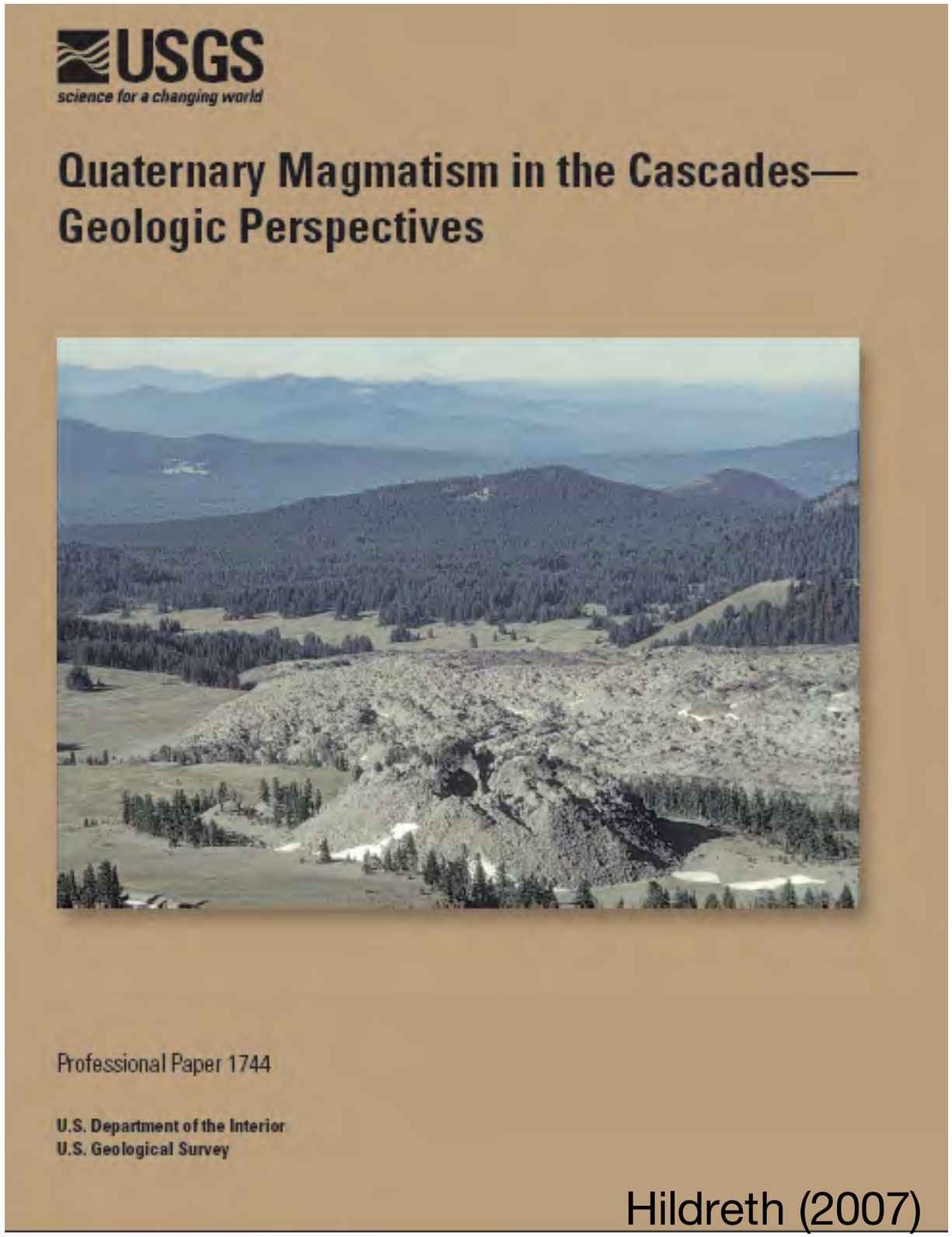
Holocene and recent volcanism in the Cascades

Kathy Cashman



Hildreth (2007)

