Unraveling MORB petrogenesis along the East Pacific Rise (EPR) 8°20’ N Seamounts and Siqueiros Transform: Insights from olivine minor and trace element geochemistry

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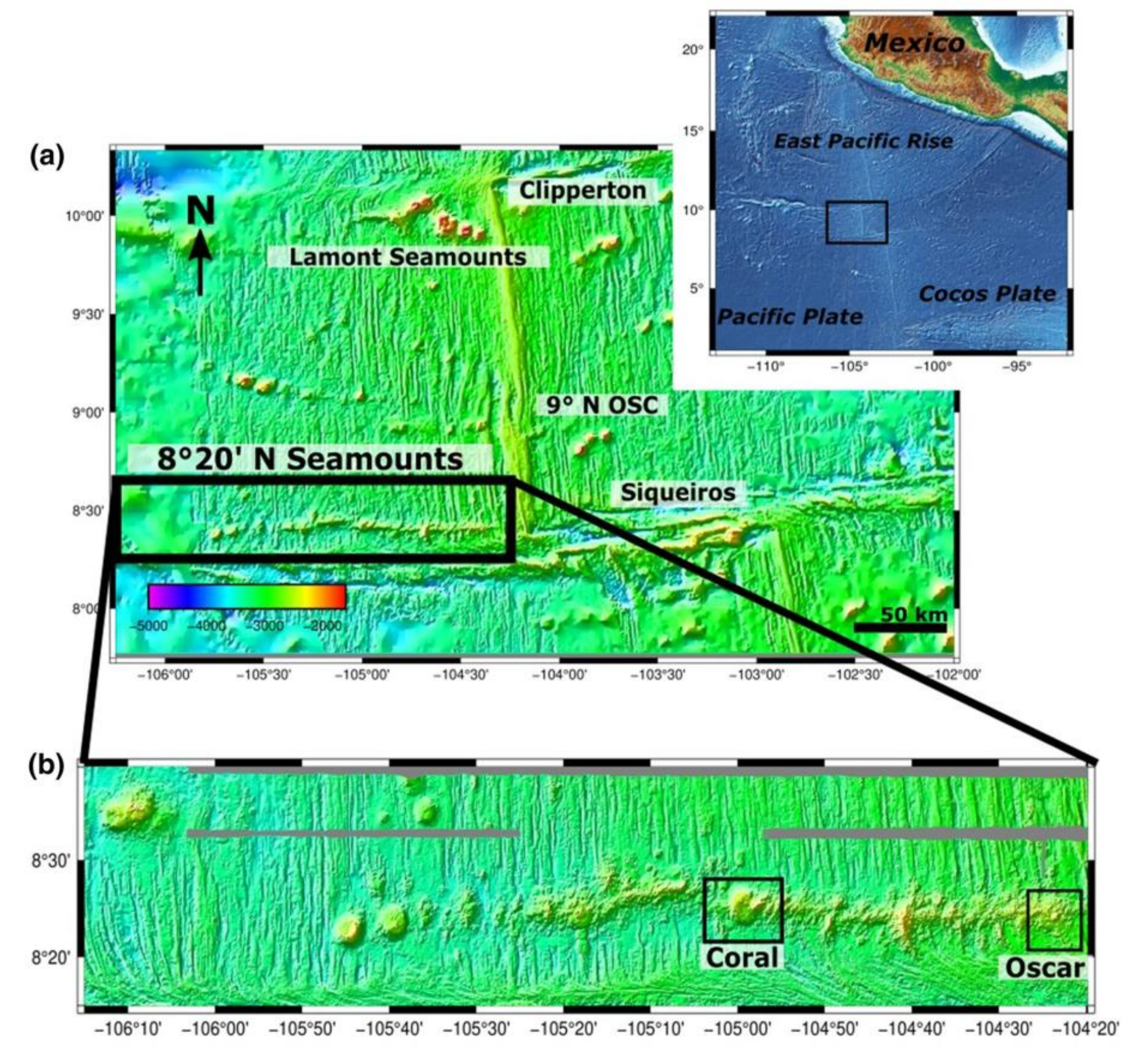
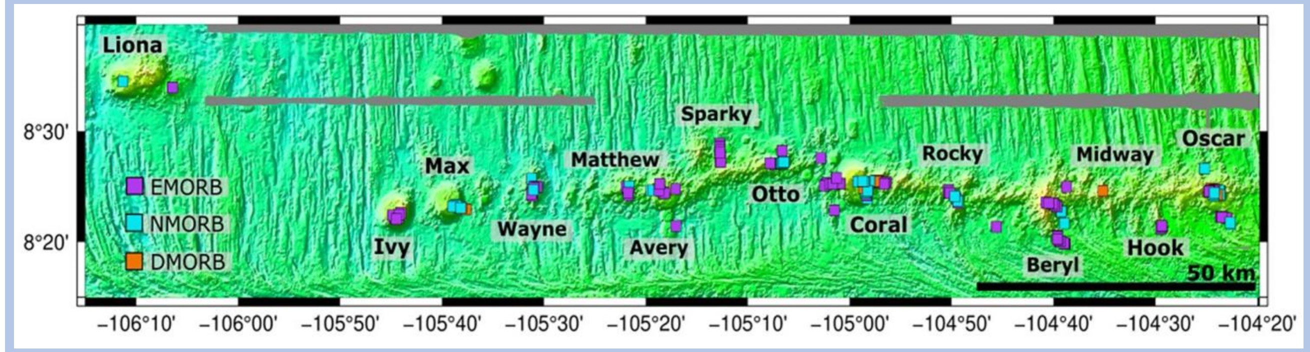
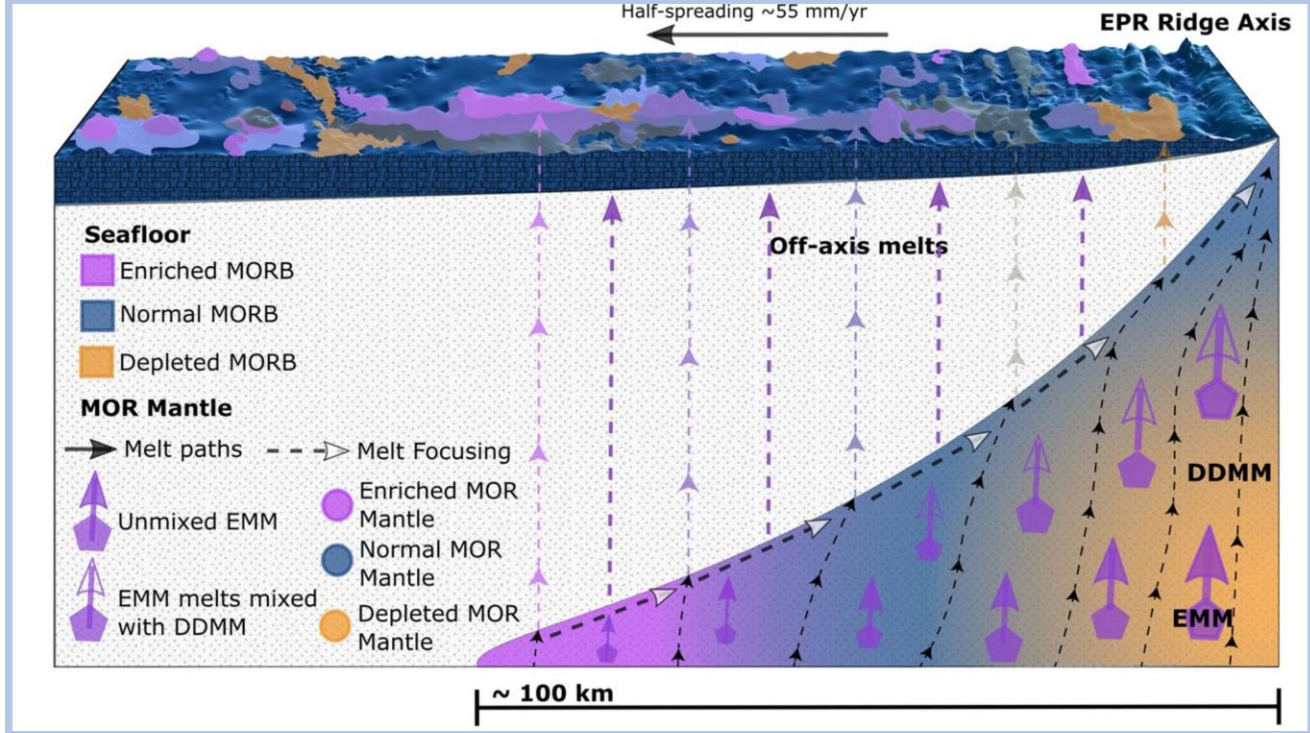
Extreme MOR mantle heterogeneity in 8°20’ N EPR?

