Composition of the shallow aqueous fluids released beneath the SE Mariana forearc rift

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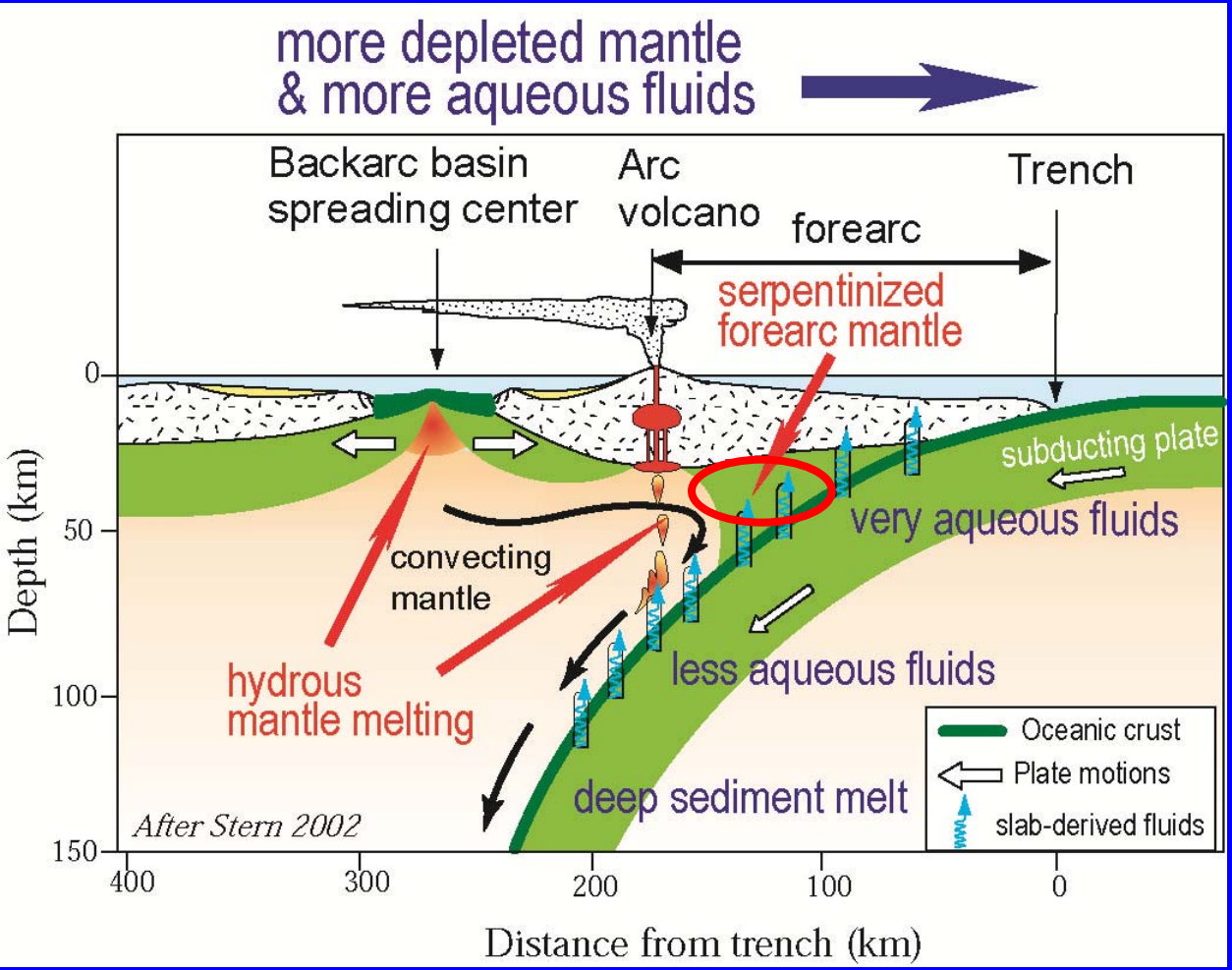
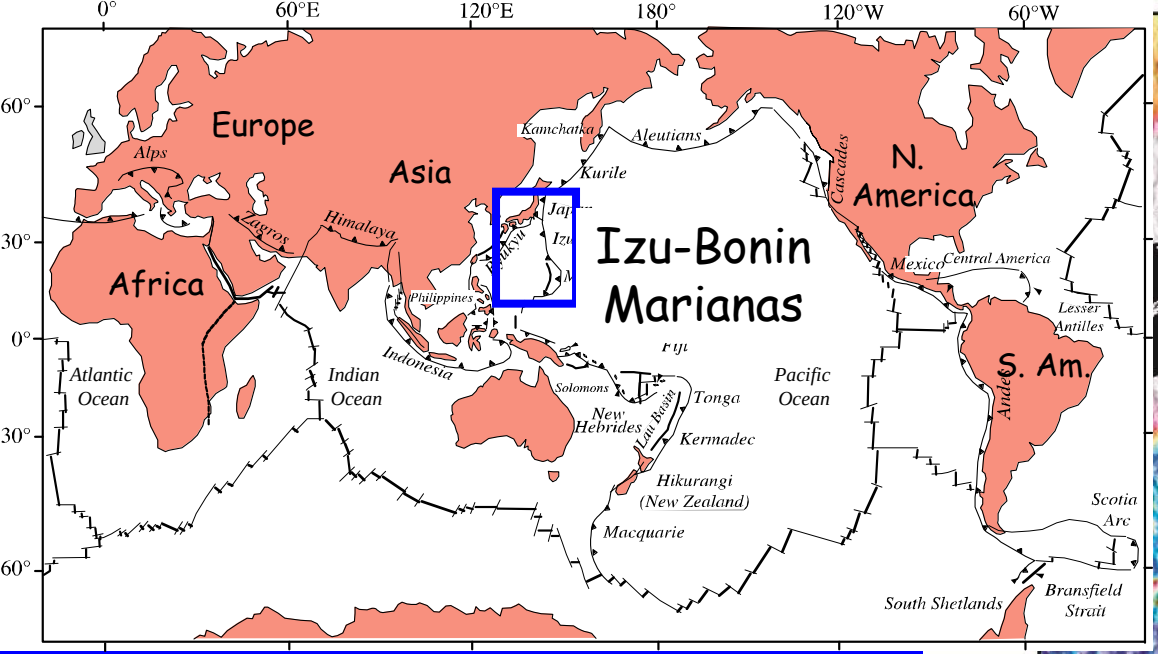
Subduction zone