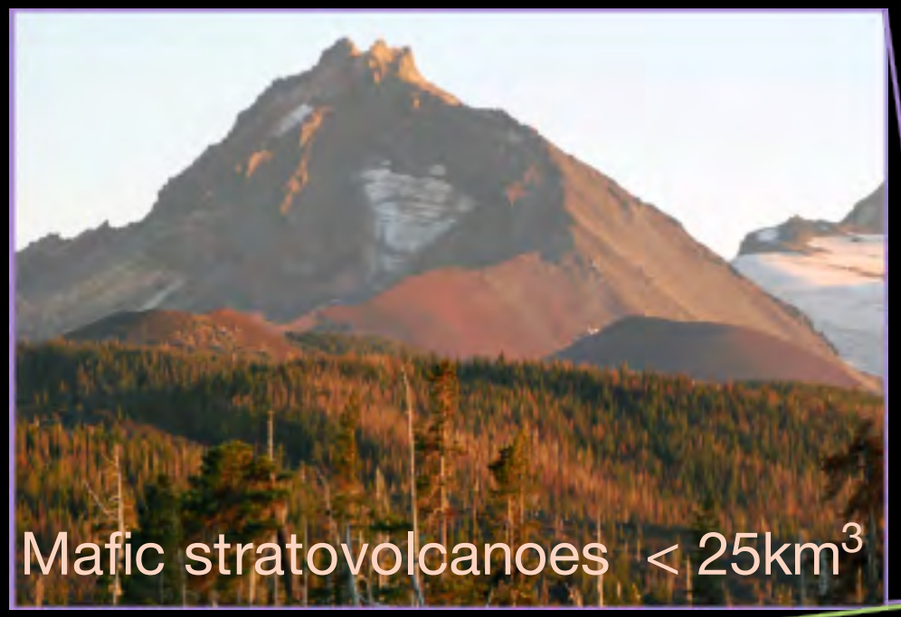
Cascades arc challenges many classical notions

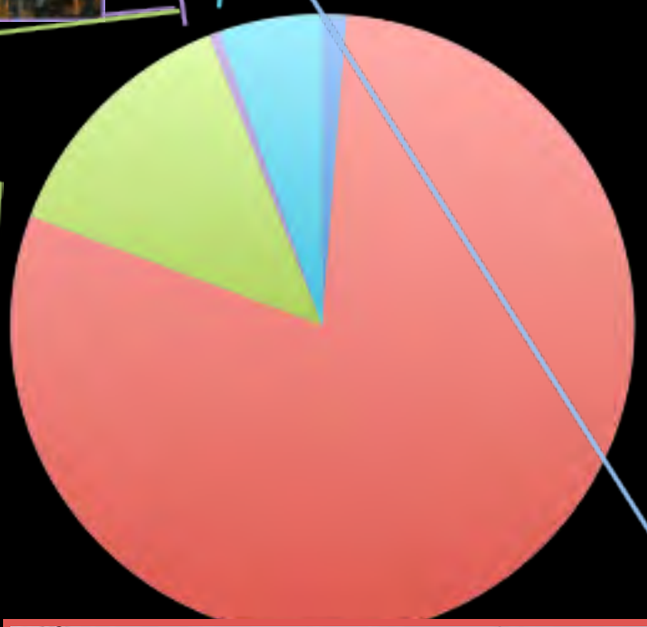
• of the 2339 Quaternary vents identified, only 19 are andesite-dacite stratovolcanoes; most vents are mafic and densely clustered