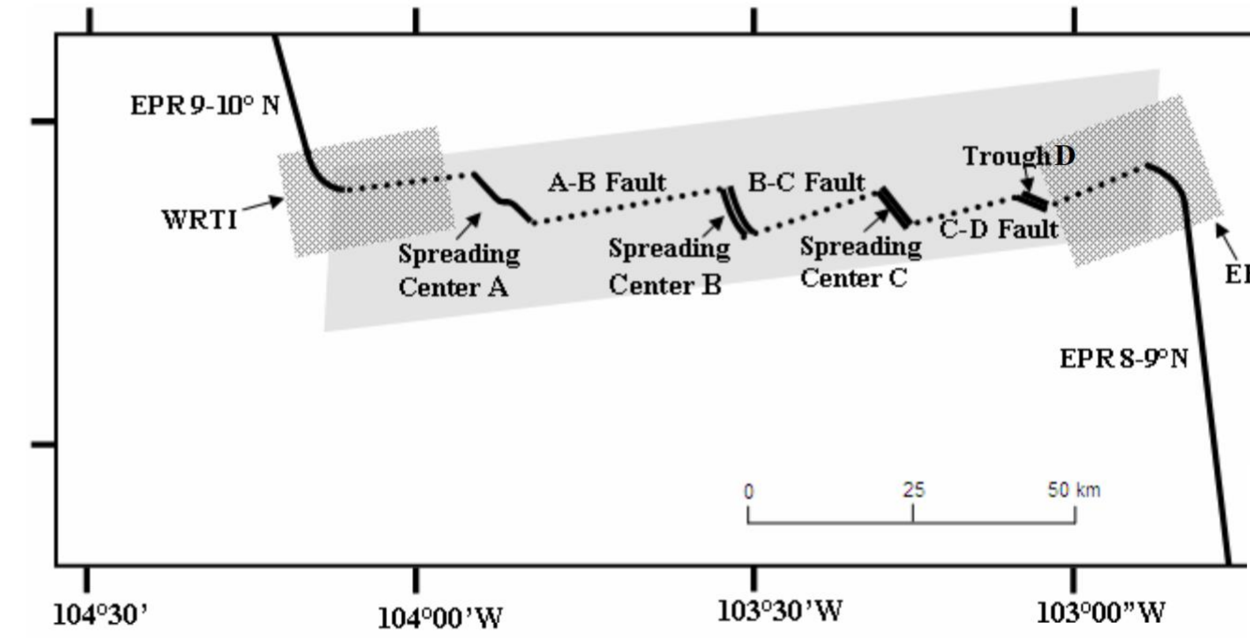


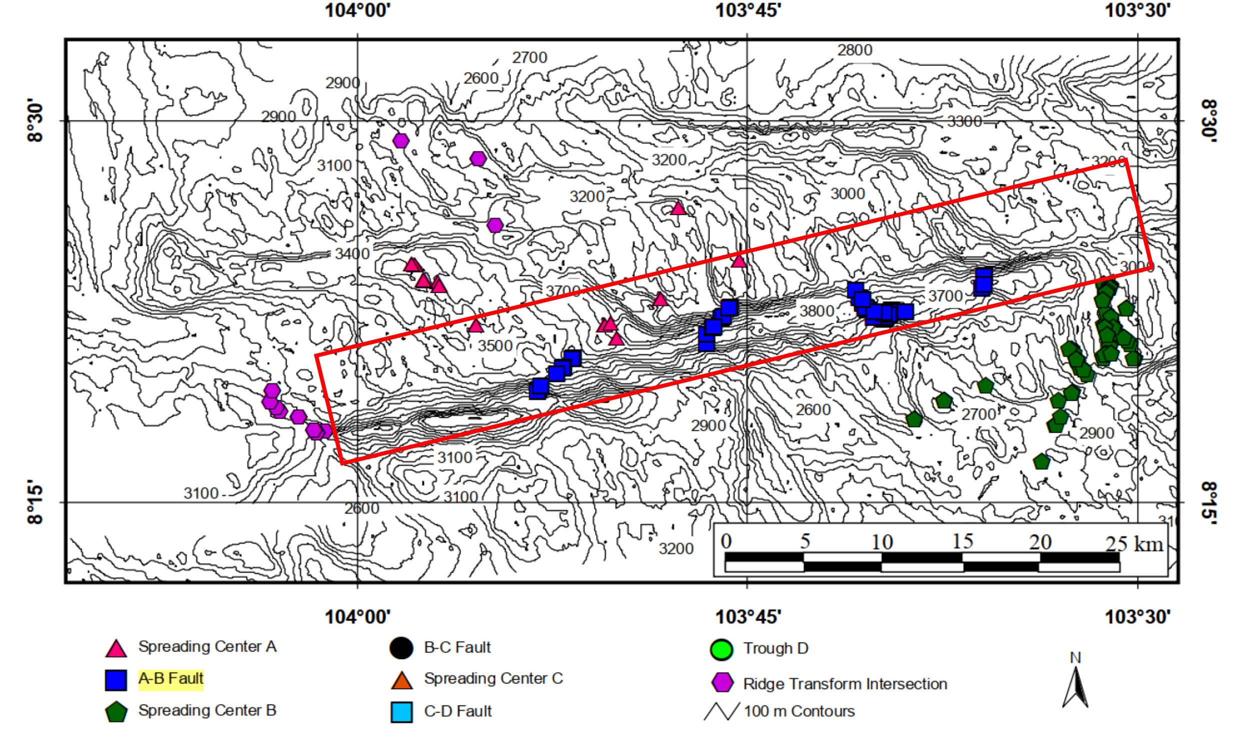




From Anderson et al. (2021), G-cubed

Siqueiros Transform: Primitive picritic basalts



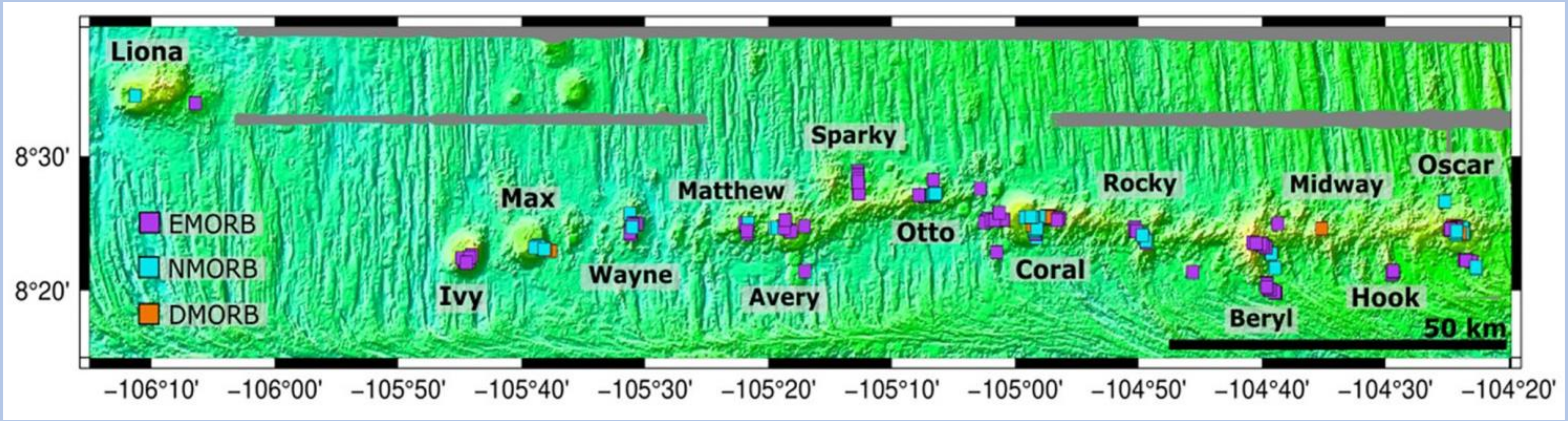


2384: Young cones in axis of A-B fault.

D20: Small cones near the midpoint of A-B faults.

From Michele Hays (2004), M.S. thesis

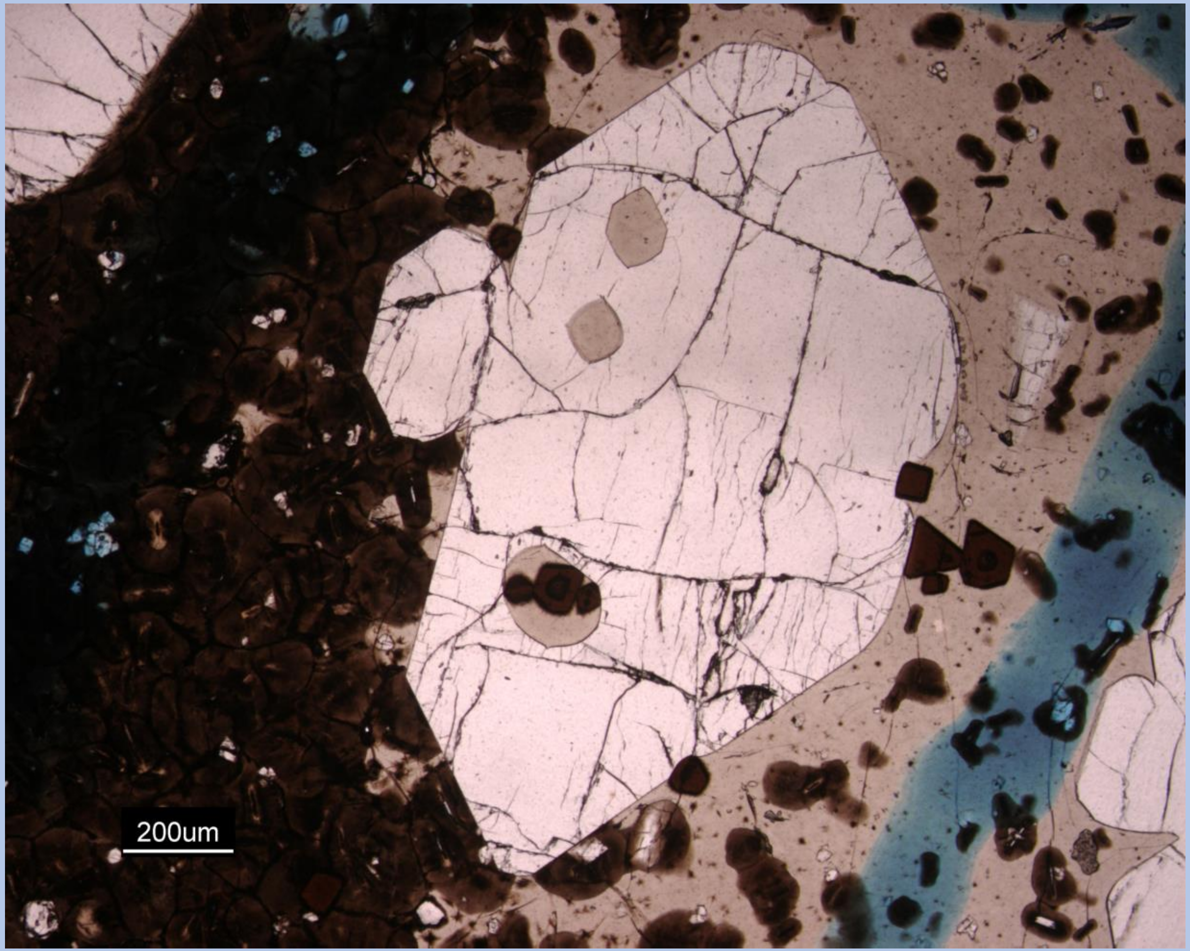
Varying MORBs (D-, N-, E-MORBs) along the 8°20’ N Near-Axis Seamounts Chain

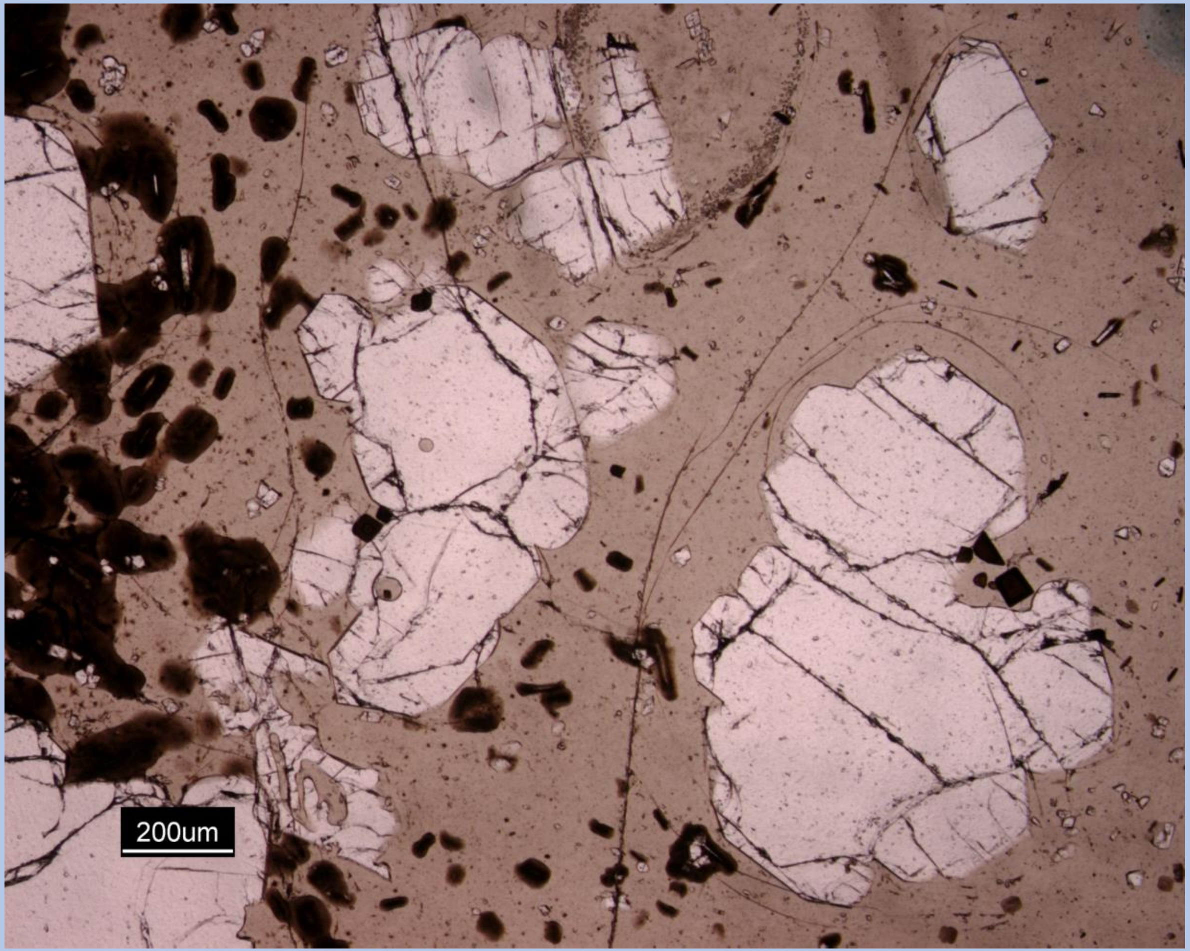


From Anderson et al. (2021), G-cubed

- Geochemically diverse olivine-bearing MORBs were selected for systematic geochemical study.