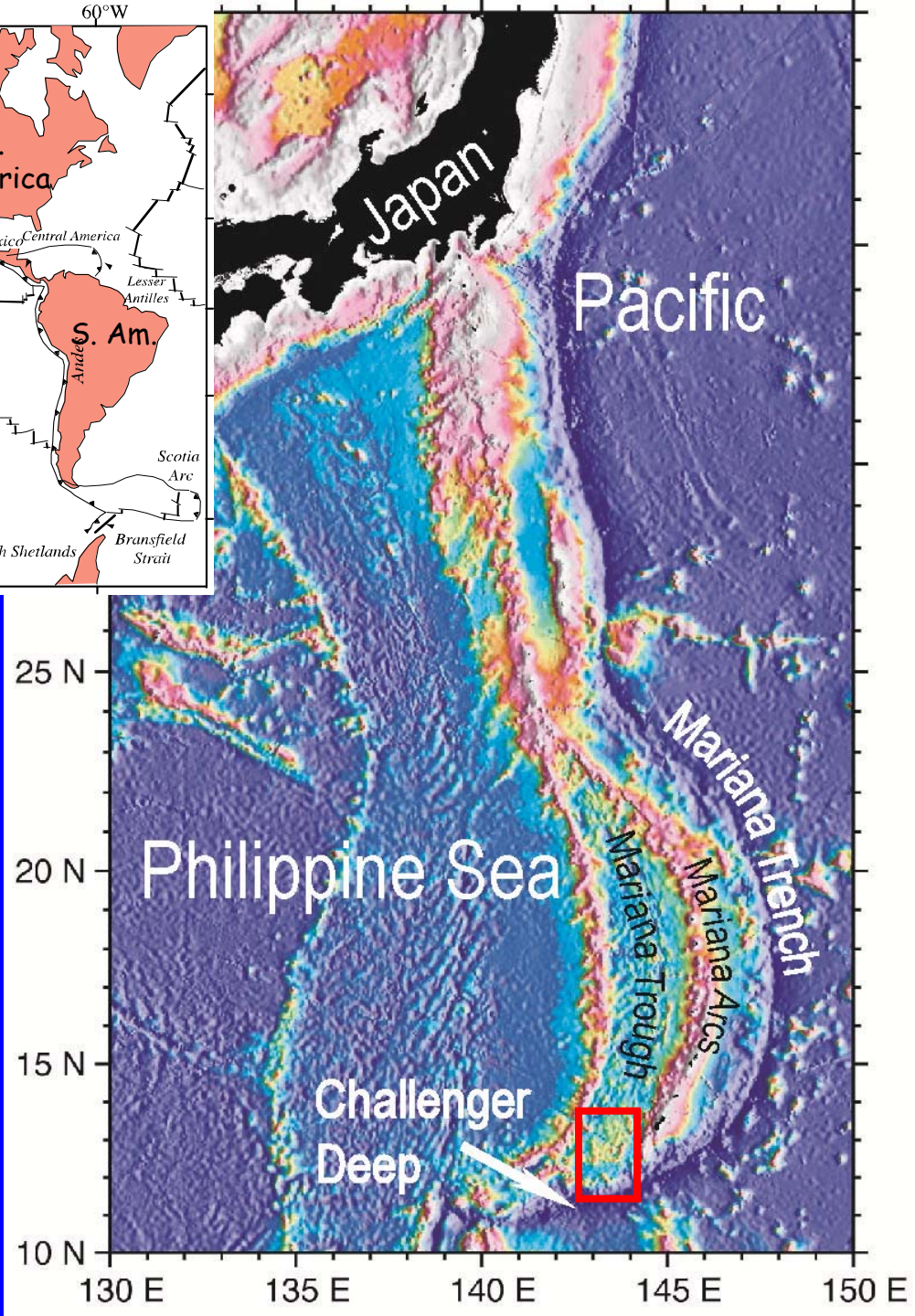


Composition of the aqueous fluids released during shallow subduction processes are not well constrained due to the lack of igneous rock in the forearc, as the cold and serpentinized forearc mantle usually does not melt.