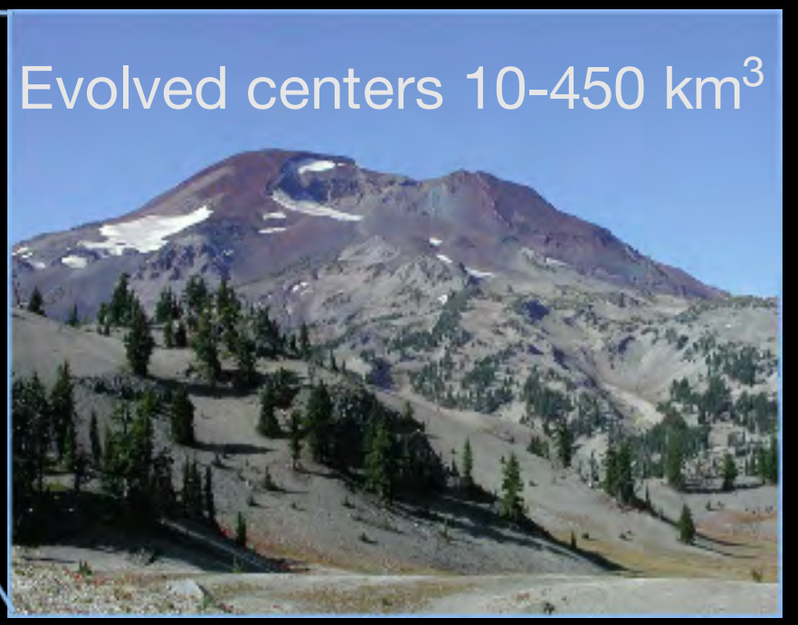
• Quaternary calderas remarkably rare

• volcanic front is diffuse and irregular; the spacing of the stratovolcanoes is highly variable, as is the breadth of the arc