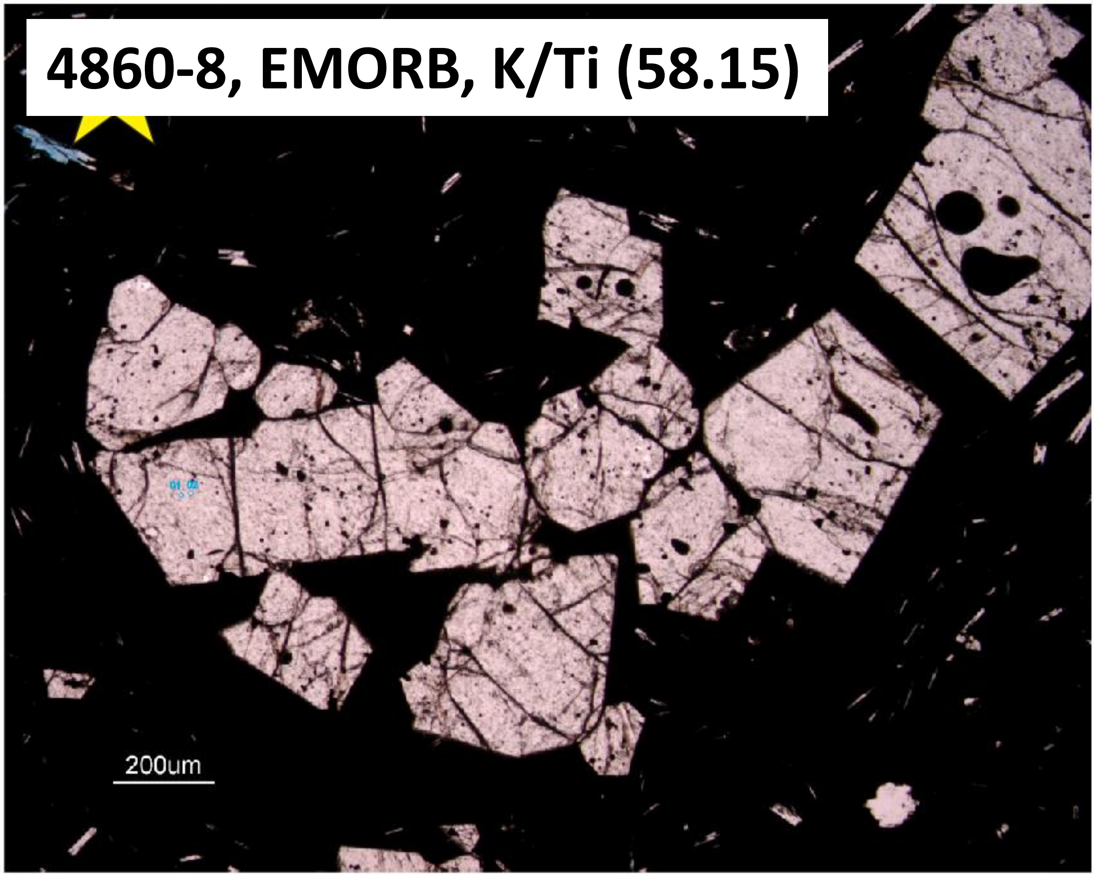
Olivine petrography among various MORBs

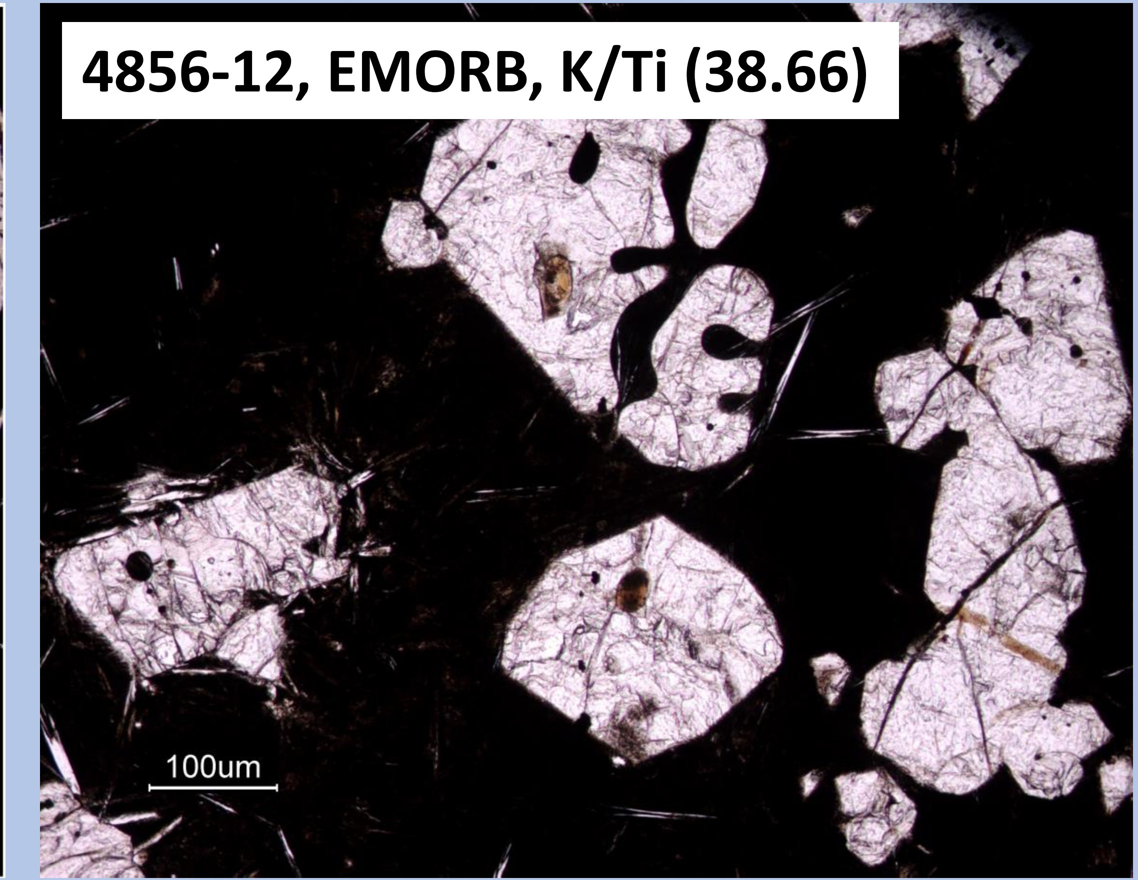




- **Siqueiros DMORBs:** euhedral-subhedral olivines, no significant embayment

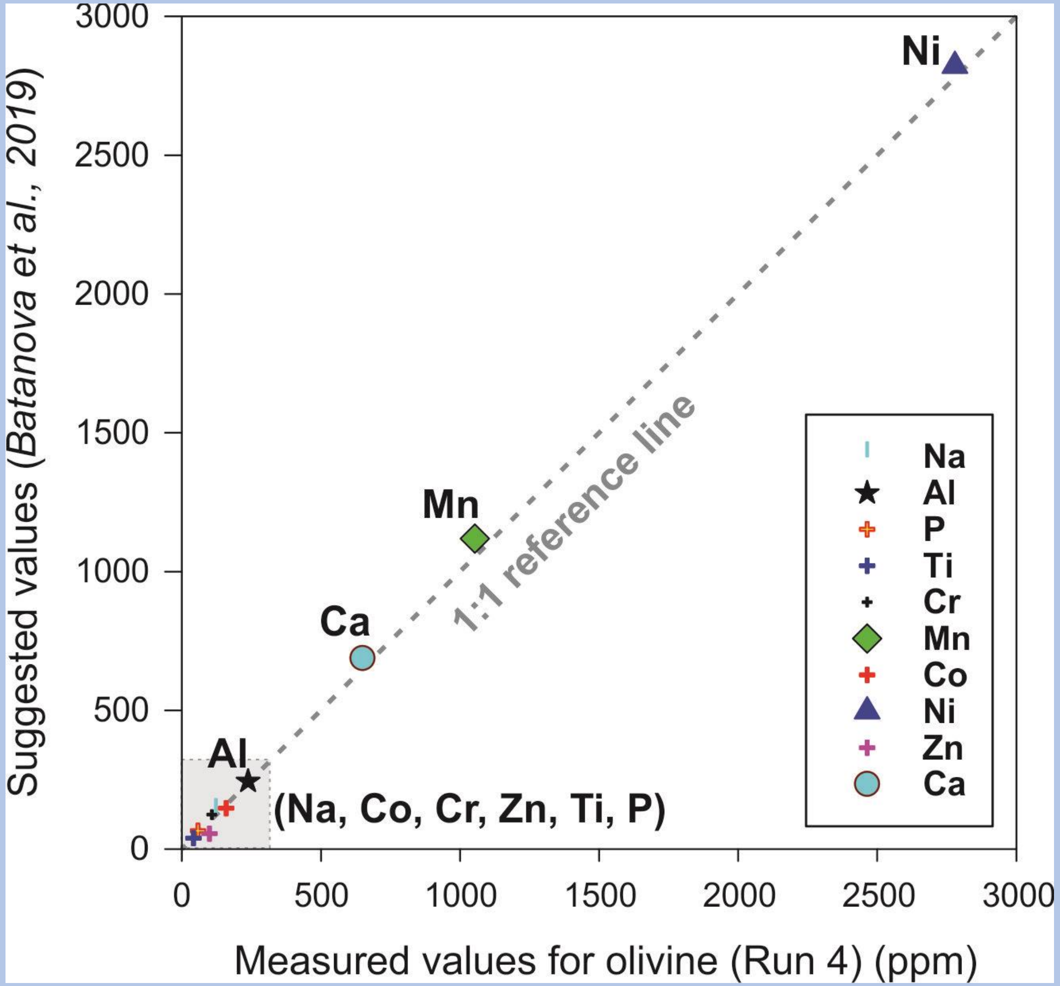
Olivine petrography among various MORBs

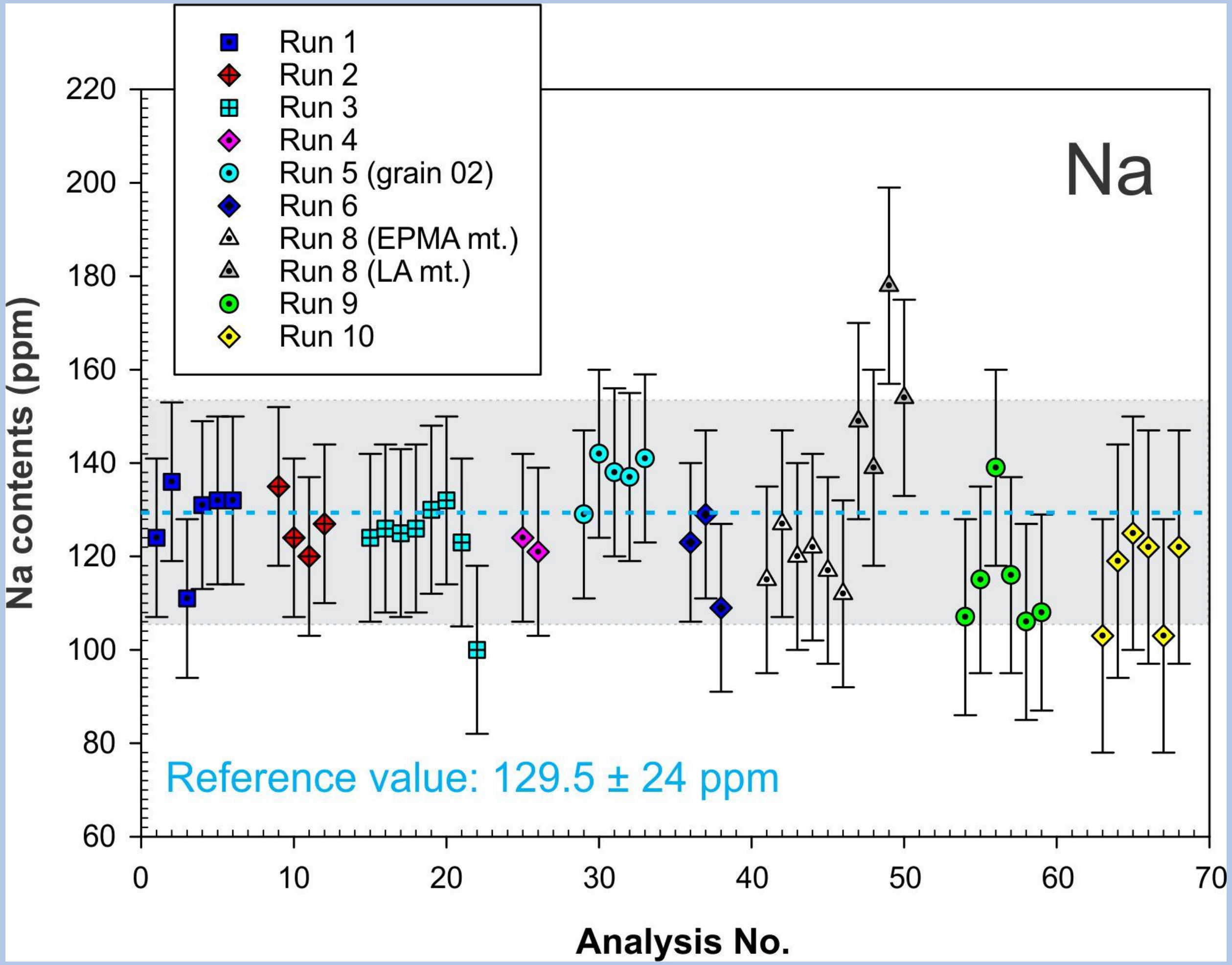

4860-8, EMORB, K/Ti (58.15)