Lallemand et al., 1999

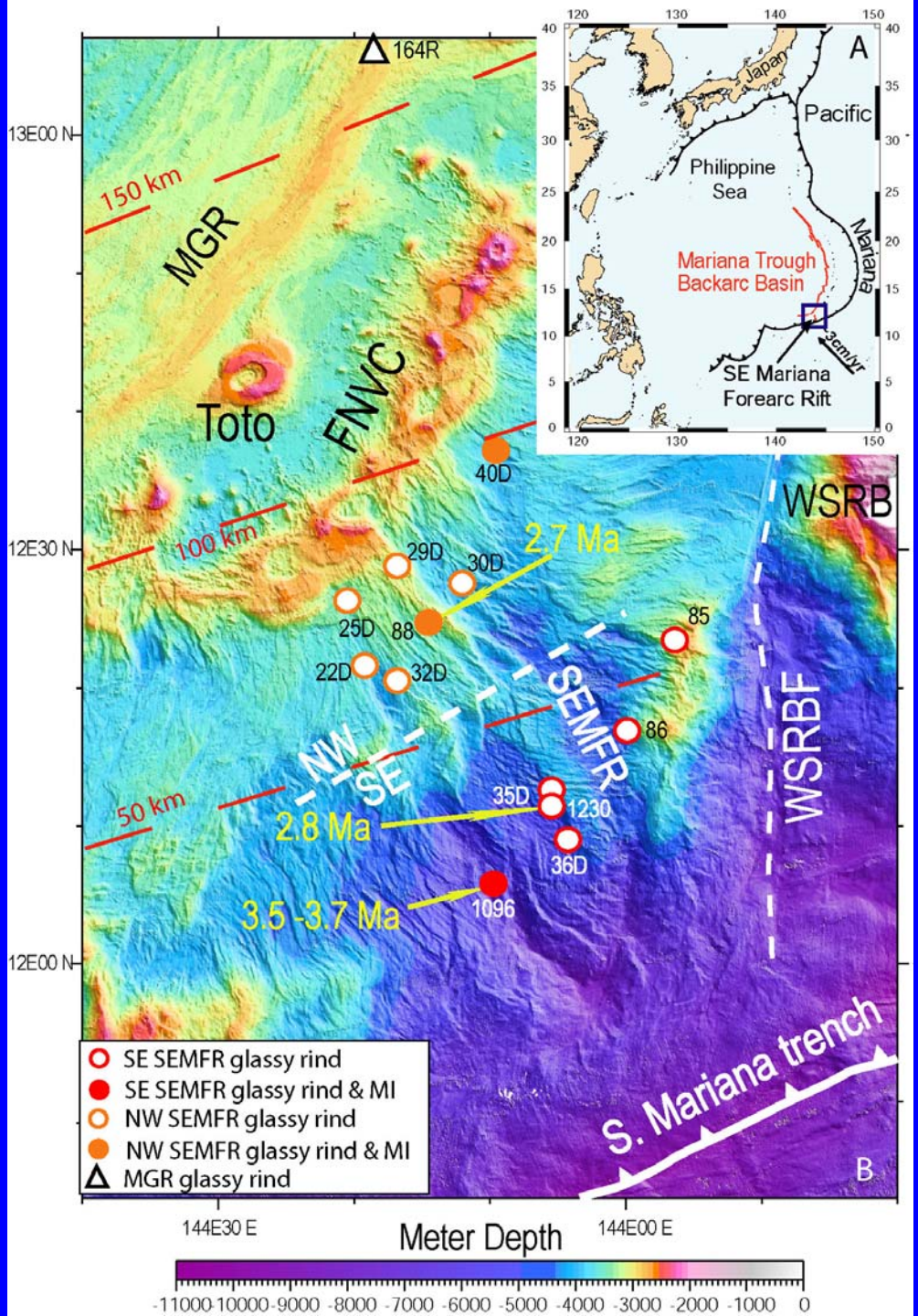
The Mariana Intraoceanic Arc



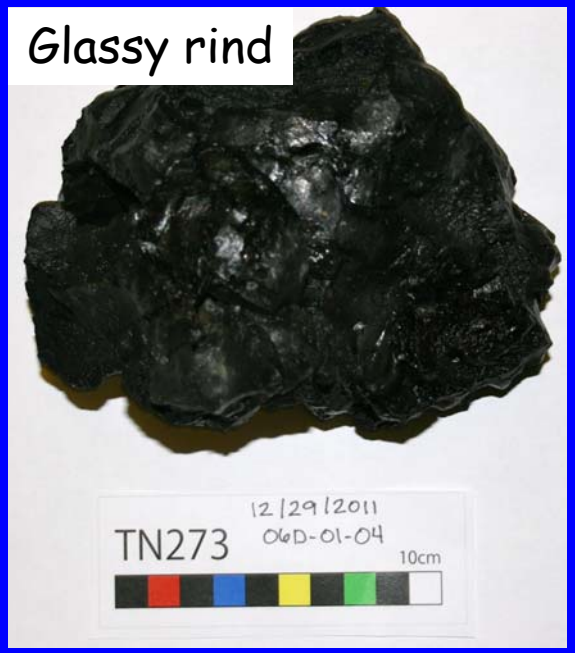
The SE Mariana Forearc Rift (SEMFR)

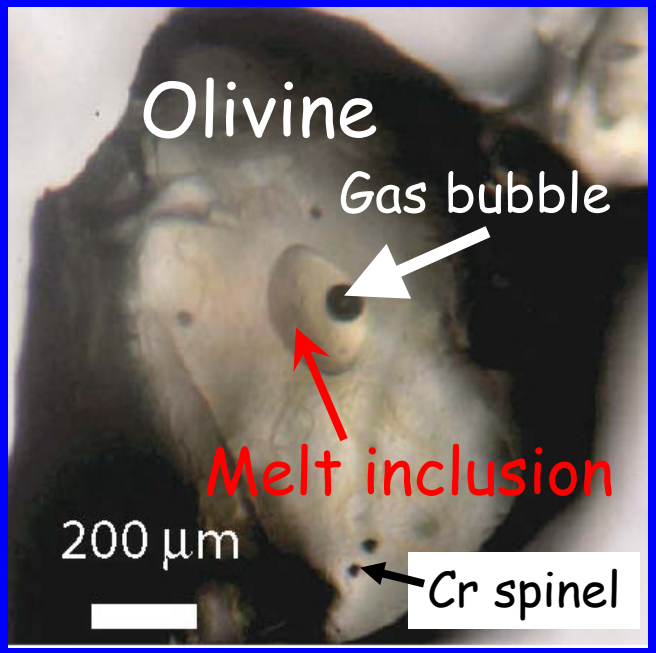
21 successful dives / dredges collected during 2 Japanese research cruises (YK08-08, YK10-12) and 1 US research cruise (TN273) along SEMFR

MGR: Malaguana-Gadao Ridge
FNVC: Fina-Nagu Volcanic Chain
WSRB: West Santa Rosa Bank
WSRBF: WSRB Fault



Material : glassy rinds and olivine-hosted melt inclusions (Ol-MI)



