The Global Chlorine Cycle: a Subduction Zone Perspective

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with lots of help from:
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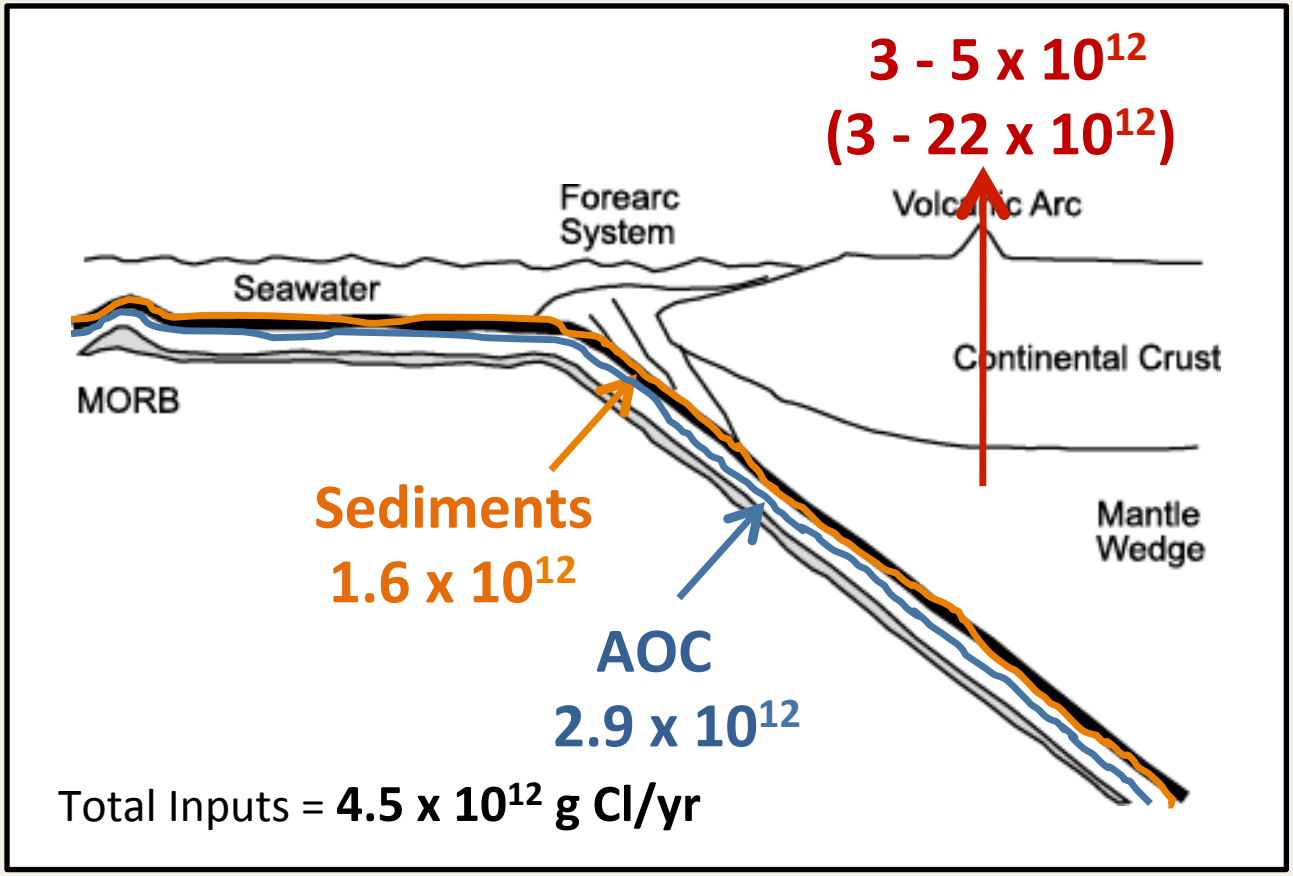
Global Chlorine Cycle

Why Chlorine?

1) Hydrophilic
2) Large component of slab-derived fluids (wt% !)
3) Cl can affect the transport efficiency of trace elements and the water activity
   ("energy and resources should be highlighted in the new program")

Global Chlorine Cycle



(Barnes and Straub, 2010; Ito et al., 1983; Jarrard, 2003; John et al., submitted; Sharp and Barnes, 2004; Straub and Layne, 2003; Wallace, 2005)

*"**serpentinite** is not included and must be considered as a potential source to arc magmas" (Straub and Layne, 2003)*

SCD theme: *Linkages between volatile release and the rheology of the plate boundary interface*

-What is the role of serpentinization in weakening the incoming plate and the plate interface?

-Does serpentinization of the incoming plate significantly change its mechanical strength?

-Does serpentinite dehydration control the location of some intermediate depth seismicity?

SCD theme: *Storage, transfer, and release of volatiles through subduction systems*

-What is the role of serpentine in subduction and release of H_2O?

-To what extent is the incoming plate serpentinized?

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SCD theme: *Storage, transfer, and release of volatiles through subduction systems*

-What is the role of **serpentine** in subduction and release of H_2O?

-To what extent is the incoming plate **serpentinized**?

Should we care or is it just a "green herring"?