• depth to the top of the seismic zone ranges from 80-150 km

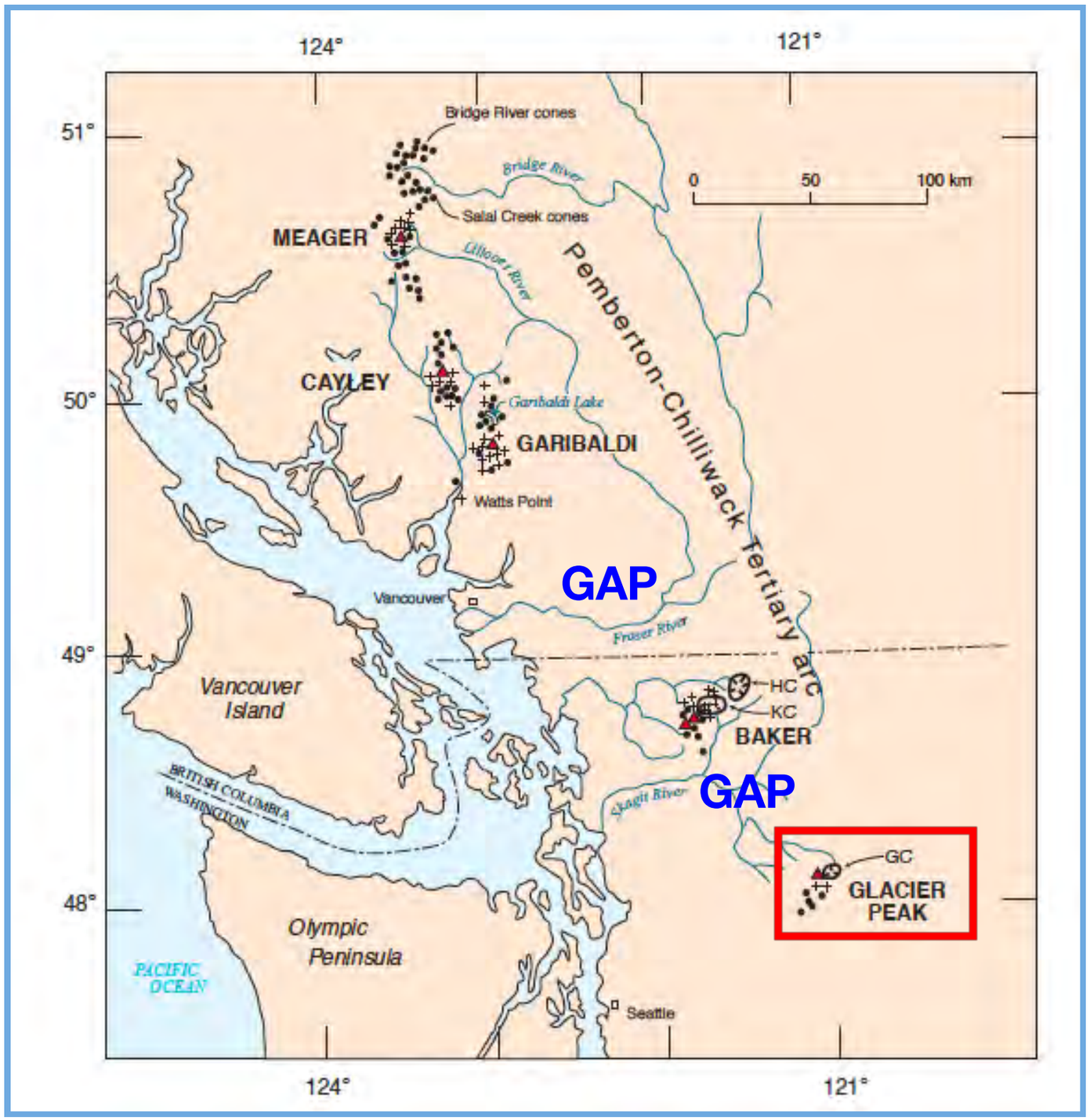






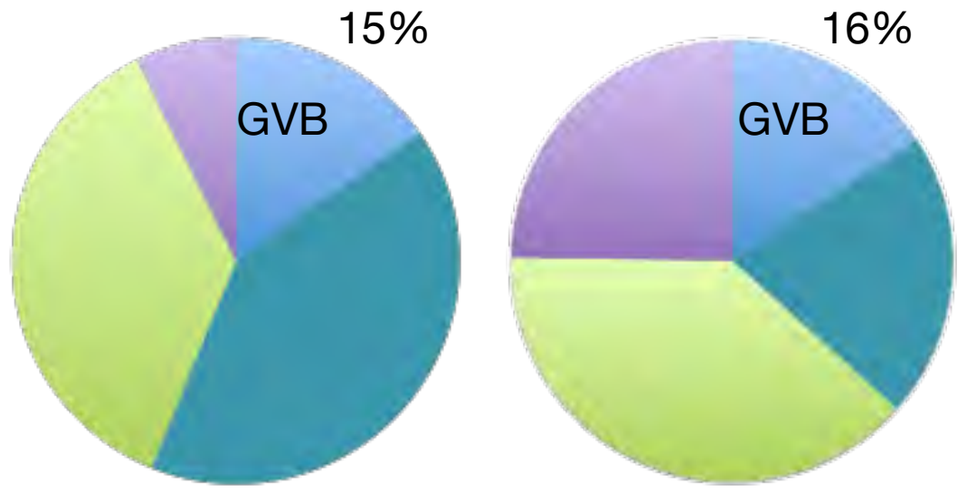
Quaternary vents

Garibaldi Volcanic Belt