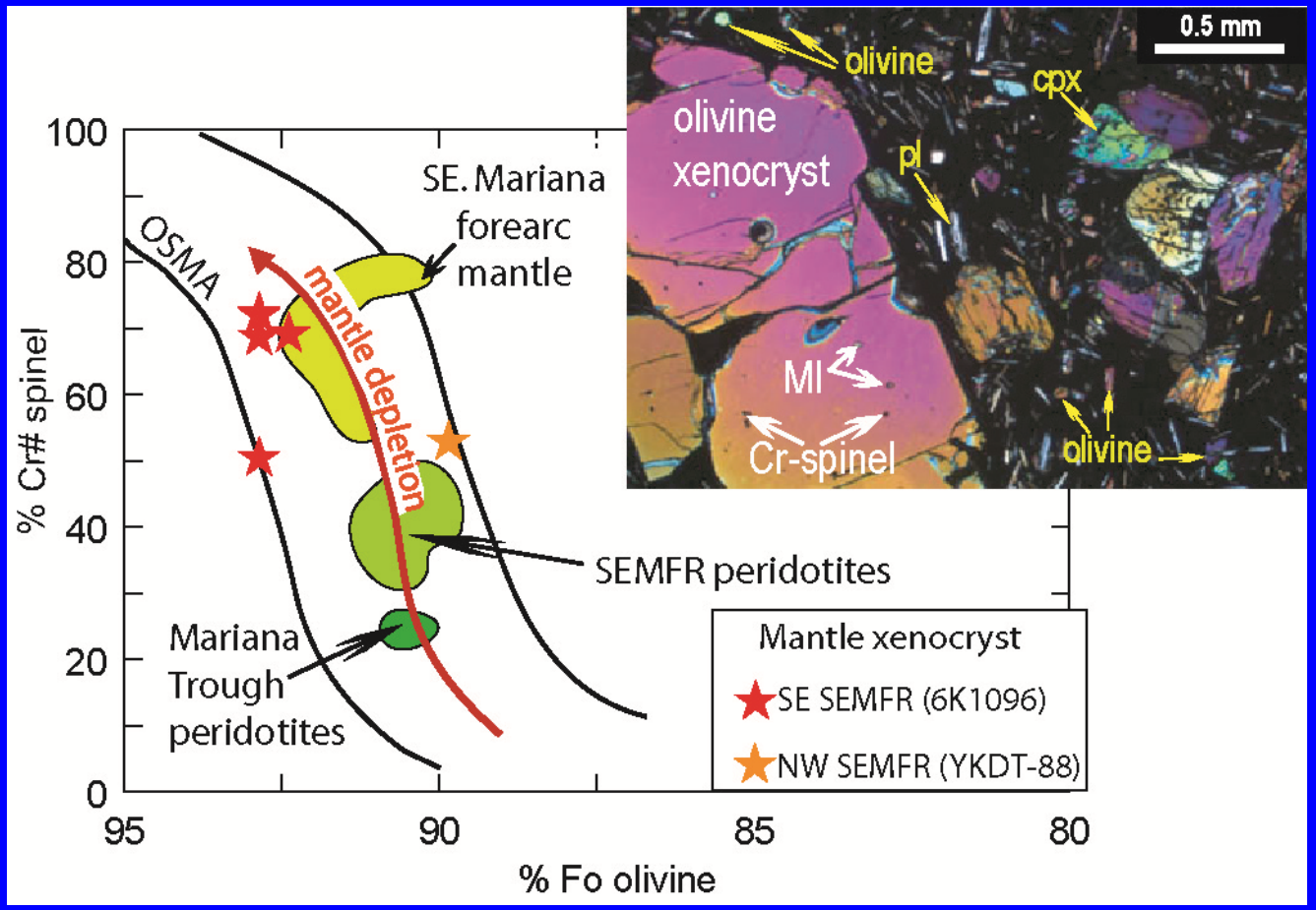


Reflected light photomicrograph

- Glassy rinds trapped magma composition during eruption
- Olivine traps small parcels of melt while they grew forming melt inclusions

➔ SEMFR Ol-MI and glassy rinds captured a reliable composition in volatiles (e.g., H_2O, CO_2, S, Cl) and in fluid-mobile elements (e.g., Rb, Cs, Ba) released from the shallow part of the downgoing plate