Geochemical fingerprint for serpentinites

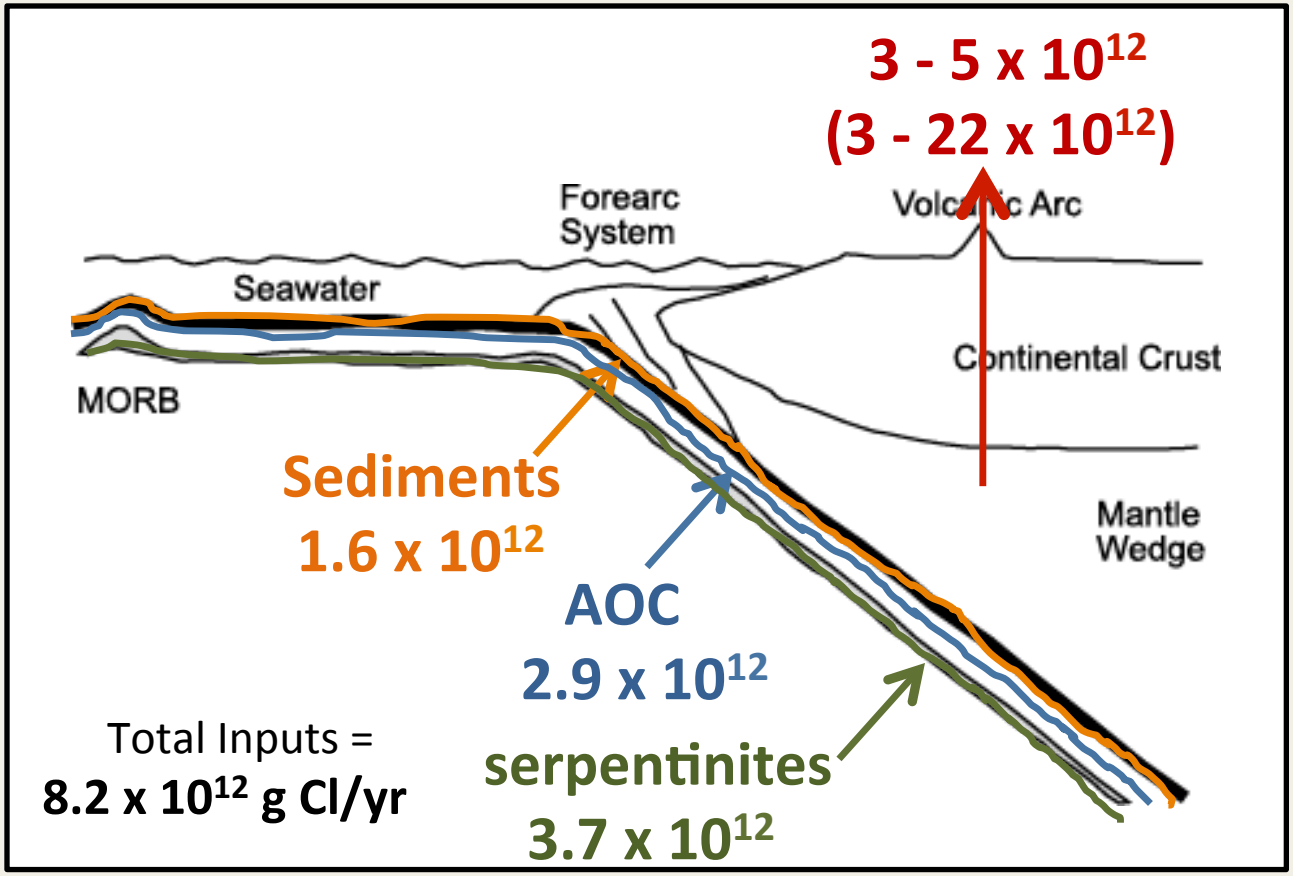
Chlorine in Serpentinites

Range from <0.01 to >1 wt% Cl
(<100 to >10,000 ppm Cl)

serpentine = ~13 wt% water
seawater = ~1.94 wt% Cl
~0.25 wt% Cl in serpentinites
(Anselmi et al., 2000)

0.26 ± 0.16 wt% Cl (n = 86)
(Sharp and Barnes, 2004)

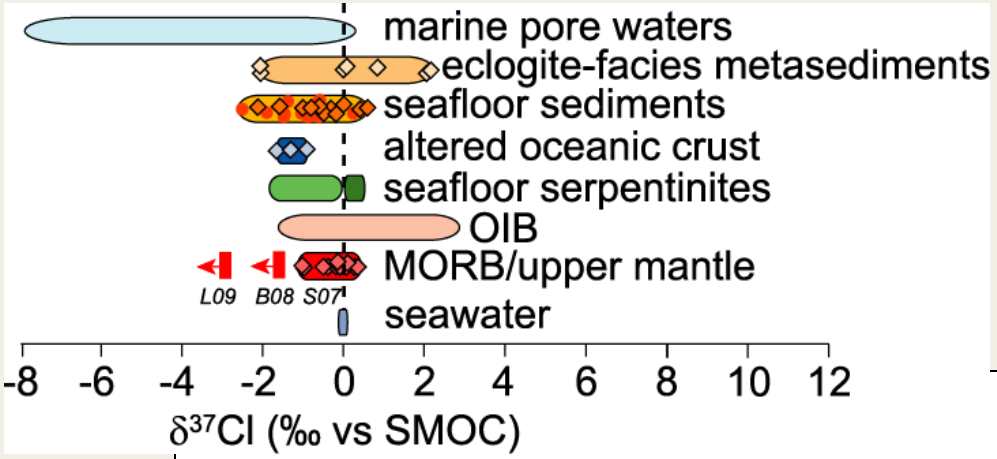
Global Chlorine Cycle: including serpentinites