4856-12, EMORB, K/Ti (38.66)

- **8°20’ N Seamounts (various MORBs):** euhedral-subhedral olivines, but some EMORBs show <u>notable embayment</u> (melt-crystal reaction)

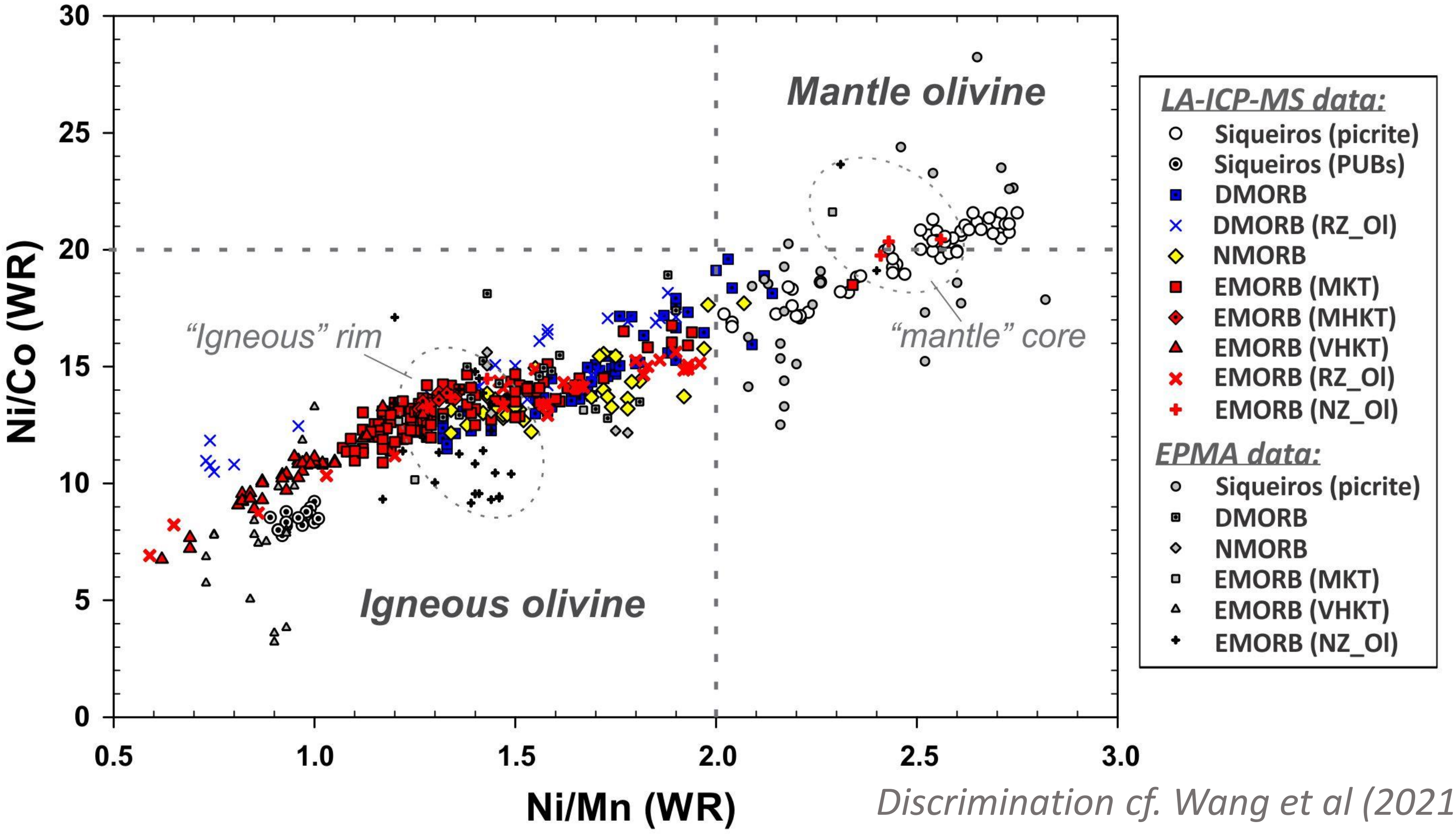
High-precision olivine minor and trace analyses



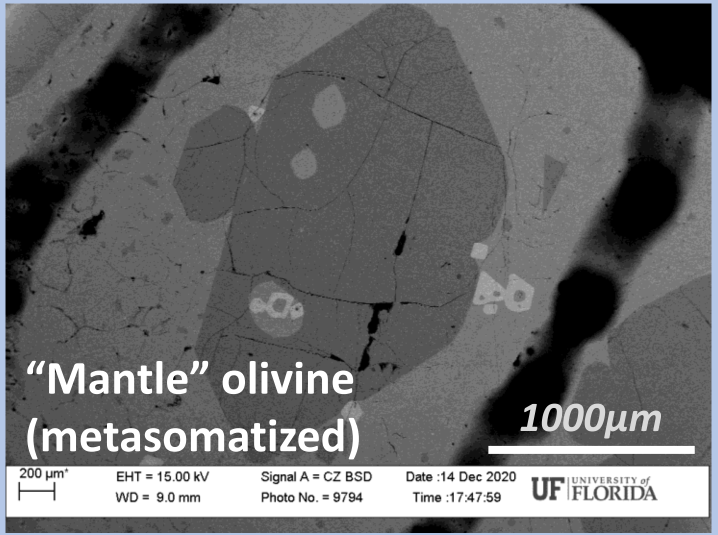


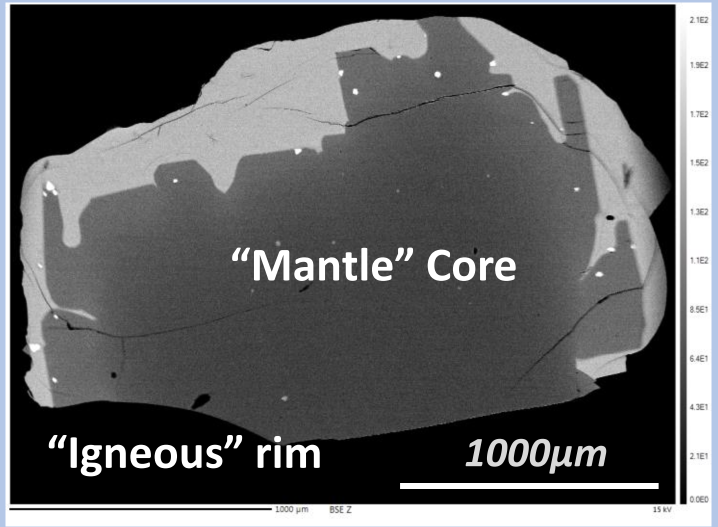
- **13 elements** (including Na, Al, Ca, Ni, Ti, P, Mn, Zn, etc.) analyzed by Cameca **EPMA**
- **18 elements** (adding Sc, V, Cu, etc.) analyzed by **LA-ICP-MS**

Discriminating olivine origin: “igneous” or “mantle”



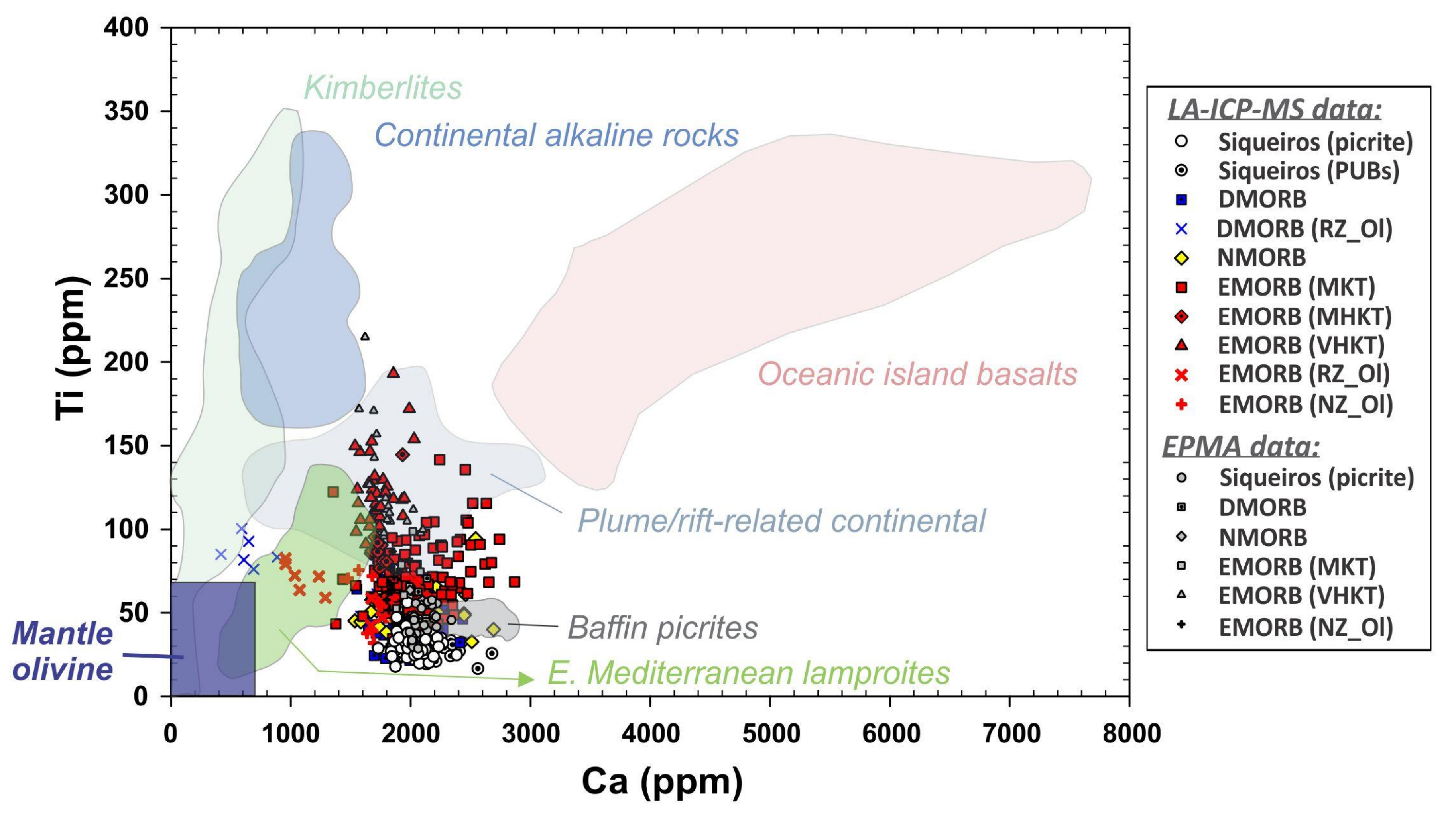
Discrimination cf. Wang et al (2021)





- **Siqueiros picrite:** mantle olivines (metasomatized).
- **8°20’ N Seamounts:** igneous olivines (majority), with some “mantle” cores.