SEMFR Ol-MI are from the forearc mantle

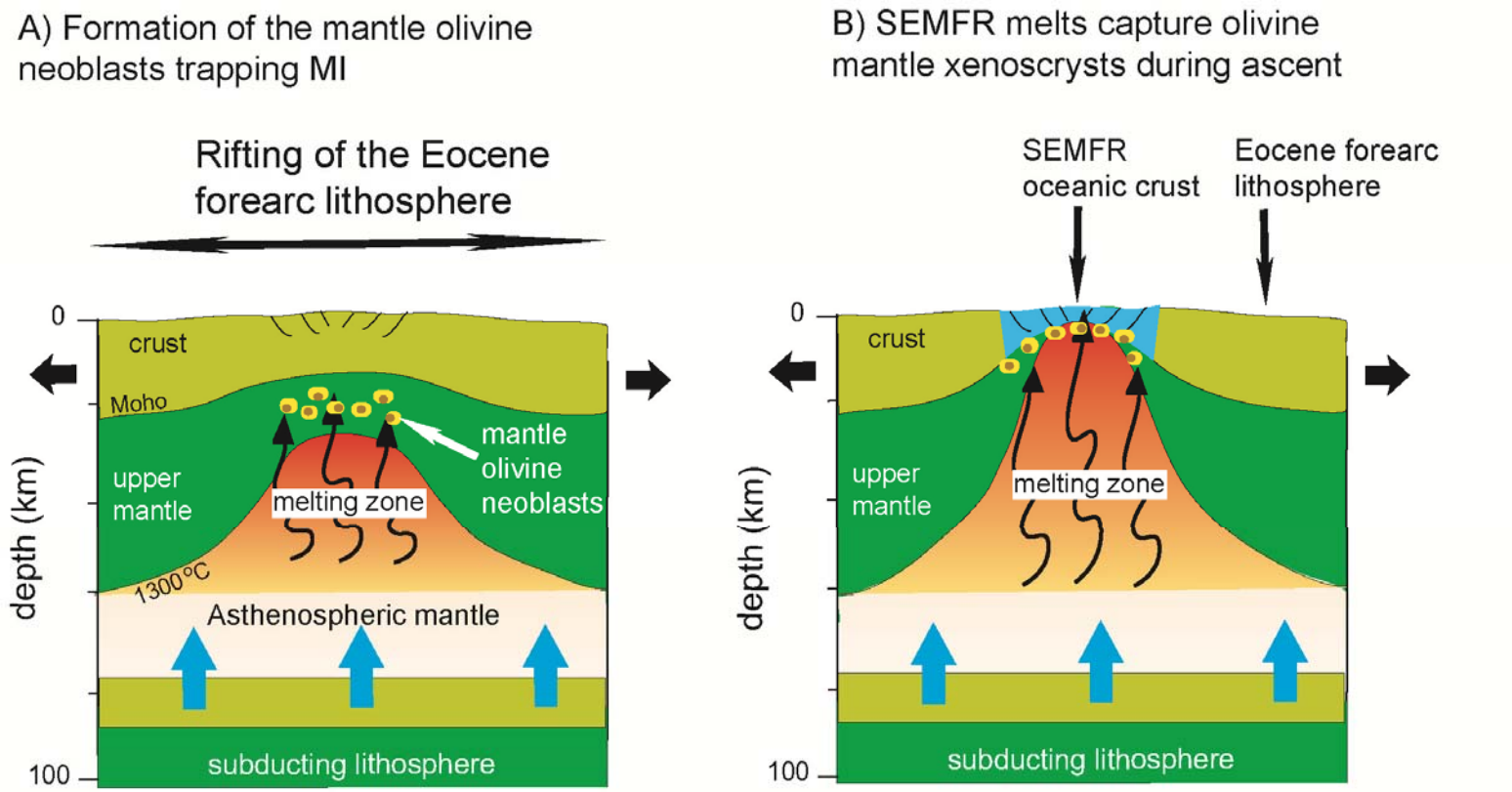


• Olivine hosts are refractory minerals (Fo_{89-93}) not in equilibrium with their host glass (Fo < 85), and they also host Cr-spinel (Cr# ≥ 50)

➔ Olivine hosting MI are xenocrysts from the forearc mantle

Ribeiro et al., in press, Island Arc

How do SEMFR Ol-MI form?



- During forearc stretching, hydrous melts rise into the forearc mantle forming mantle olivine neoblasts that trapped equilibrium melt during their growth at ~ 22 ± 6.6 km depth
- Further stretching of the SE Mariana forearc lithosphere opens SEMFR and SEMFR melts entrained ol xenocrysts during ascent

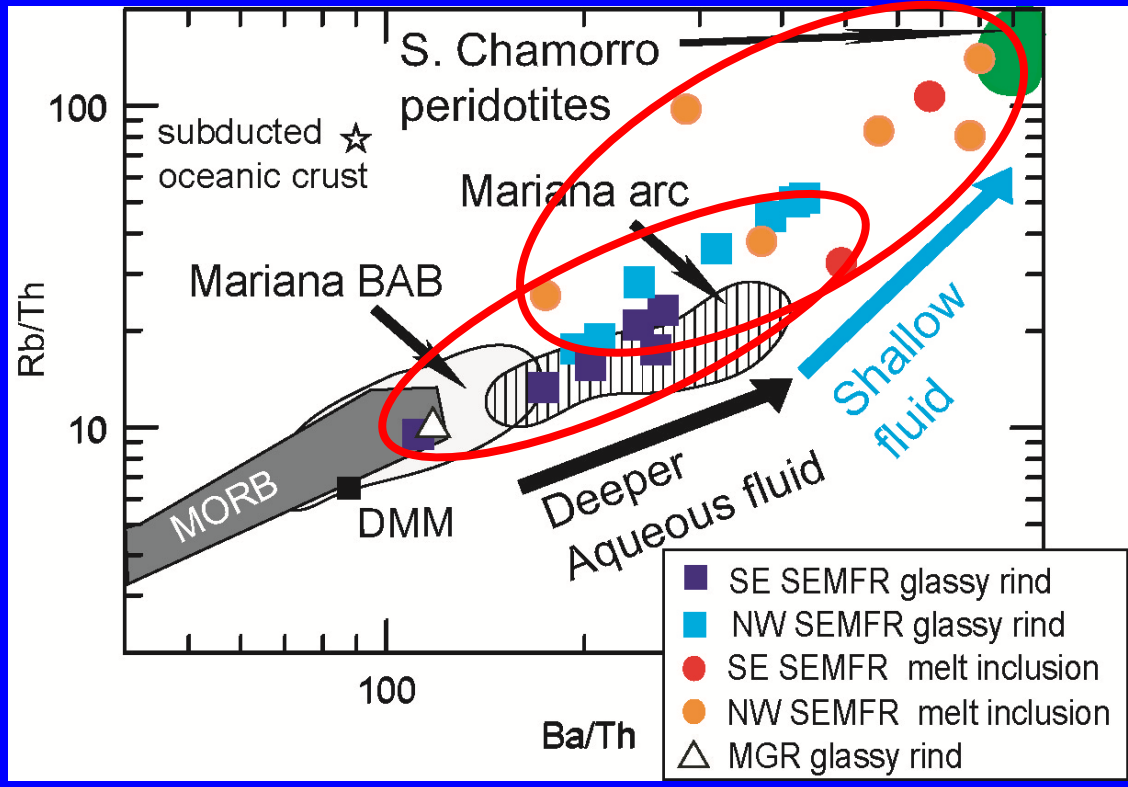
What is the composition of the shallow slab-derived fluids released beneath SEMFR?