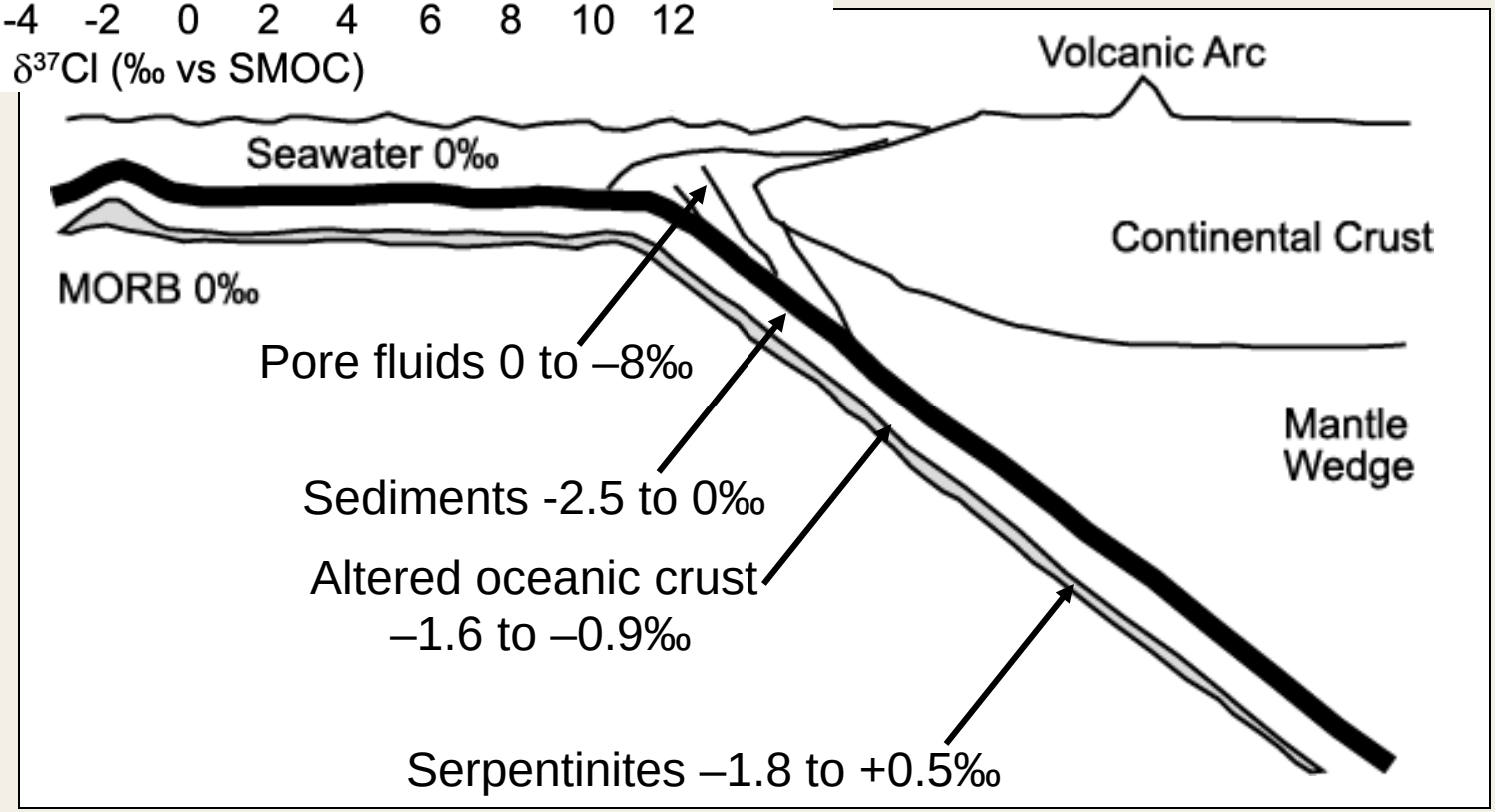
(Barnes and Straub, 2010; Ito et al., 1983; Jarrard, 2003; John et al., submitted; Sharp and Barnes, 2004; Straub and Layne, 2003; Wallace, 2005)

-highly saline fluid inclusions in Alpine eclogites (e.g., Selverstone et al., 1992; Scambelluri et al., 1997)
-deeply subducted serpentinites with ~150 ppm Cl (e.g., John et al., submitted; Scambelluri et al., 2004)