Notable Ca-Ti enrichment in olivines: implications for mantle metasomatism

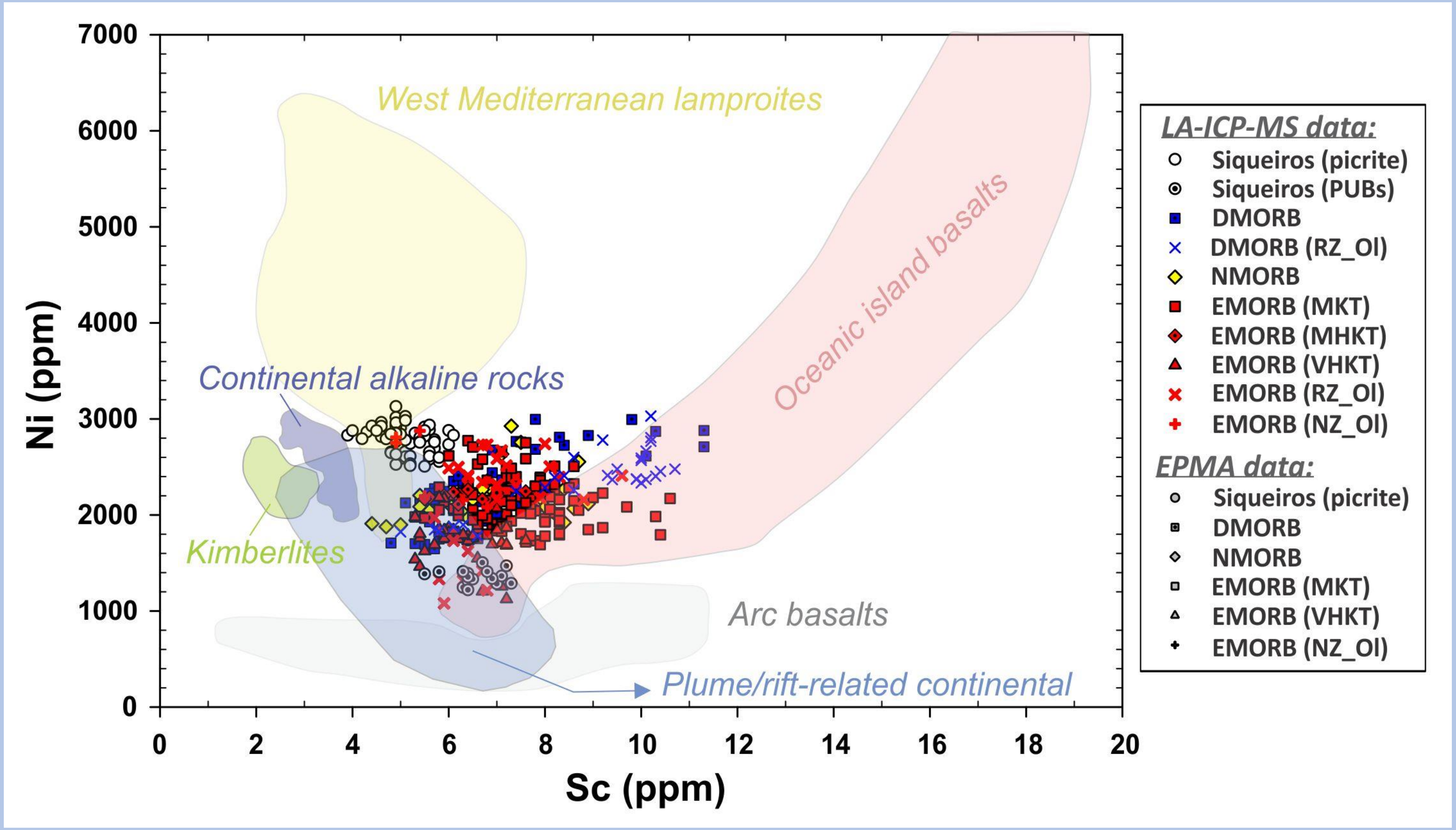


- Mantle metasomatized by **carbonate-silicate melt**.

(Foley et al., 2013)

Base image from Foley et al (2013)

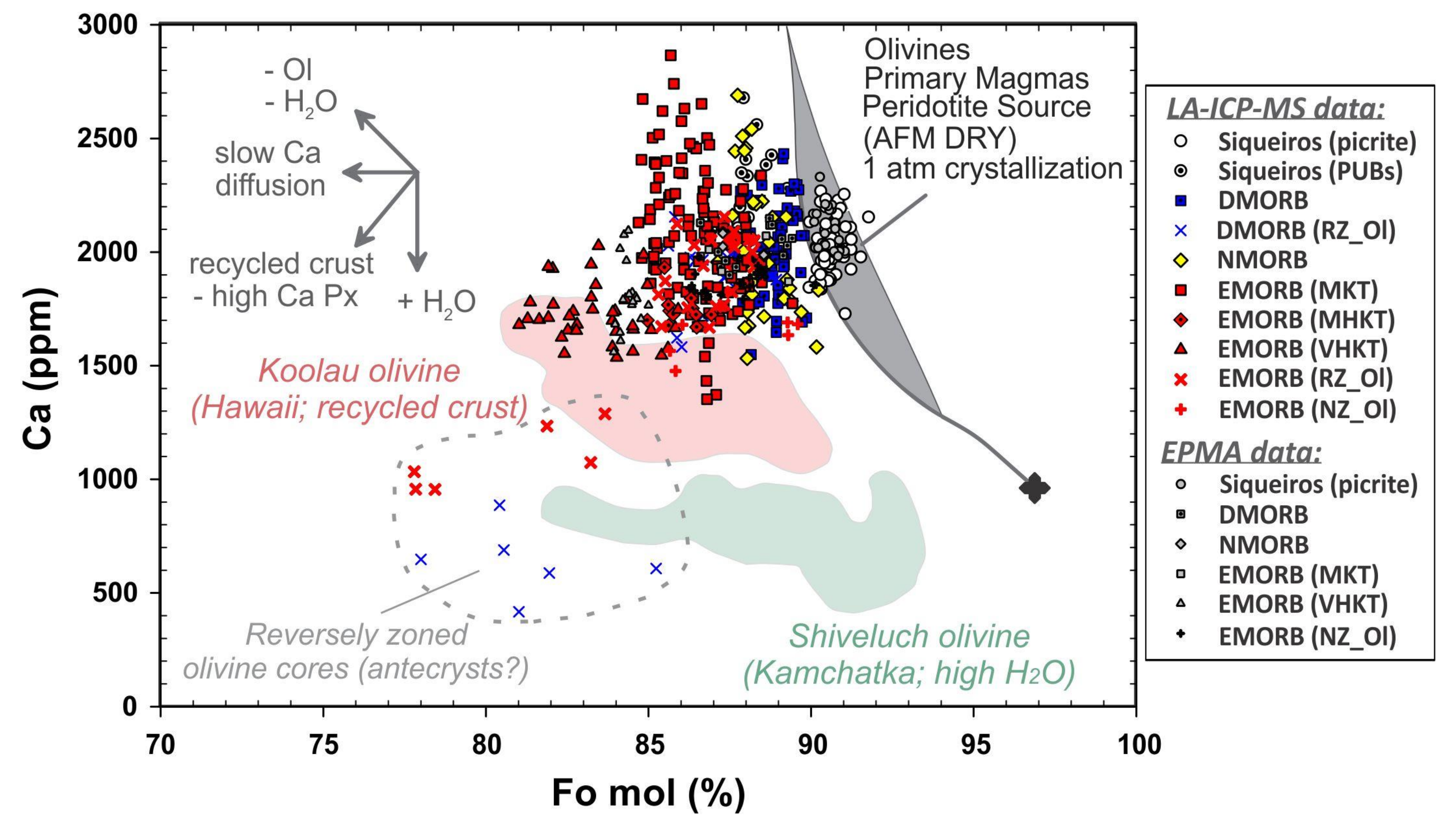
Mantle metasomatism: hot spot-like melt source



- Mantle metasomatized by **hot-spot like** enriched melt.

Base image from Foley et al (2013)

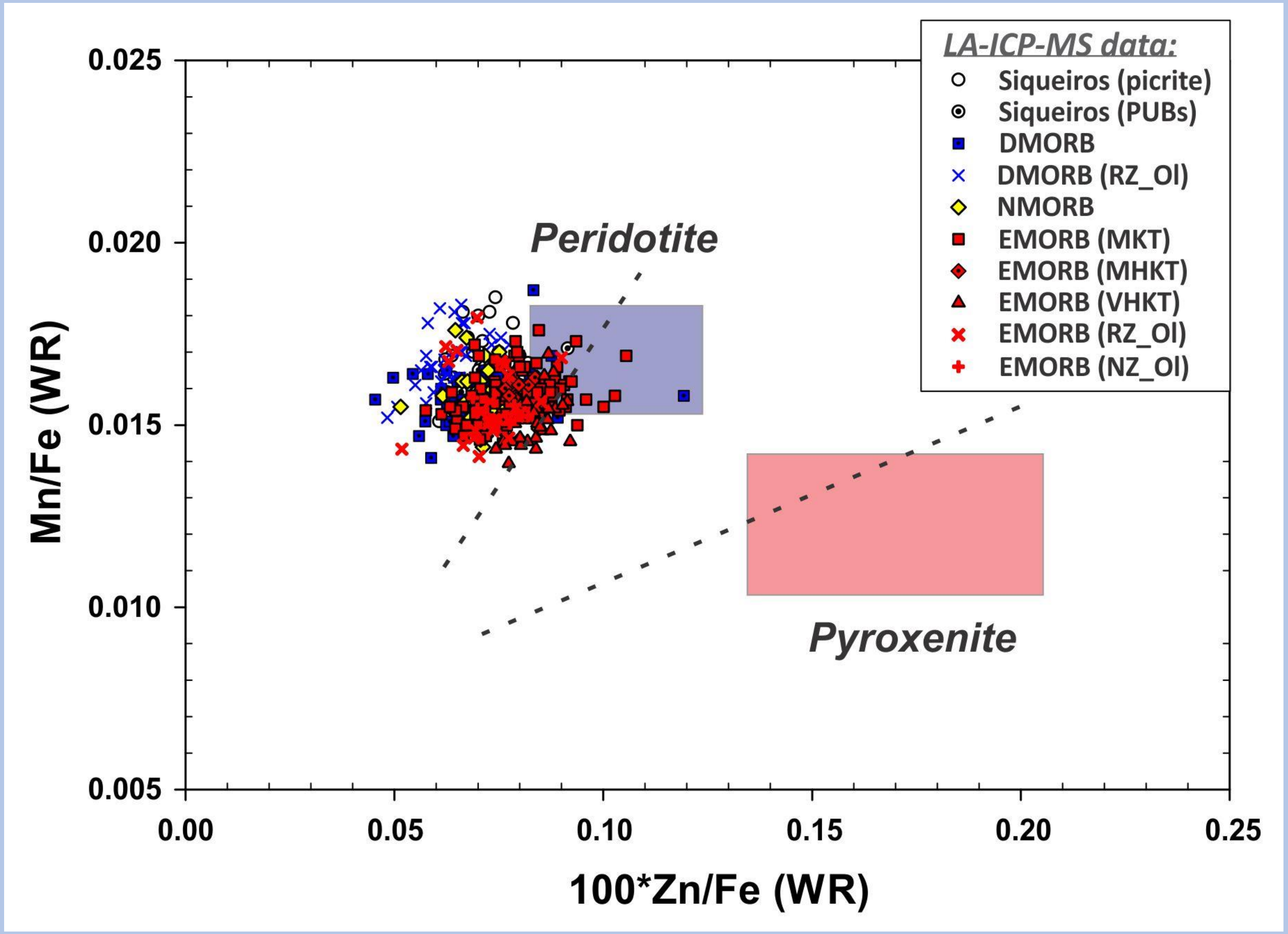
Mantle metasomatism: hot spot-like melt source



