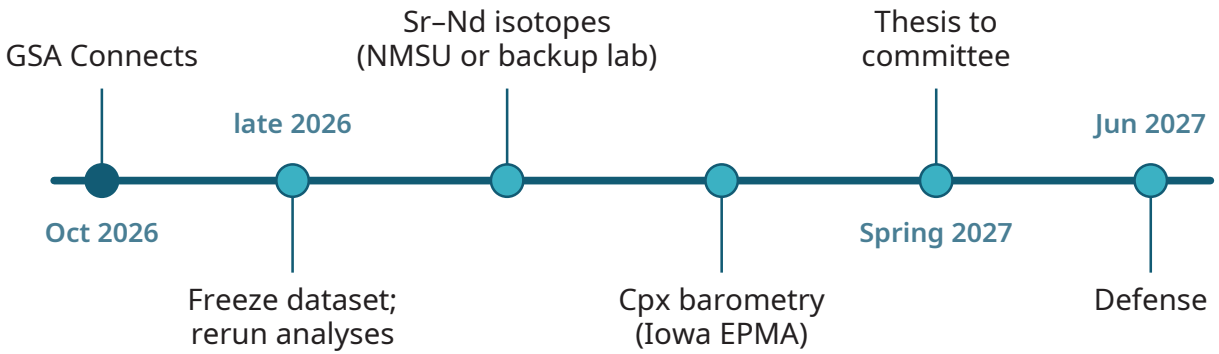
- Lid-direction signal
- Evidence remains provisional
- Source remains unresolved

Conclusion

Supported	Gd/Yb differs between islands in the direction the lid effect predicts
Provisional	The association is island-level and marginal, and hinges on São Miguel's lithosphere
Open	Whether source enrichment can mimic the lid signal (Sr–Nd test)
Not yet tested	Storage depths vs. architecture (clinopyroxene barometry)

Lithospheric architecture is a plausible control on Gd/Yb, not yet a demonstrated one

Conclusion



NEXT STEPS

What turns a test into a result?

- Freeze dataset; rerun analyses
- Sr–Nd tests source control
- Cpx constrains storage depths
- Refine uncertain LAB depths

Acknowledgments:

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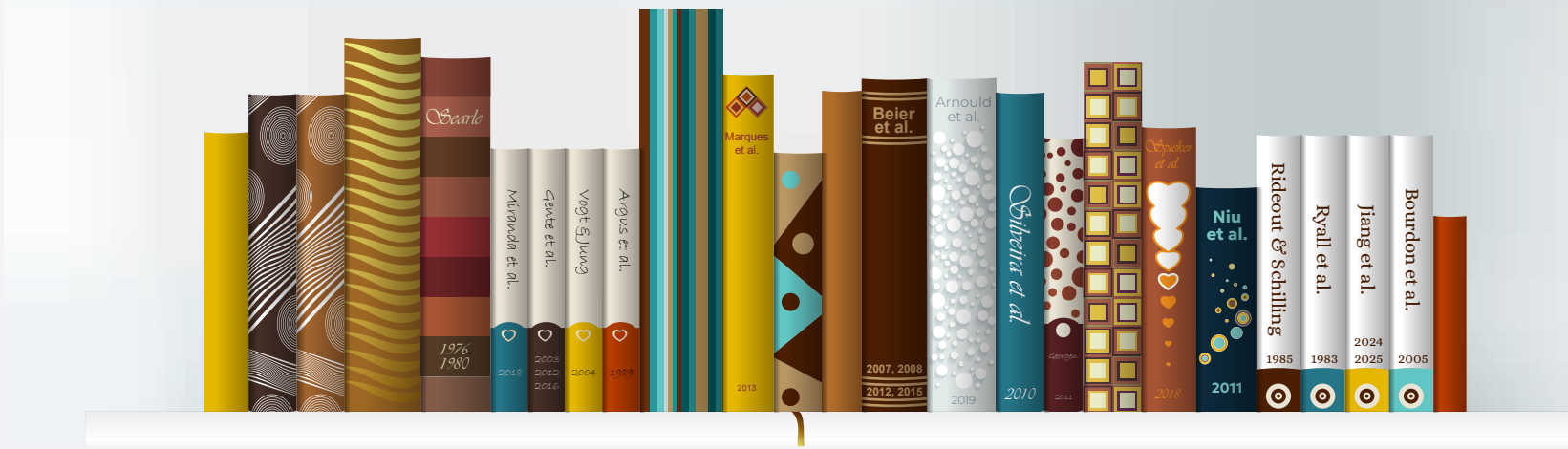
DATA REFERENCES



Questions?



REFERENCES