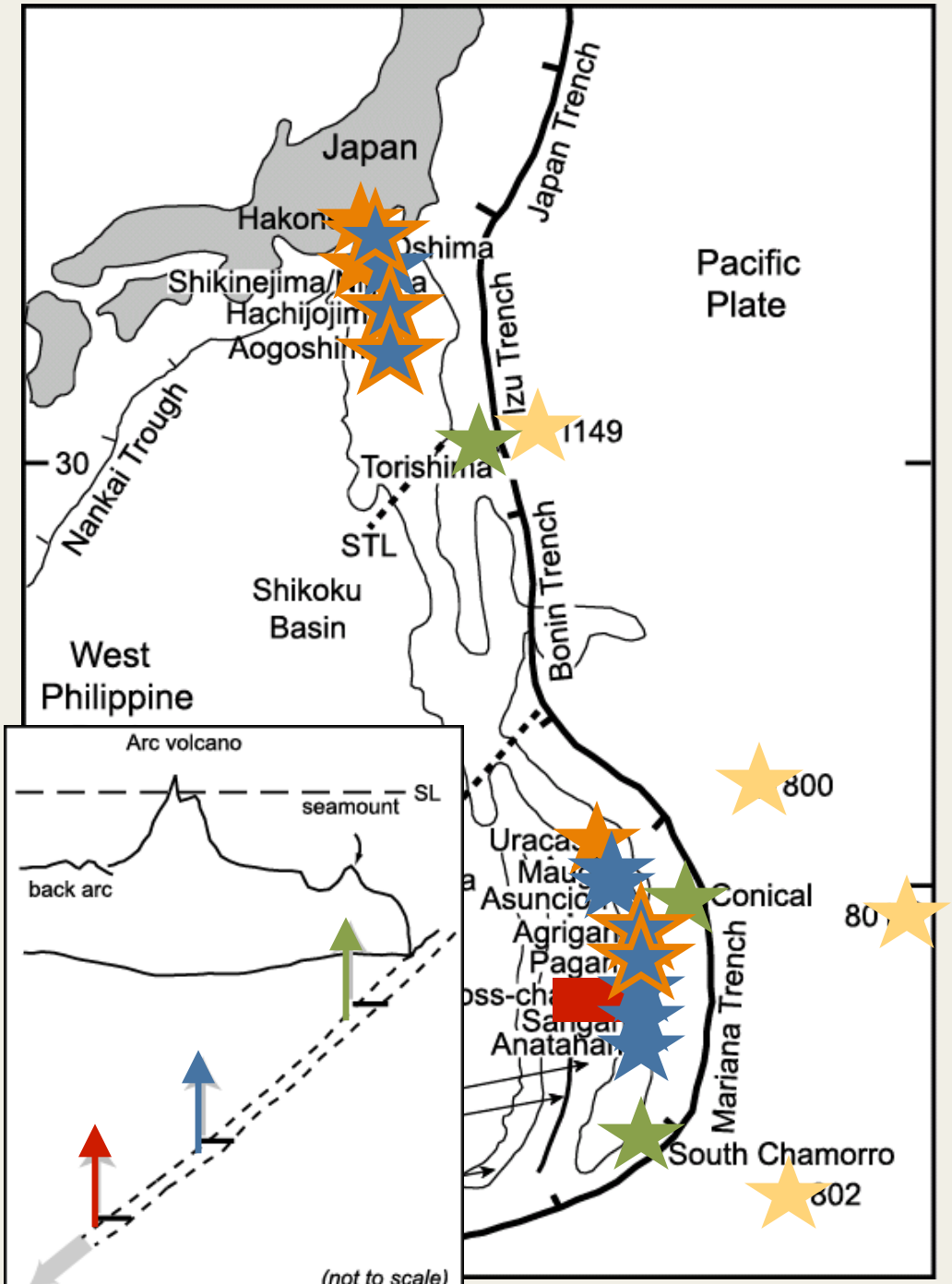
Chlorine Stable Isotopes



$$\delta^{37}Cl = \frac{\left(\frac{^{37}Cl}{^{35}Cl}\right)_{sample} - \left(\frac{^{37}Cl}{^{35}Cl}\right)_{standard}}{\left(\frac{^{37}Cl}{^{35}Cl}\right)_{standard}} \; x\; 1000$$



(Arcuri and Brimhall, 2003; Barnes and Sharp, 2006; Barnes et al., 2008, 2009; Bonifacie et al., 2007, 2008; Godon et al., 2004; Hesse et al., 2000; John et al., 2010; Kaufmann et al., 1984; Layne et al., 2009; Ransom et al. 1995; Sharp et al., 2007; Spivack et al., 2002)



Izu-Bonin-Mariana

→ sediments

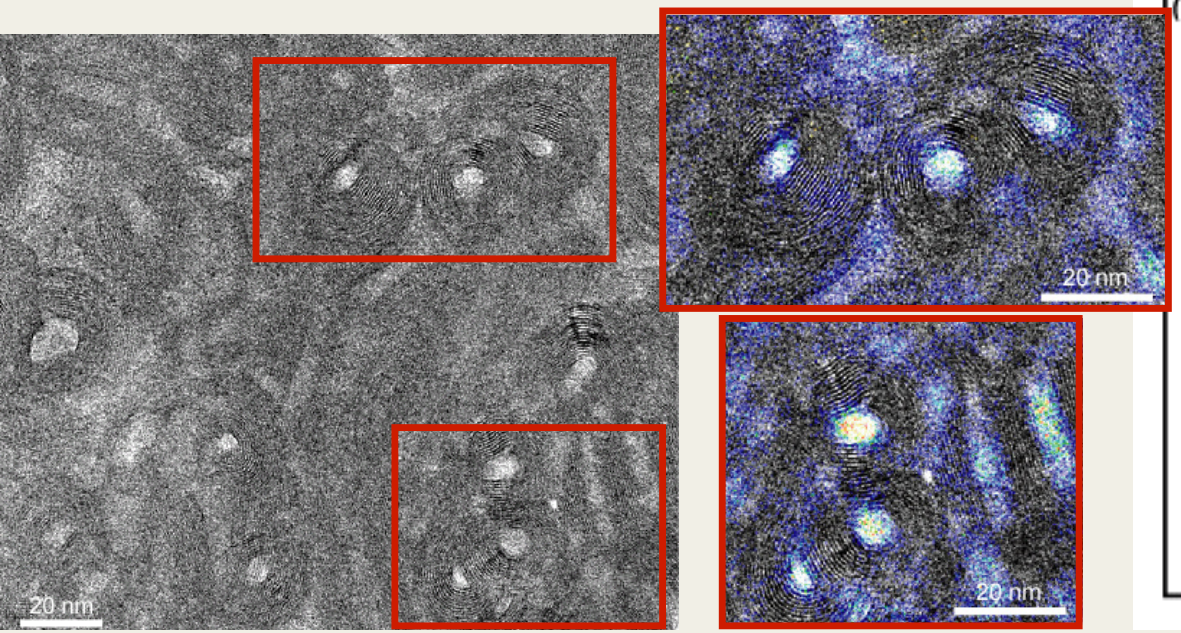
→ serpentine mud volcanoes

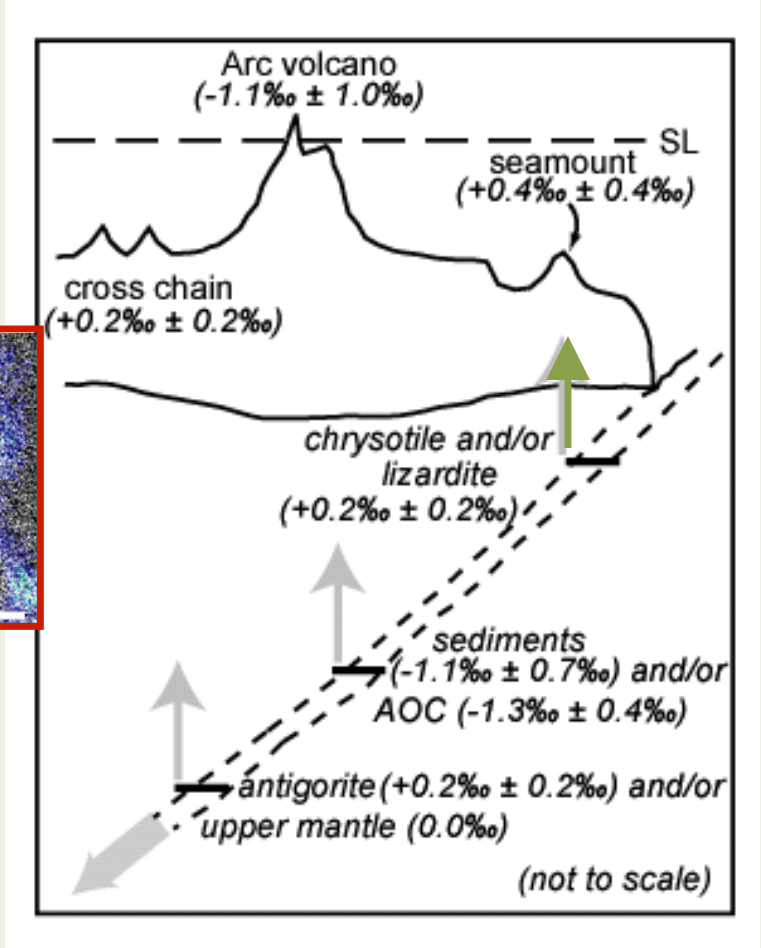
→ arc volcanoes (gases/wells & ashes)