Evolved edifices account for 90% of Quaternary erupted volume

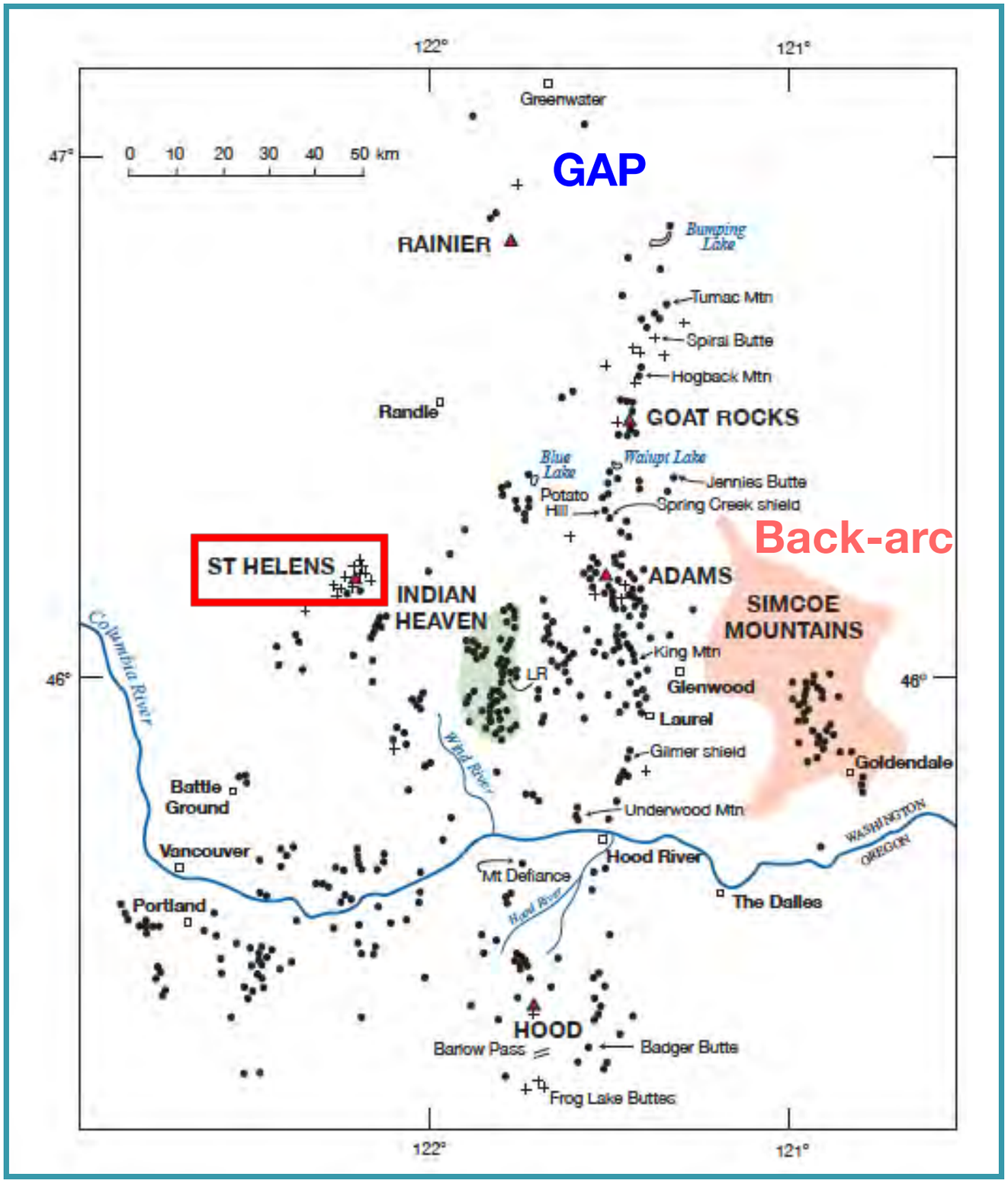
Post-glacial volcanism



Number Volume

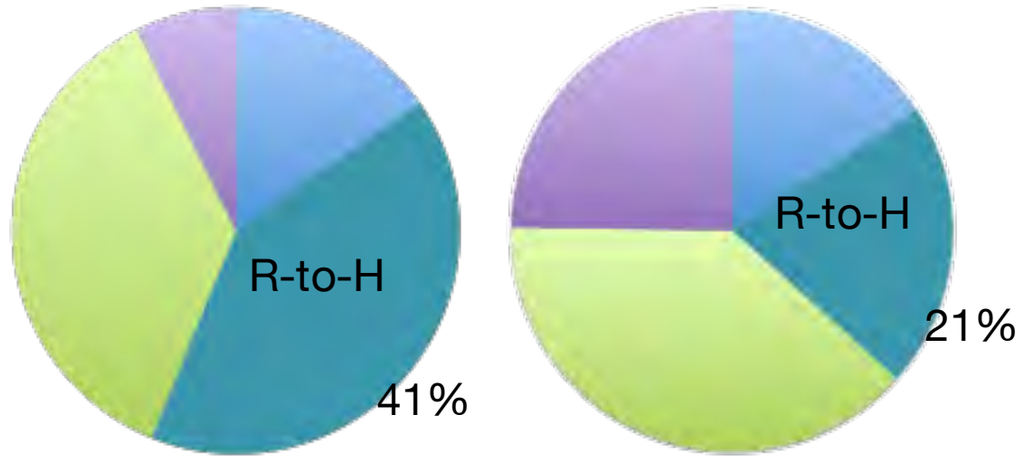
By volume, Glacier Peak accounts for 11%