Rb/Th, Cs/Th and Ba/Th = proxies for aqueous fluids

Dryer magmas
< 1 wt% H_2O

MORBs: mid-ocean ridge basalts
Mariana backarc basin (BAB) lavas
Mariana arc lavas

Wetter magmas
~ 0 - 7 wt% H_2O

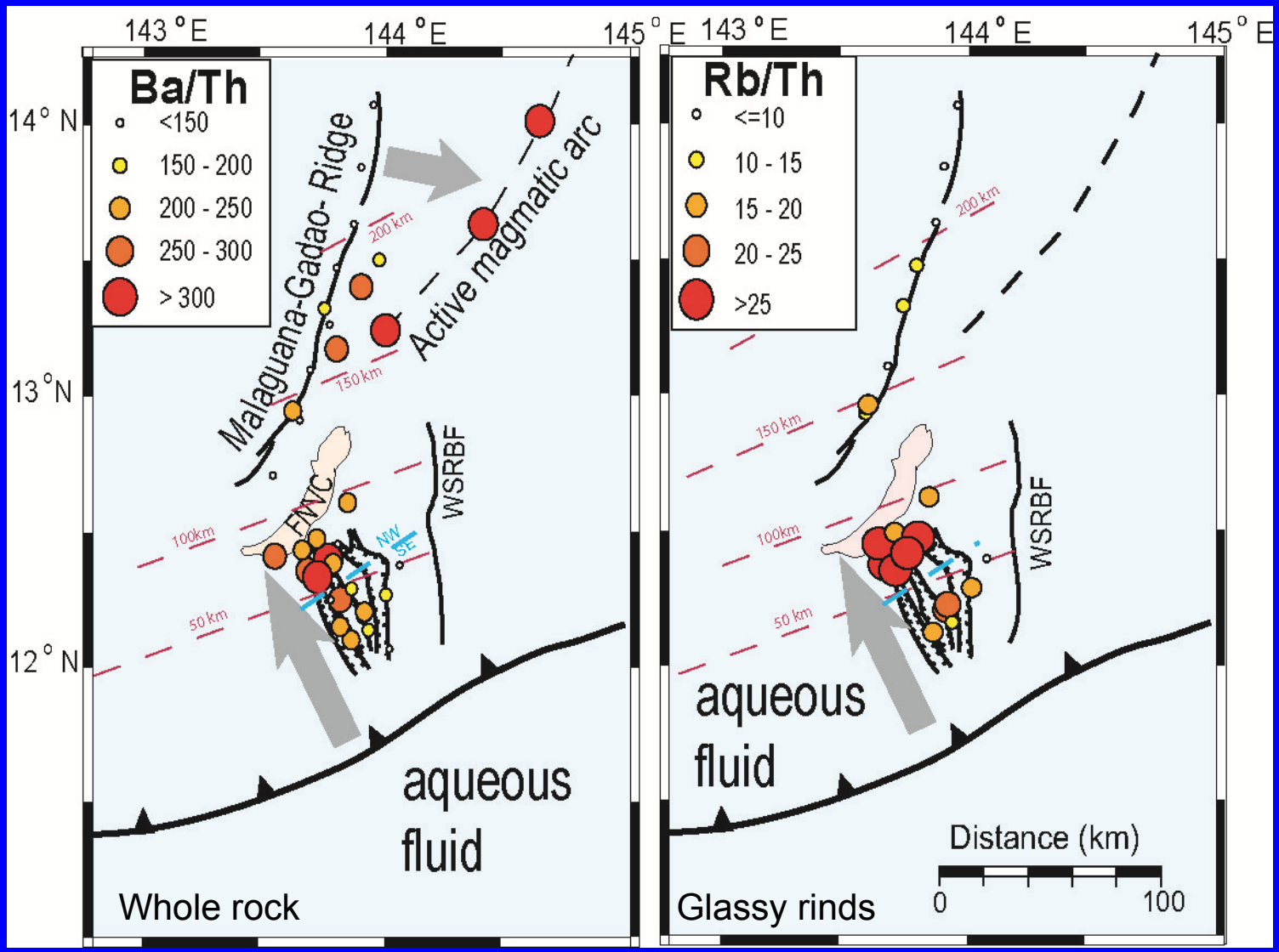


After Pearce et al. (2005, G-cubed)

- We are looking at only glass to avoid alteration effects
- The SEMFR glassy rinds and Ol-MI have higher Ba/Th, Rb/Th, Cs/Th than do the Mariana arc and BAB lavas
- The shallow aqueous slab-derived fluids released beneath SEMFR have distinctive Ba/Th, Cs/Th and Rb/Th than do the deeper aqueous fluids released beneath the Mariana arc

Ribeiro et al., in press, G-cubed

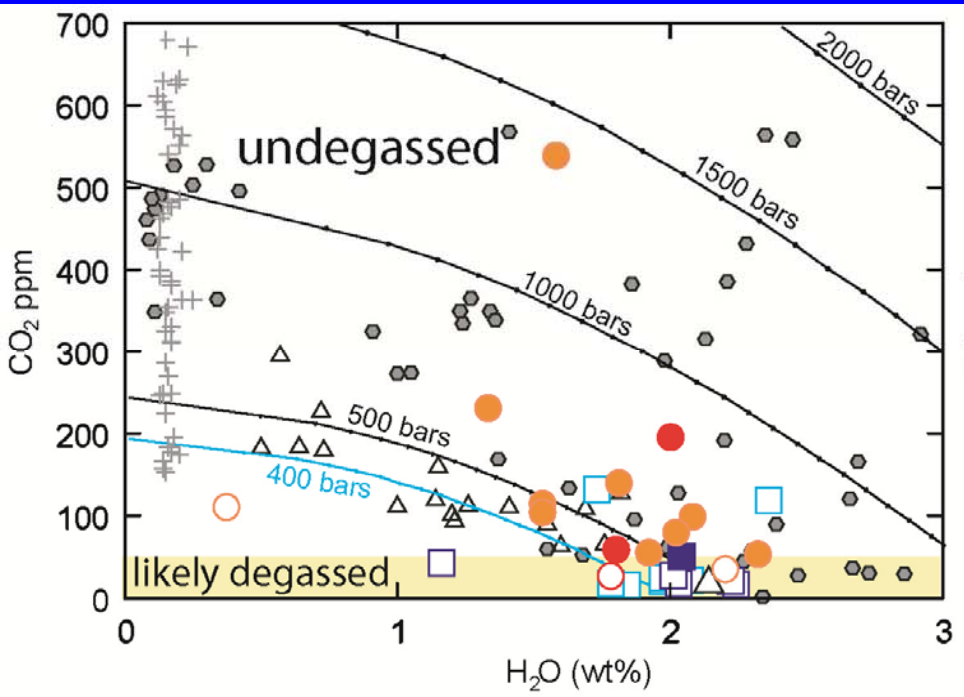
The shallow aqueous fluids increase toward the arc volcanoes (~ 50 – 100 km slab depth)