→ cross-chain (basalts)

IBM Summary

1) Serpentine seamounts → Cl from chrysotile- antigorite transition

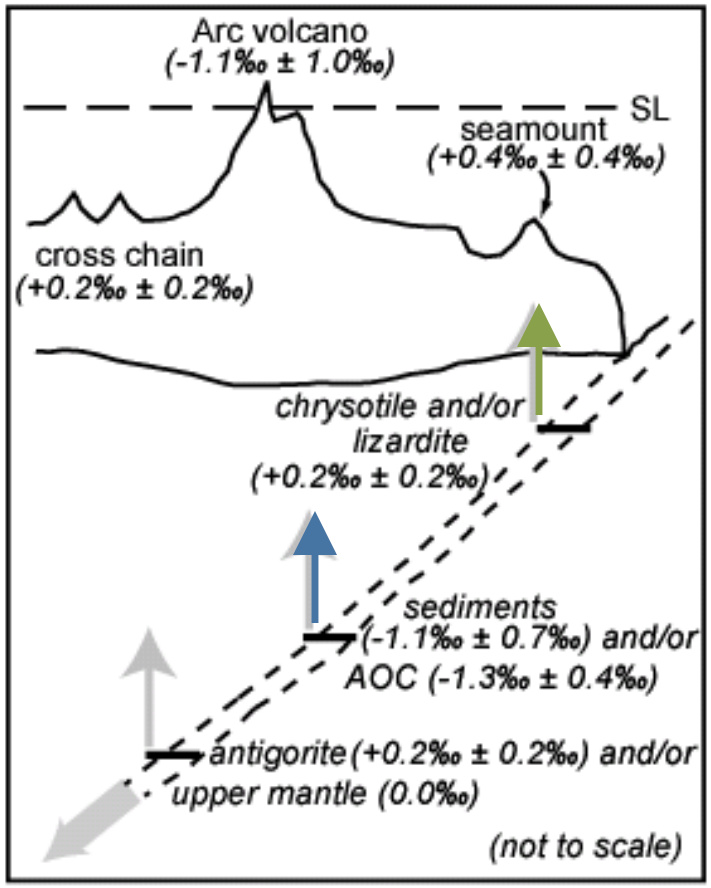




Brearley et al. (submitted)

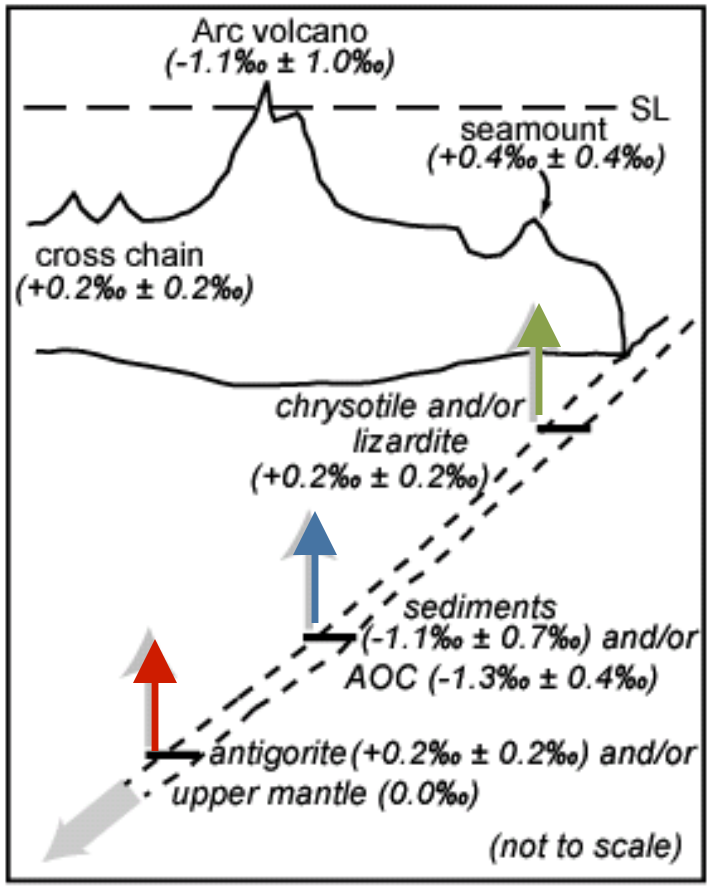
IBM Summary

1) Serpentine seamounts → Cl from chrysotile- antigorite transition
2) Arc volcanoes → sediments/ AOC; Little variation along the length of the arc