Rainier to Hood



Evolved edifices account for 75% of Quaternary erupted volume

Post-glacial volcanism

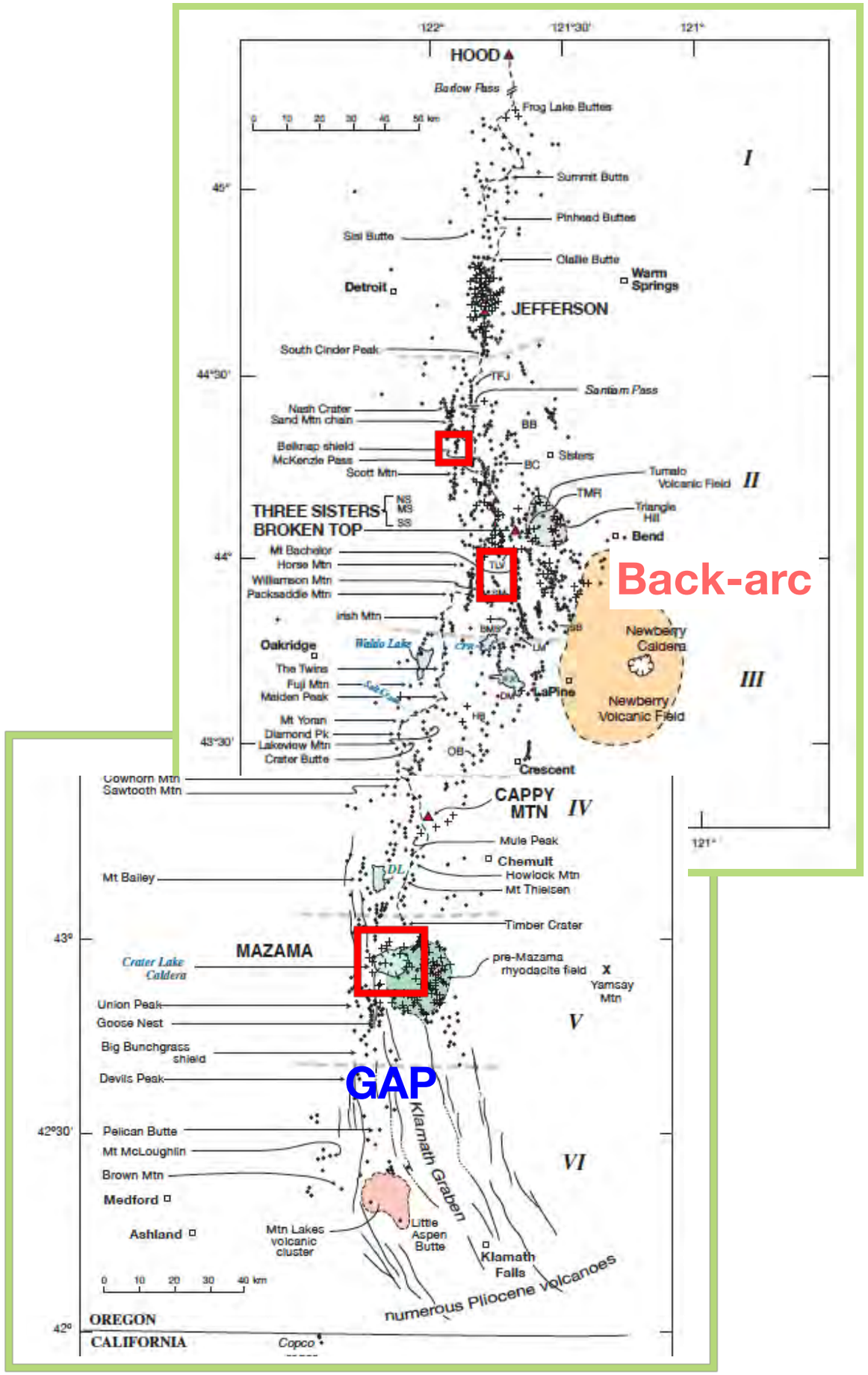


Number Volume