- Mantle metasomatized by **hot-spot like** enriched melt.
- High water content in melts (revealed by Ol antecrysts)

Base image from Herzberg (2021, personal communication), PRIMELT3 modeling.
Shaded olivine regions, cf. Gavrilenko et al (2016)

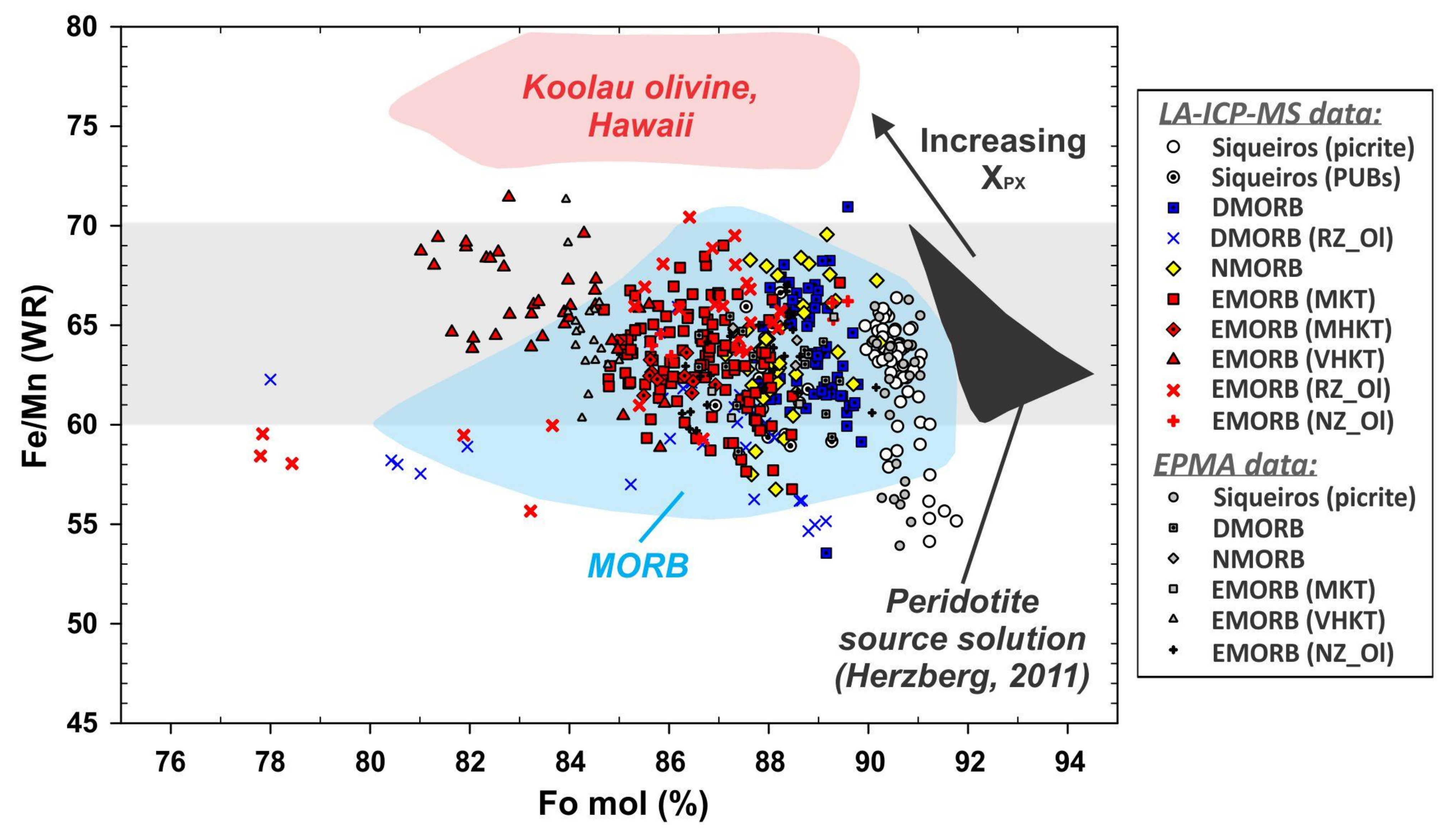
Mantle source constraints: No pyroxenite needed!



Base image from Howarth and Harris (2017)

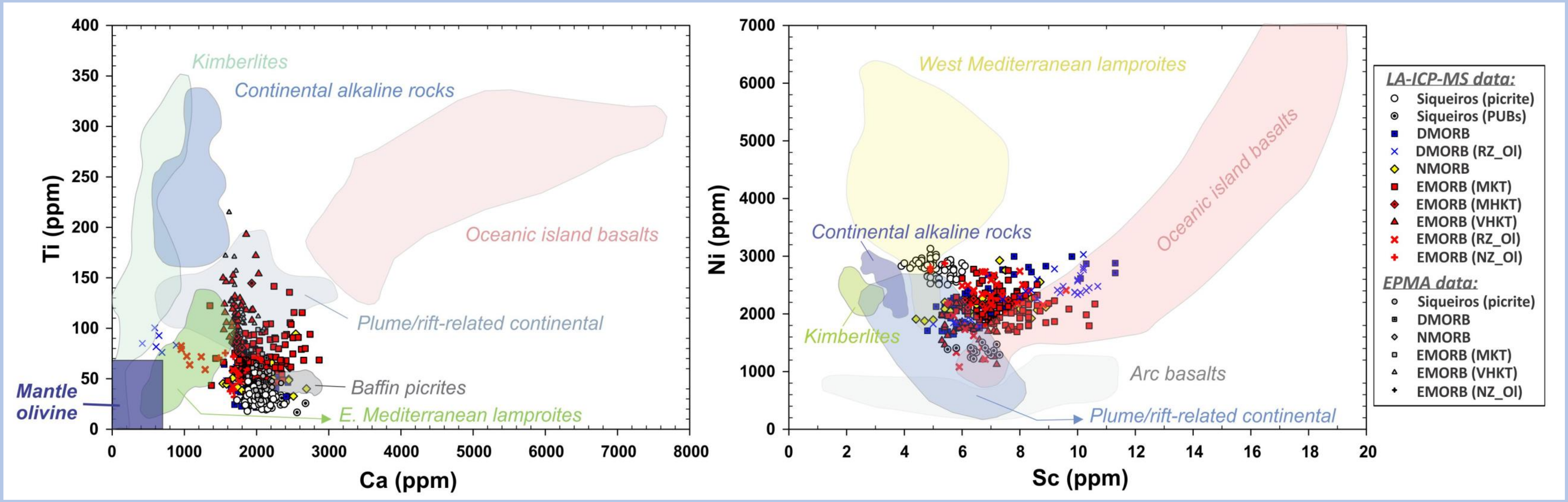
- Basically, falling around the peridotite mantle source region.
- No pyroxenite is required.

Mantle source constraints: No pyroxenite needed!



Base image from Gleeson and Gibson (2019)

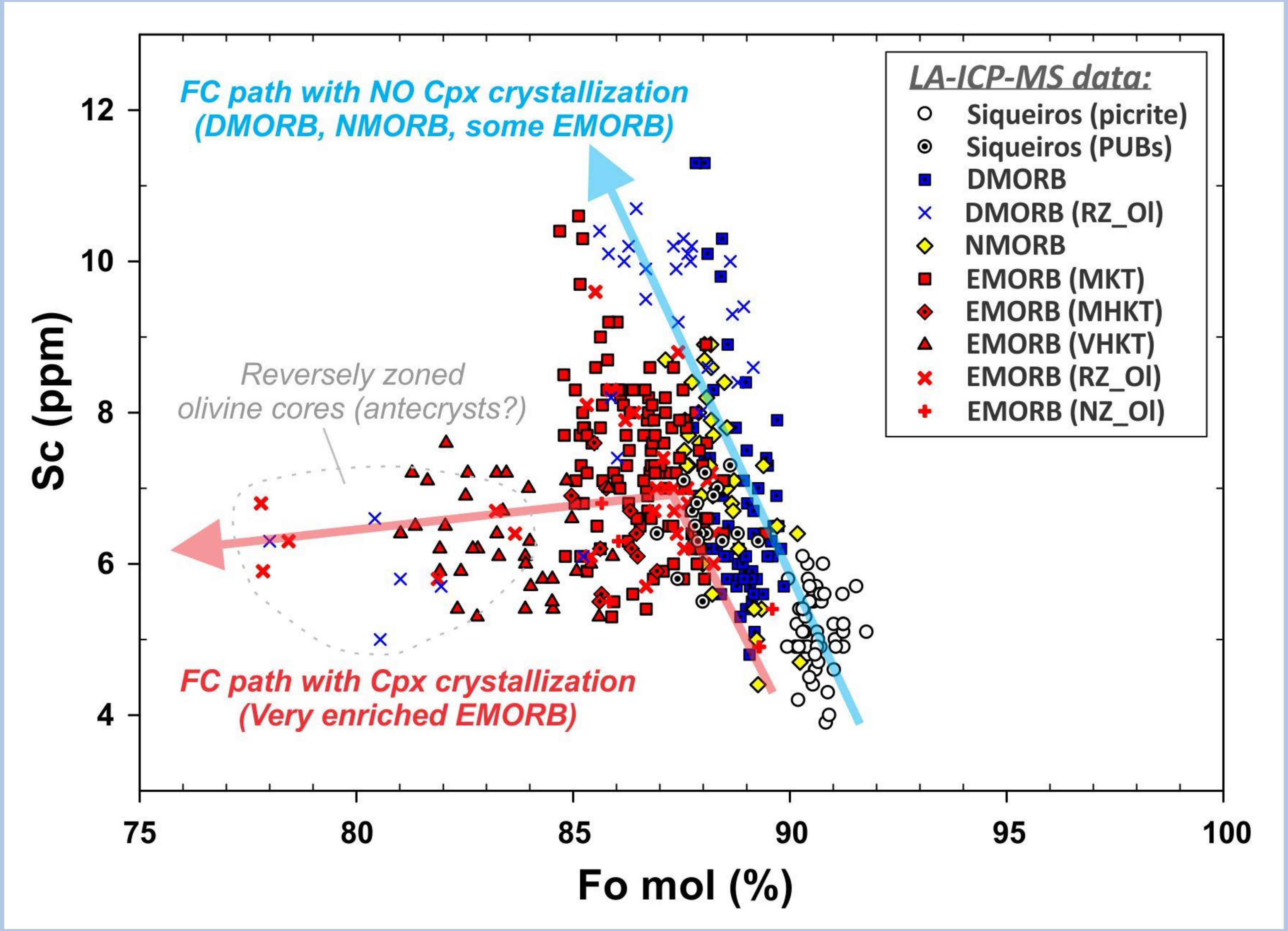
BUT… Why is there extreme heterogeneity of lavas?



- ➢ Ca-Ti and Sc-Ni plots as indicators of heterogeneous mantle metasomatism.