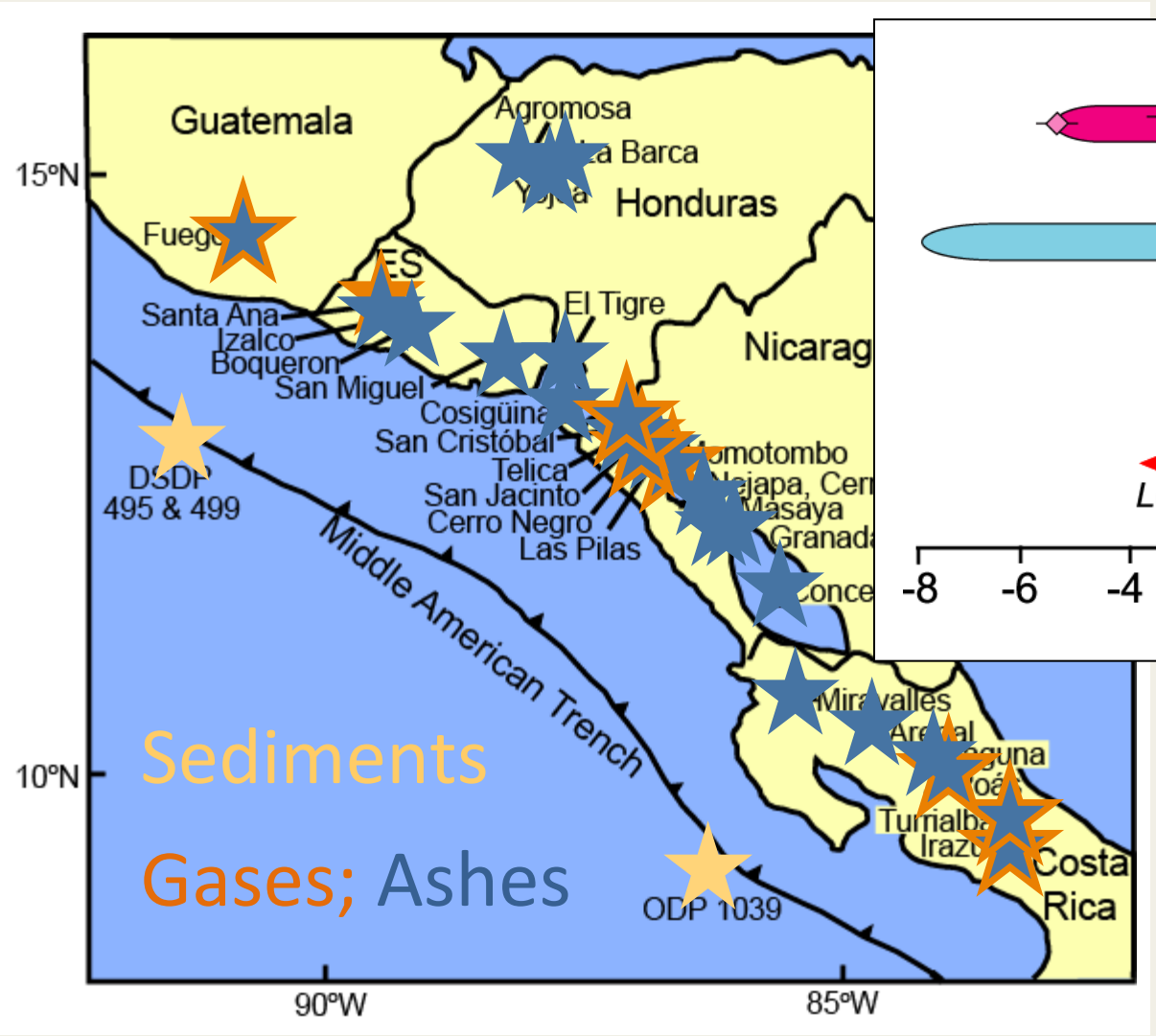


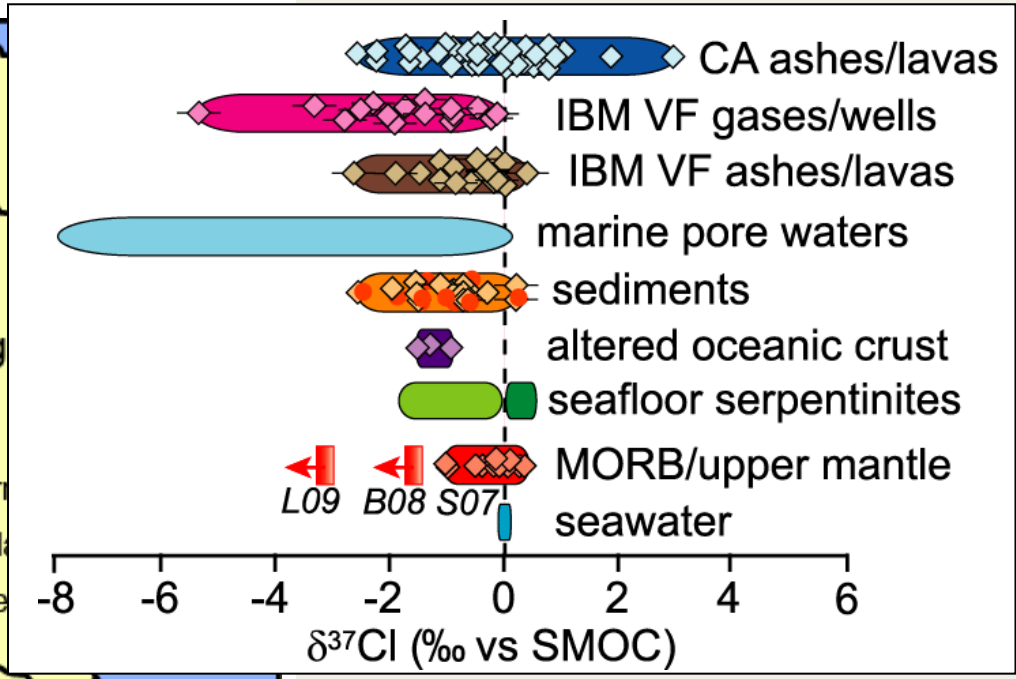
IBM Summary

1) Serpentine seamounts → Cl from chrysotile- antigorite transition
2) Arc volcanoes → sediments/ AOC; Little variation along the length of the arc
3) Guguan cross-chain → antigorite breakdown/ mantle?