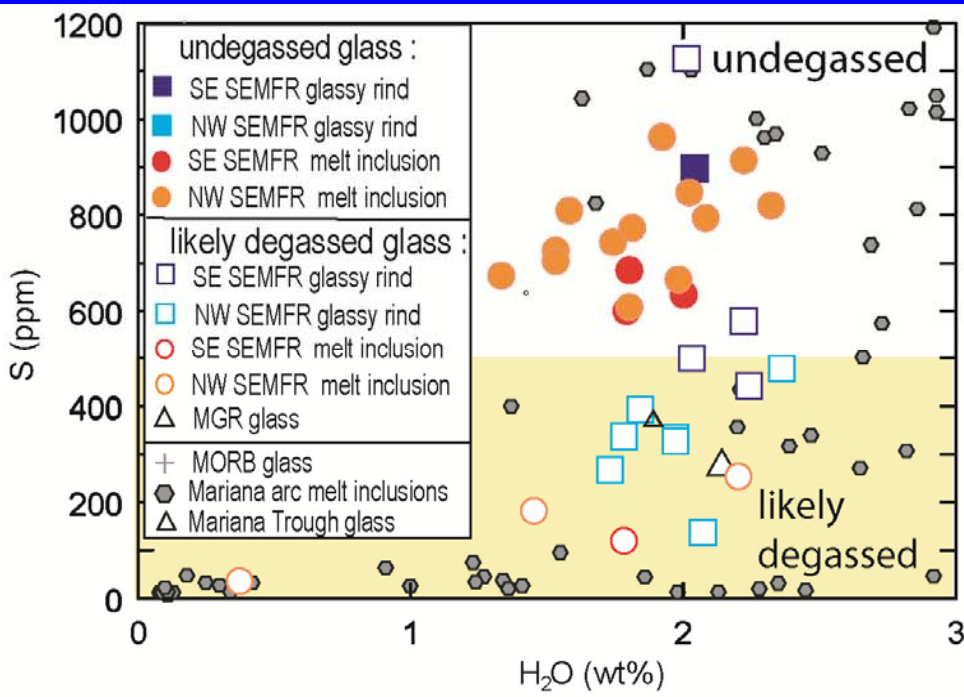


Ribeiro et al., in press, G-cubed

Volatile contents of SEMFR glassy rinds and Olivine-hosted melt inclusions

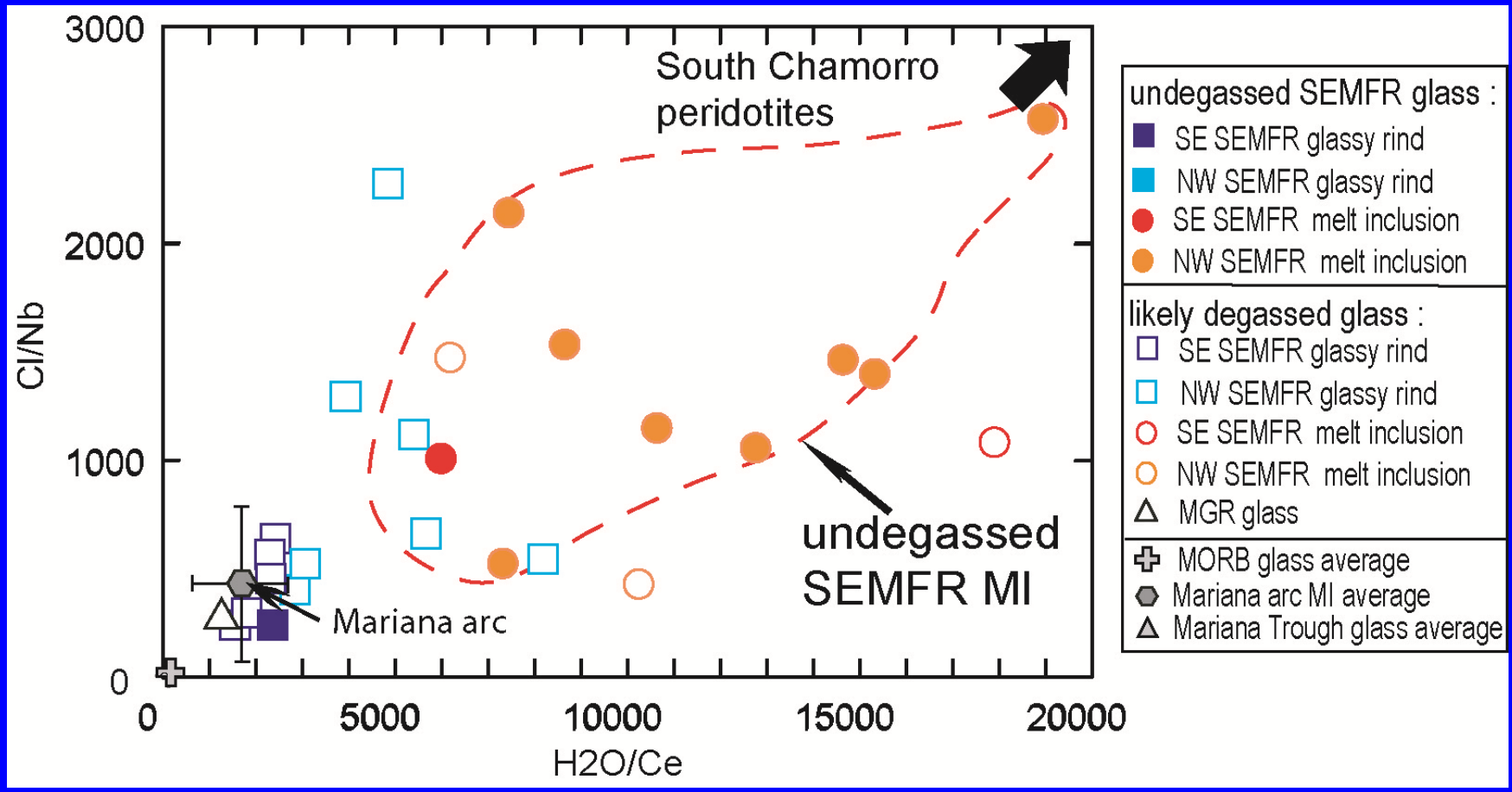
Filtering for degassed samples





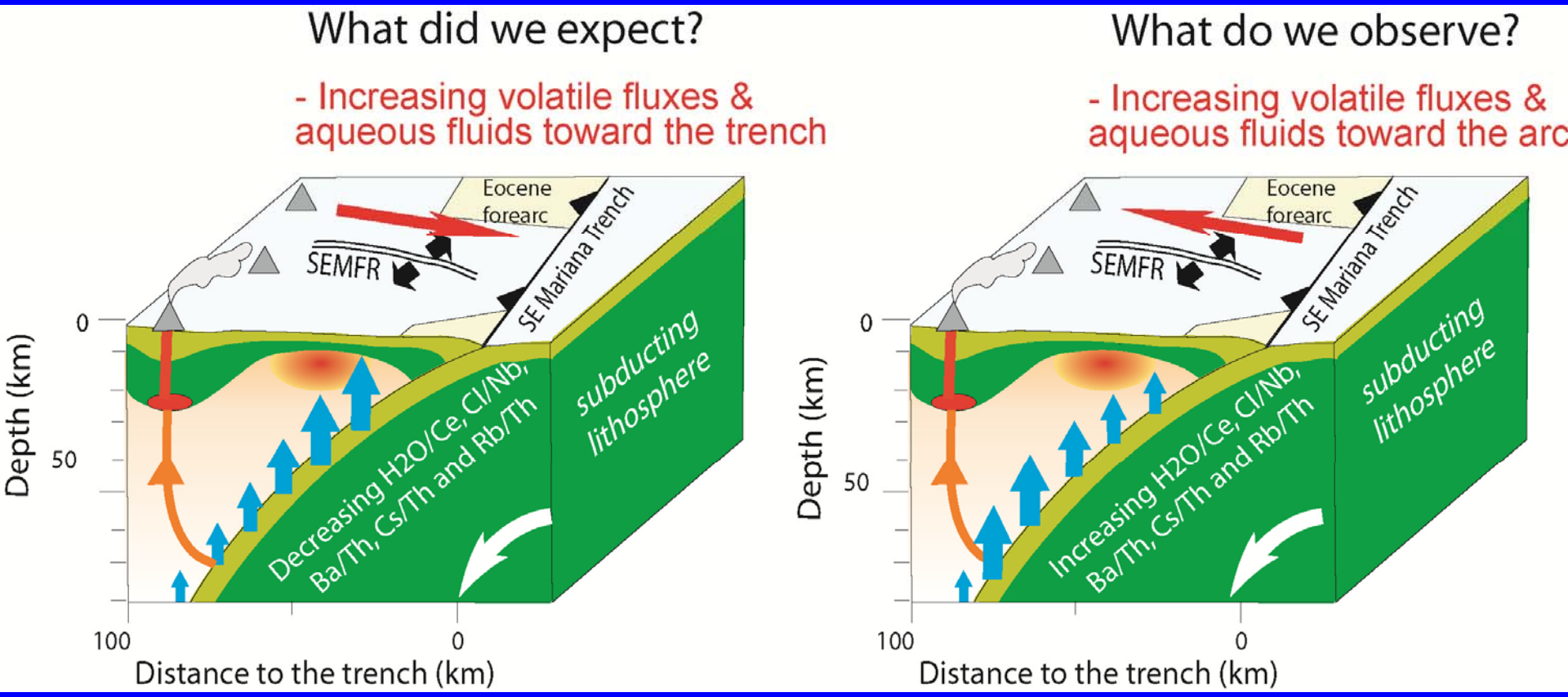
Samples with CO_2 < 50 ppm and S < 500 ppm are likely to have degassed some H_2O. Isobars were calculated using the VolatileCalc vapor solubility model for basalt compositions (Newman and Lowenstern, 2002). The blue saturation curve models the approximate depth of the SEMFR seafloor.

SEMFR glass are richer in H2O/Ce and Cl/Nb than are the Mariana arc and the Mariana backarc basin lavas



H_2O/Ce and Cl/Nb = proxies for the slab-derived volatile fluxes

More aqueous slab-derived fluids and higher volatile fluxes at ~ 50 – 100 km slab depth, beneath the arc volcanoes



After Ribeiro et al., in press, G-cubed

Conclusions

•SEMFR glassy rinds and Ol-MI have higher Ba/Th, Cs/Th, Rb/Th, H_2O/Ce and Cl/Nb than have the Mariana arc lavas and Mariana backarc basin lavas.

•These ratios are the highest between 50 - 100 km depth to slab.

• In the Marianas, most of the minerals from the subducting plate released their fluids beneath the arc volcanoes, consistent with the modelings of Van Keken et al. (2011, JGR) and the results of Bebout et al. (2013, Chem. Geol.) and Pabst et al. (2012, Lithos) in metamorphic rocks.

•SEMFR Ol-MI have the highest FMEs/Th, H_2O/Ce and Cl/Nb recorded in the Mariana lavas.