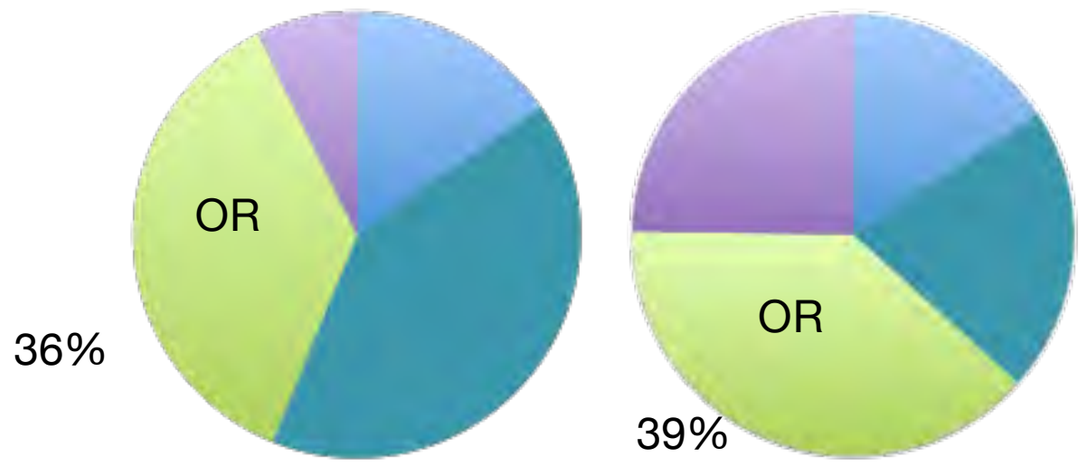
By volume, MSH accounts for 17%

Oregon

Evolved edifices account for <12% of Quaternary erupted volume



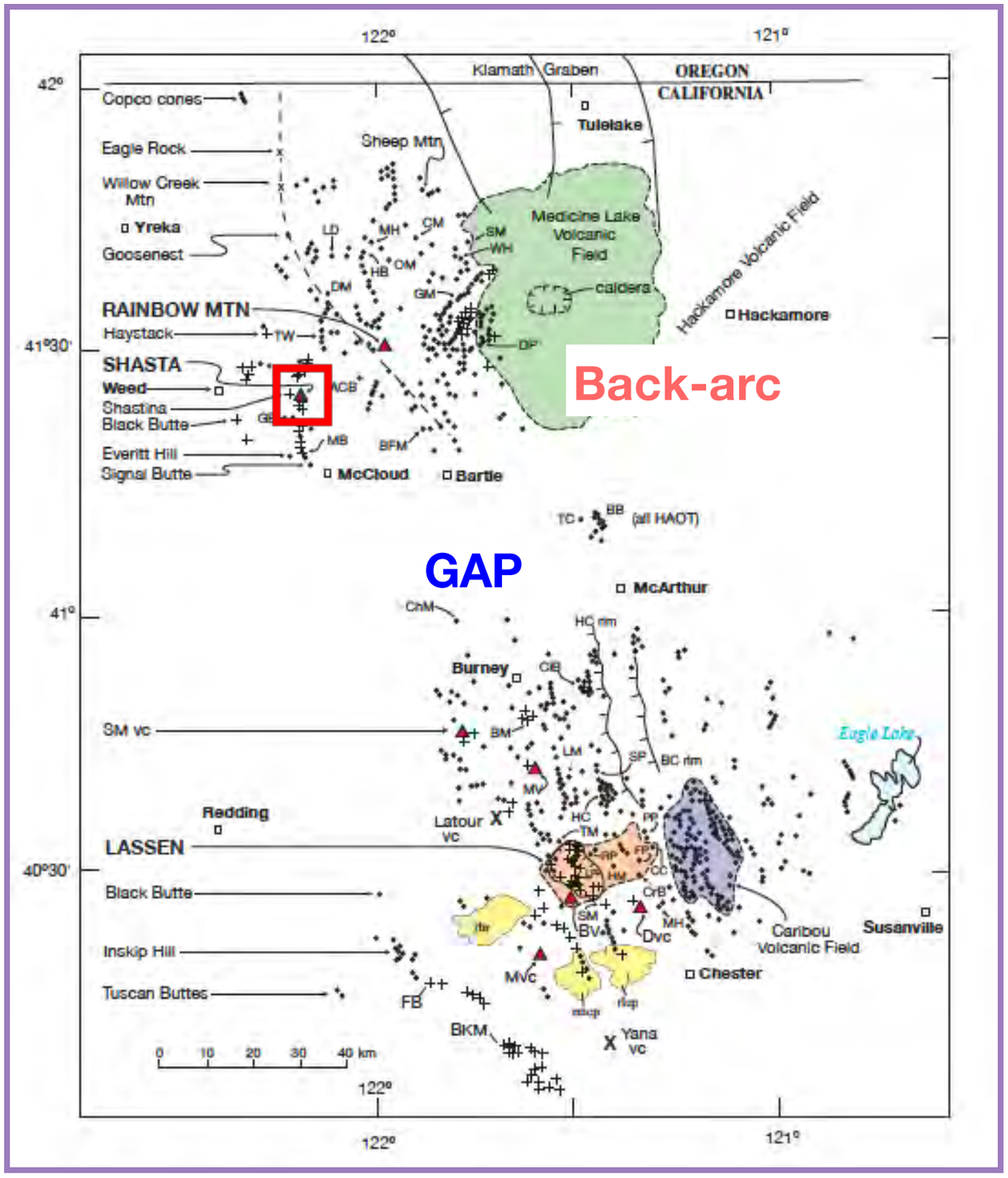