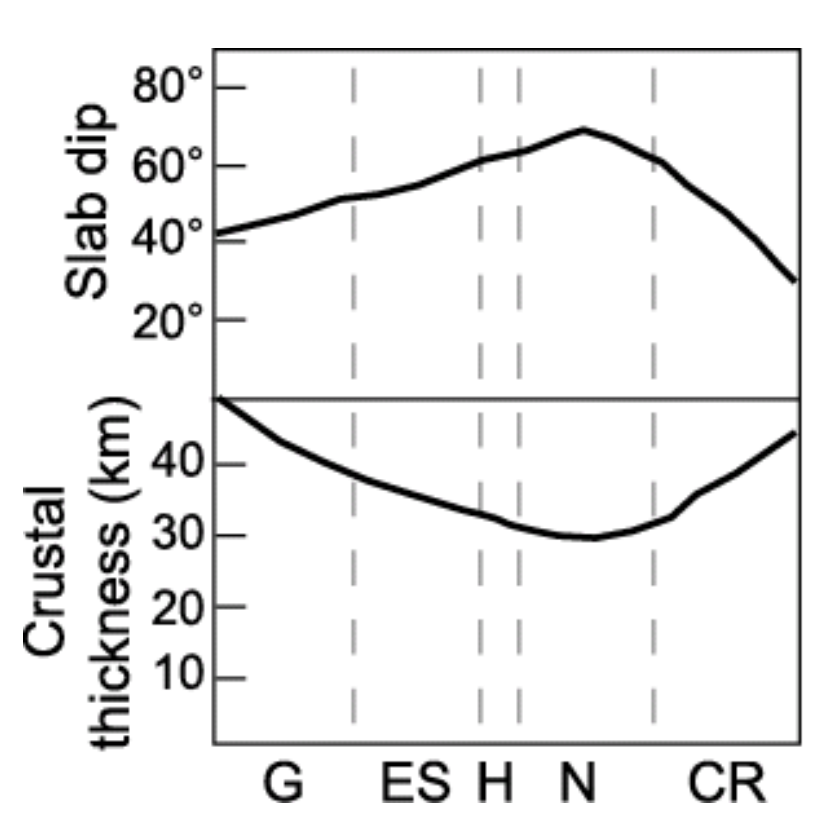


Central America

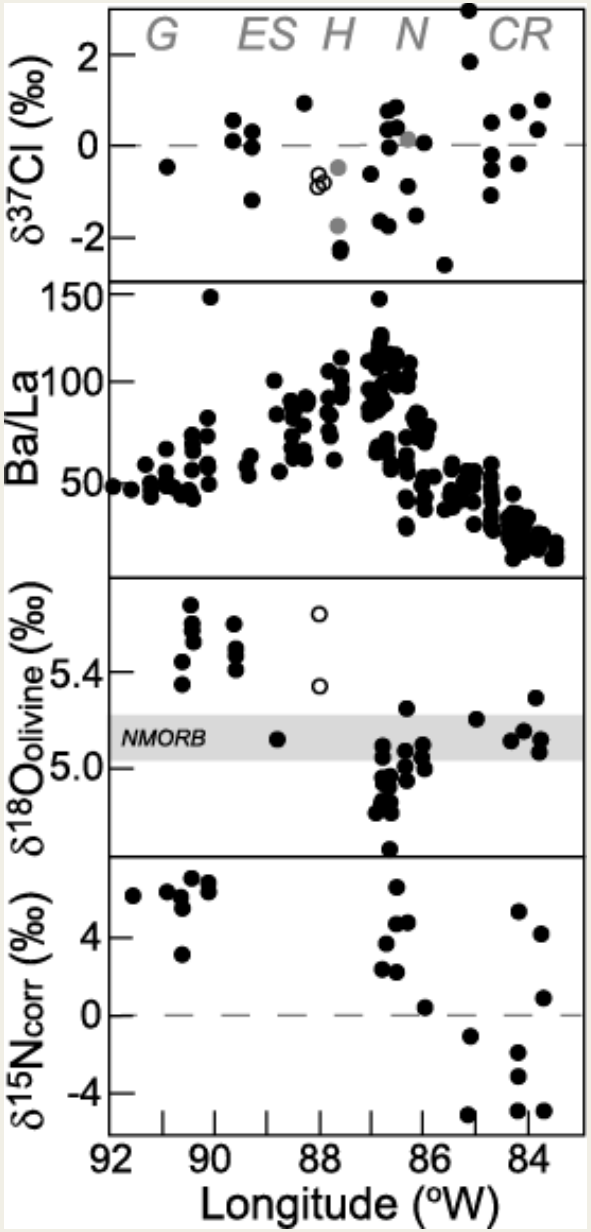




Ashes and Tephras



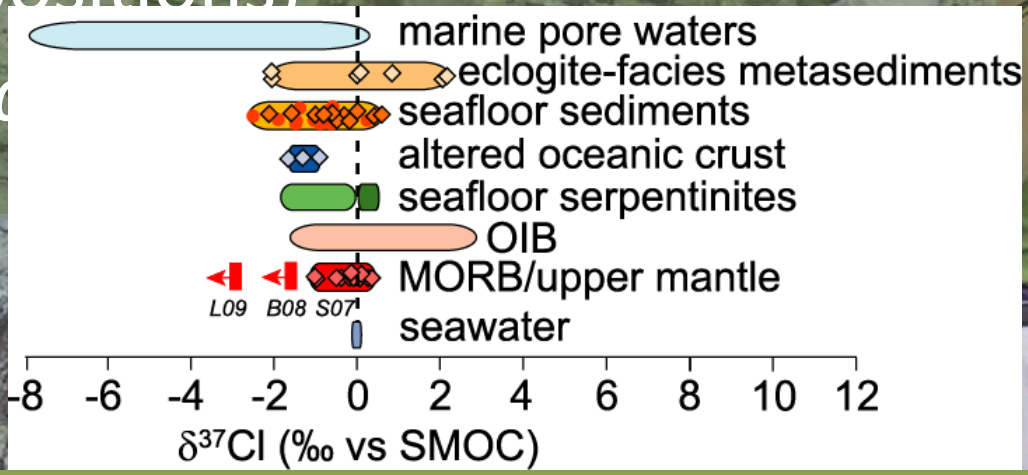
(Carr and Stoiber, 1990; Carr et al., 2004)