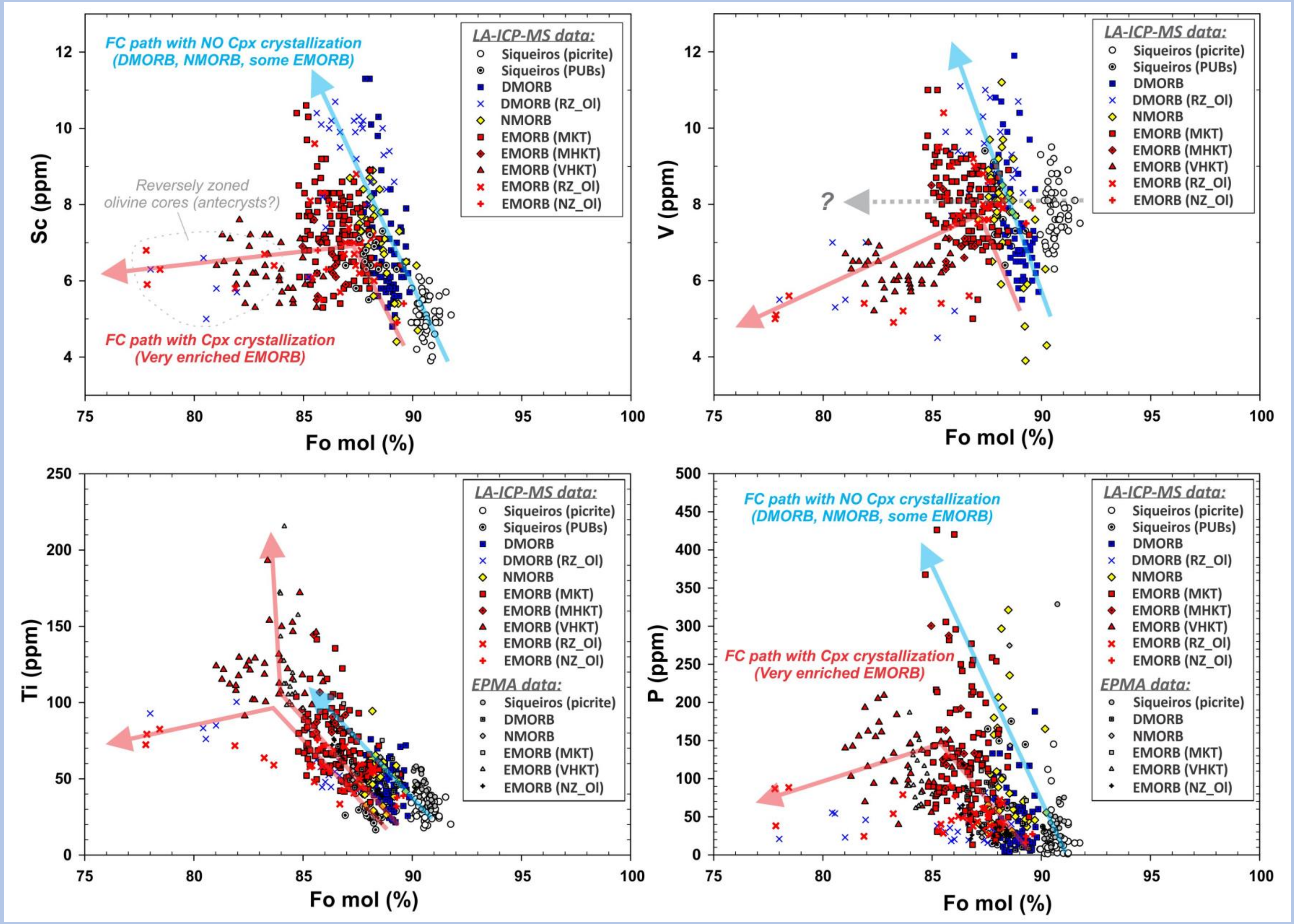
- ▪ **Fractional crystallization?**
- ▪ **Magma mixing?**

Tracing magmatic processes: Fractional Crystallization



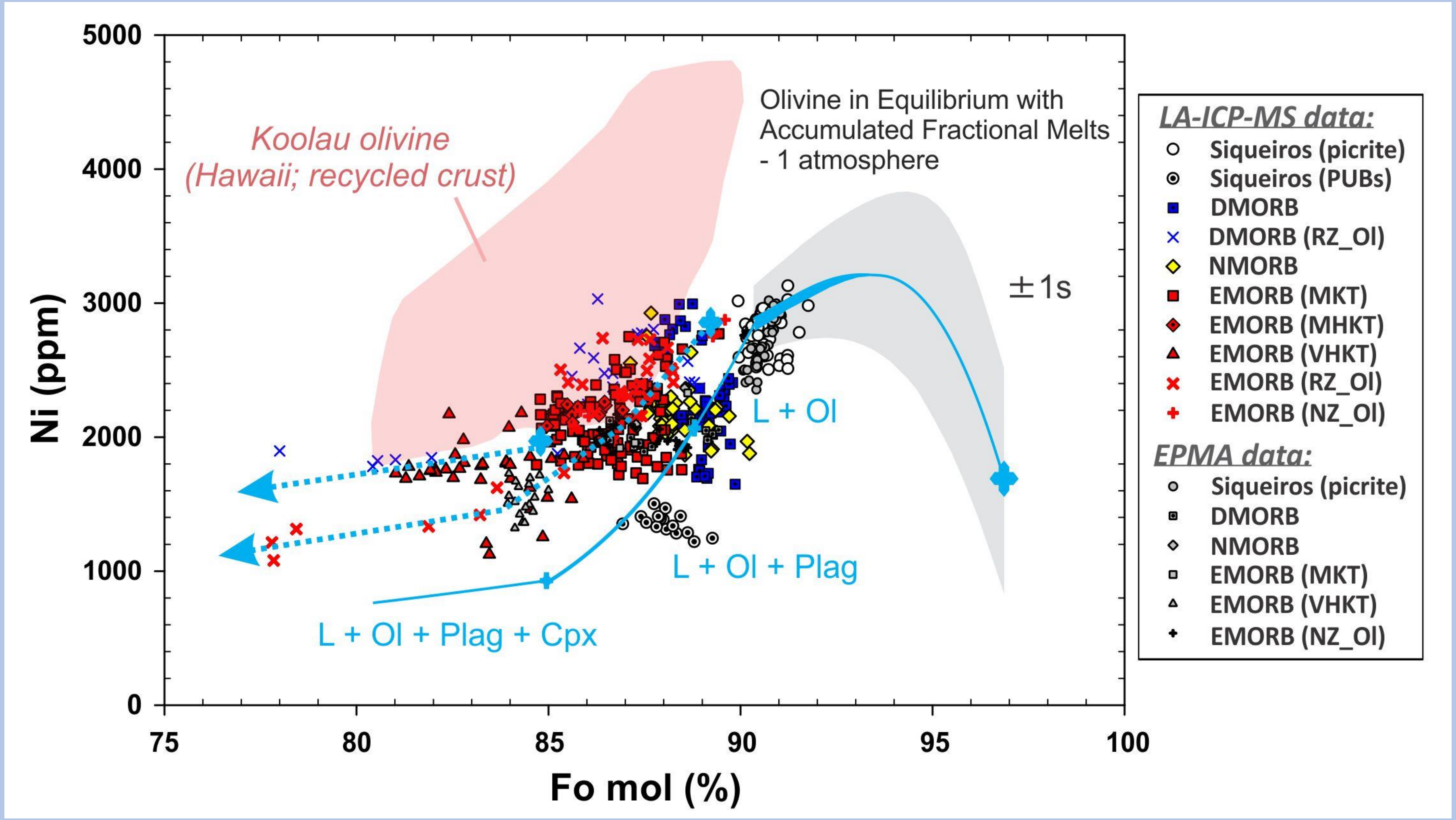
- **Divergent FC trends**
- Cpx crystallization observed ONLY in very enriched EMORBs

Tracing magmatic processes: Fractional Crystallization



- **Divergent FC trends**
- Revealed by **Sc, Ti, V, P – Fo** plots.
- Cpx crystallization observed ONLY in very enriched EMORBs

Tracing magmatic processes: Fractional Crystallization

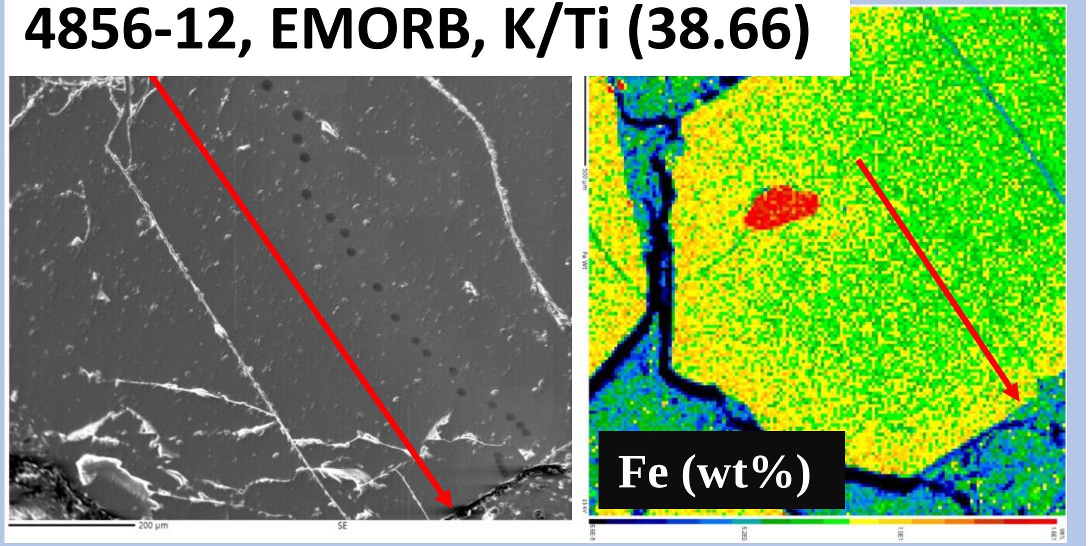


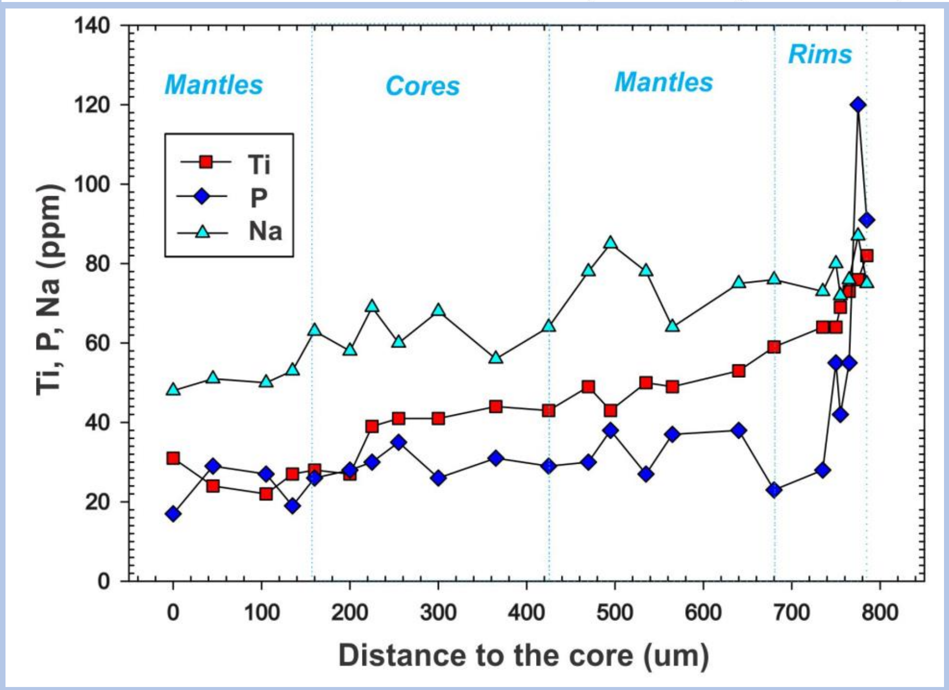
Base image from Herzberg (2021, personal communication), PRIMELT3 modeling

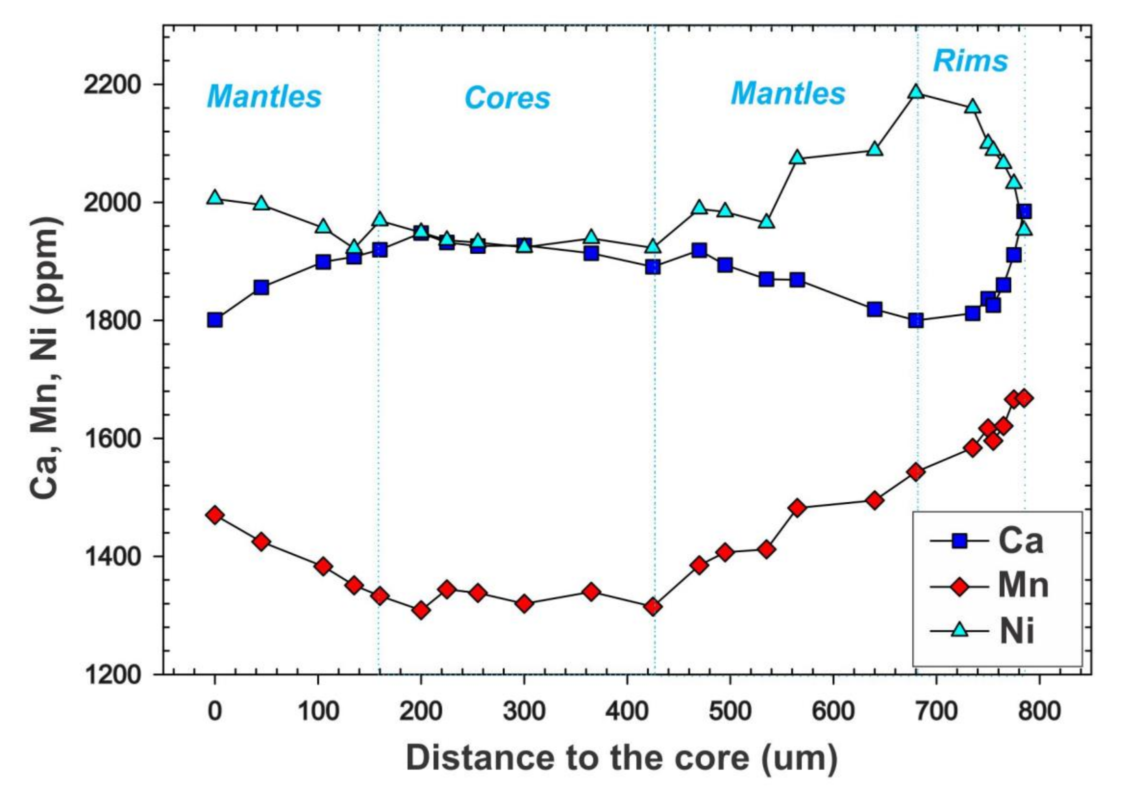
- Different parental melts from heterogeneously metasomatized mantle are expected, with potential higher-pressure crystallization.