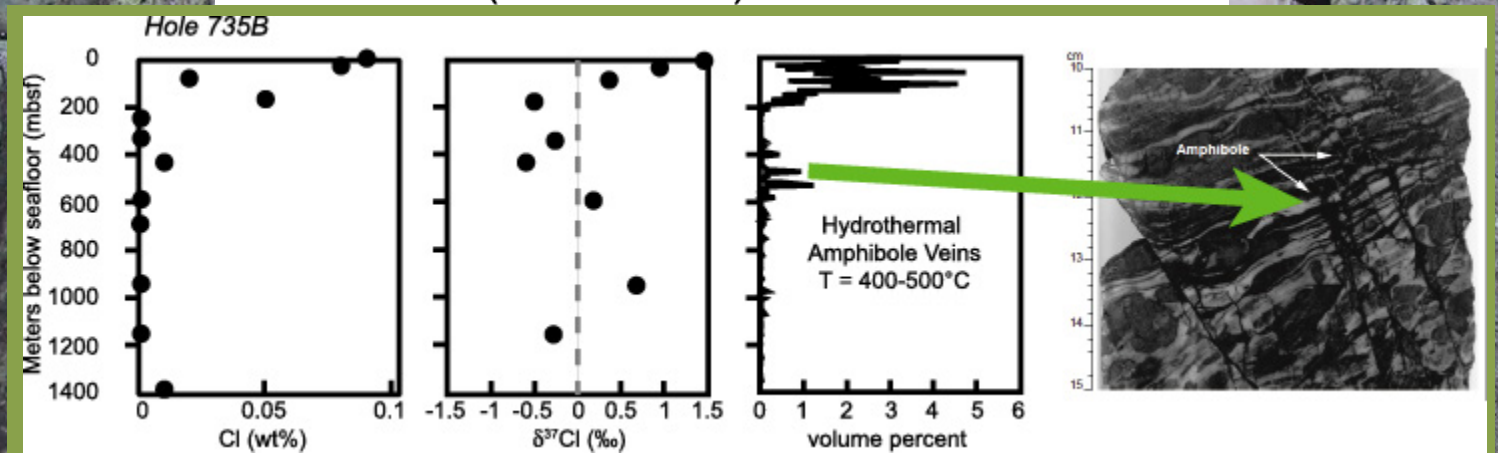


Barnes et al. (2009), Eiler et al. (2005), Elkins et al. (2006), Fischer et al. (2002), Zimmer et al. (2004), M. Carr's online database

Current and Future Directions

1) Defining/refining volatile (Cl, F, S, C) reservoirs & fluxes (concentrations & isotopic compositions)
(includ





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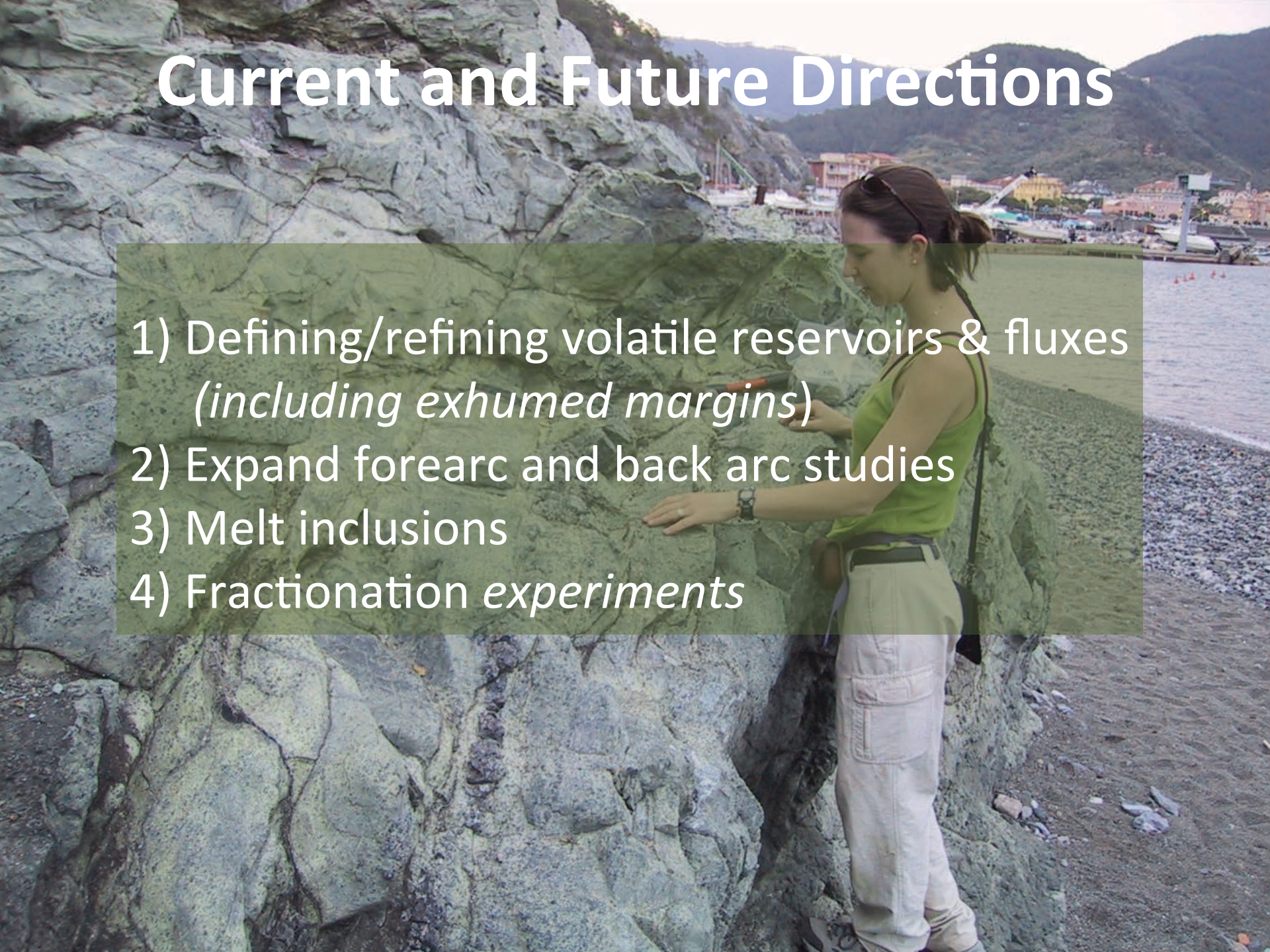

1) Defining/refining volatile reservoirs & fluxes
   (including exhumed margins)
2) Expand forearc and back arc studies
3) Melt inclusions
4) Fractionation *experiments*