Magma mixing revealed by normally & reversely zoned olivine

4856-12, EMORB, K/Ti (38.66)



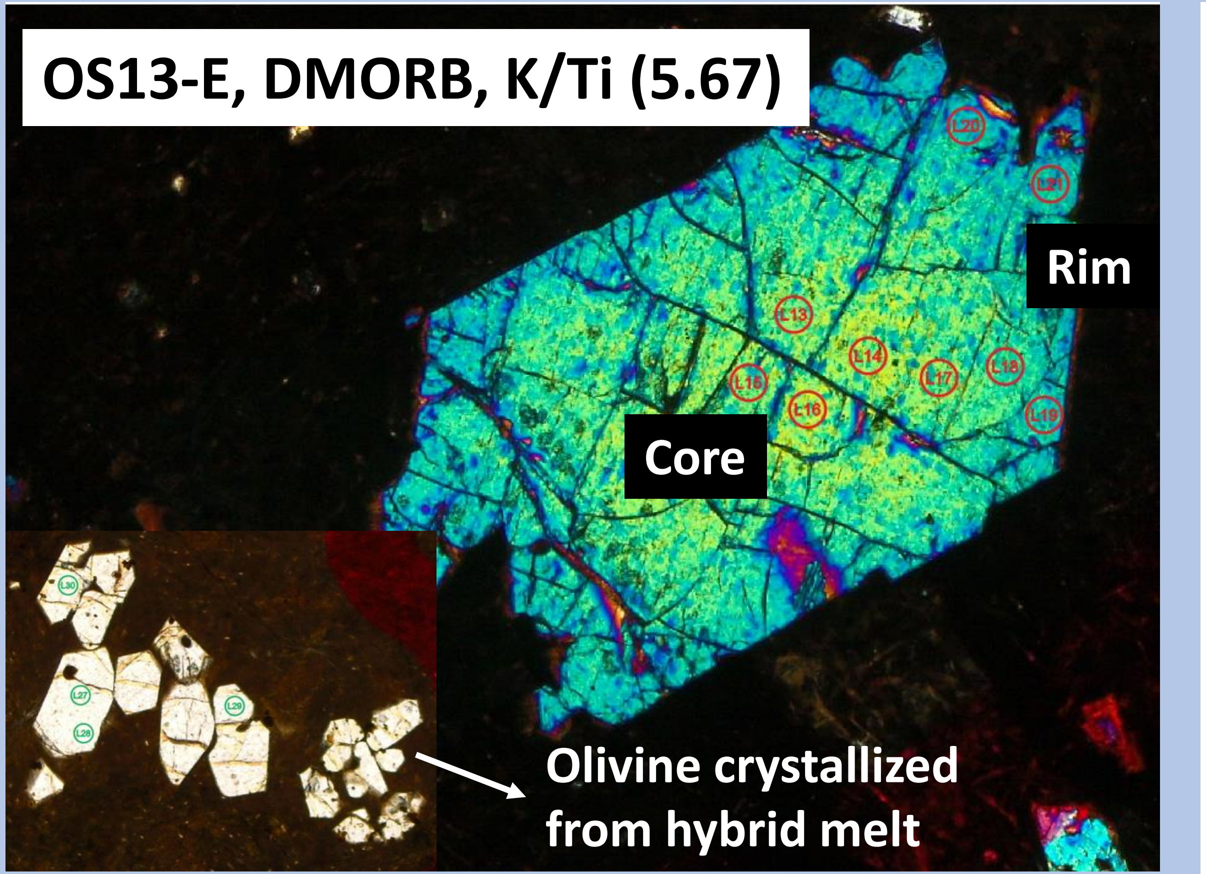


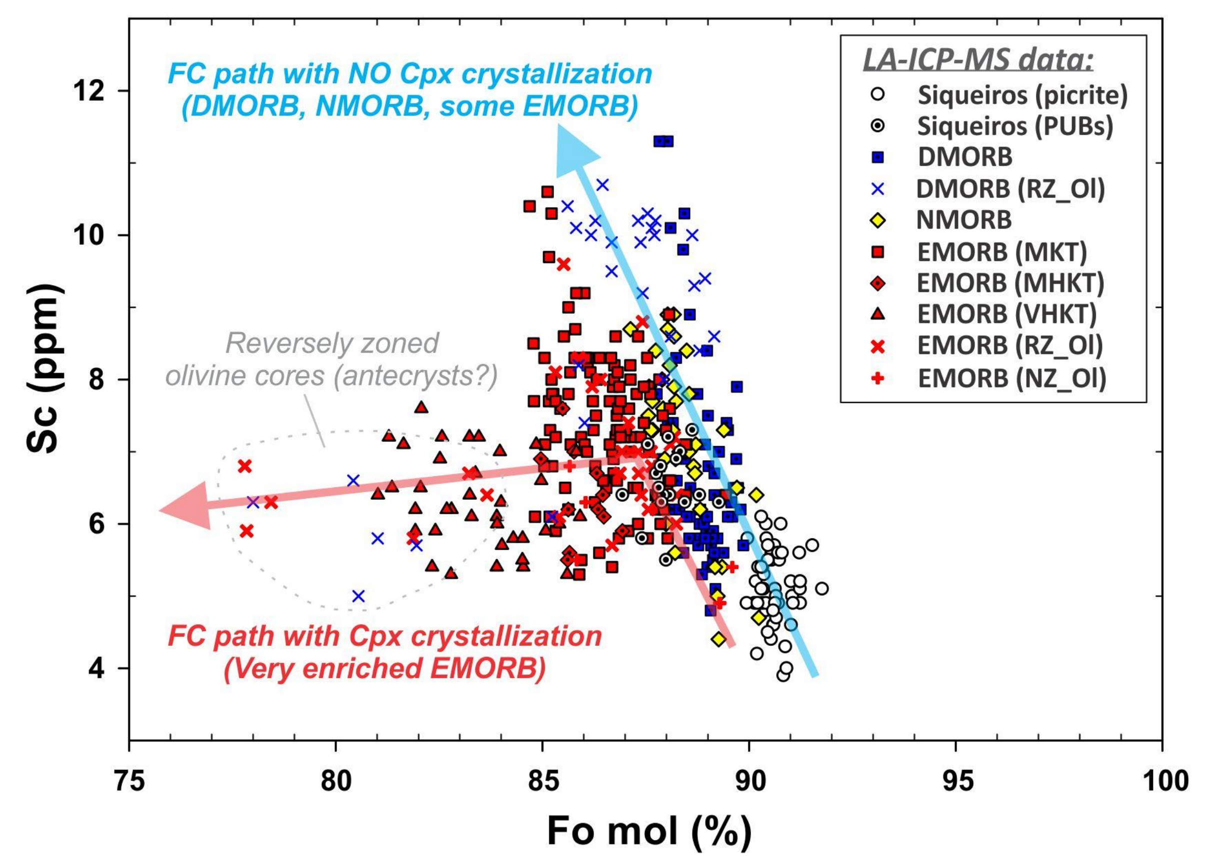


- **Normally zoned olivines:** “depleted” core, “enriched” rim
- Rapid P (slow diffusion element) increase from igneous core to igneous rim: **magma mixing** (Shea et al., 2019)

➢ **D-melt mixed with E-melt, forming EMORB**

Magma mixing revealed by normally & reversely zoned olivine





- **<u>Reversely zoned olivines:</u>** "Enriched" core with "depleted" rim

➢ **E-melt mixed with D-melt, forming DMORB**

MORB Petrogenesis along 8°20’N EPR : a genetic model

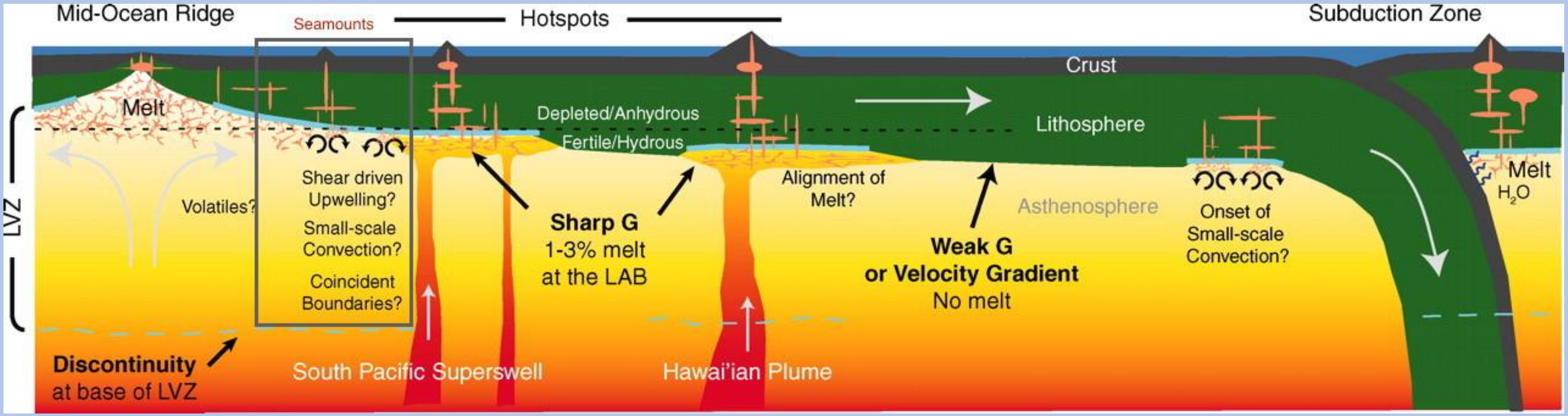


Figure modified after Schmerr (2012)

- Peridotite has been heterogeneously metasomatized by carbonate-silicate melts and hot-spot like enriched melts.
- Divergent FC + varying magma mixing generated heterogenous MORB types in 8°20’ N Seamounts.

Conclusions and Implications:

- Geochemically diverse MORBs along the East Pacific Rise (EPR) 8°20’ N Seamounts and Siqueiros Transform evolved from a **peridotite mantle source, without clear evidence of a pyroxenite mantle source.**

- The peridotite mantle has been **heterogeneously metasomatized** by carbonate-silicate melts and “hot-spot”-like enriched melts, with potential recycled continental crust contribution (?). Partial melting of this metasomatized mantle generated parental magmas with varying compositions.

- **Divergent fractional crystallization paths** played a significant role in generating MORBs extreme composition variations, along with off-axis **magma mixing** at varying evolution stages.

Thank You!

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