Post-glacial volcanism



Number Volume

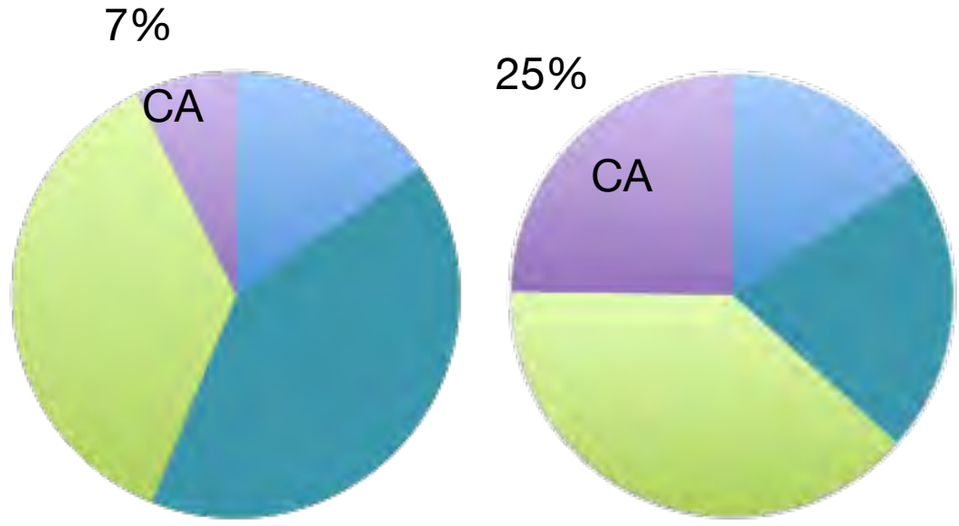
By volume, Mazama accounts for 20%; 13% from Bachelor & Belknap (mafic)

California



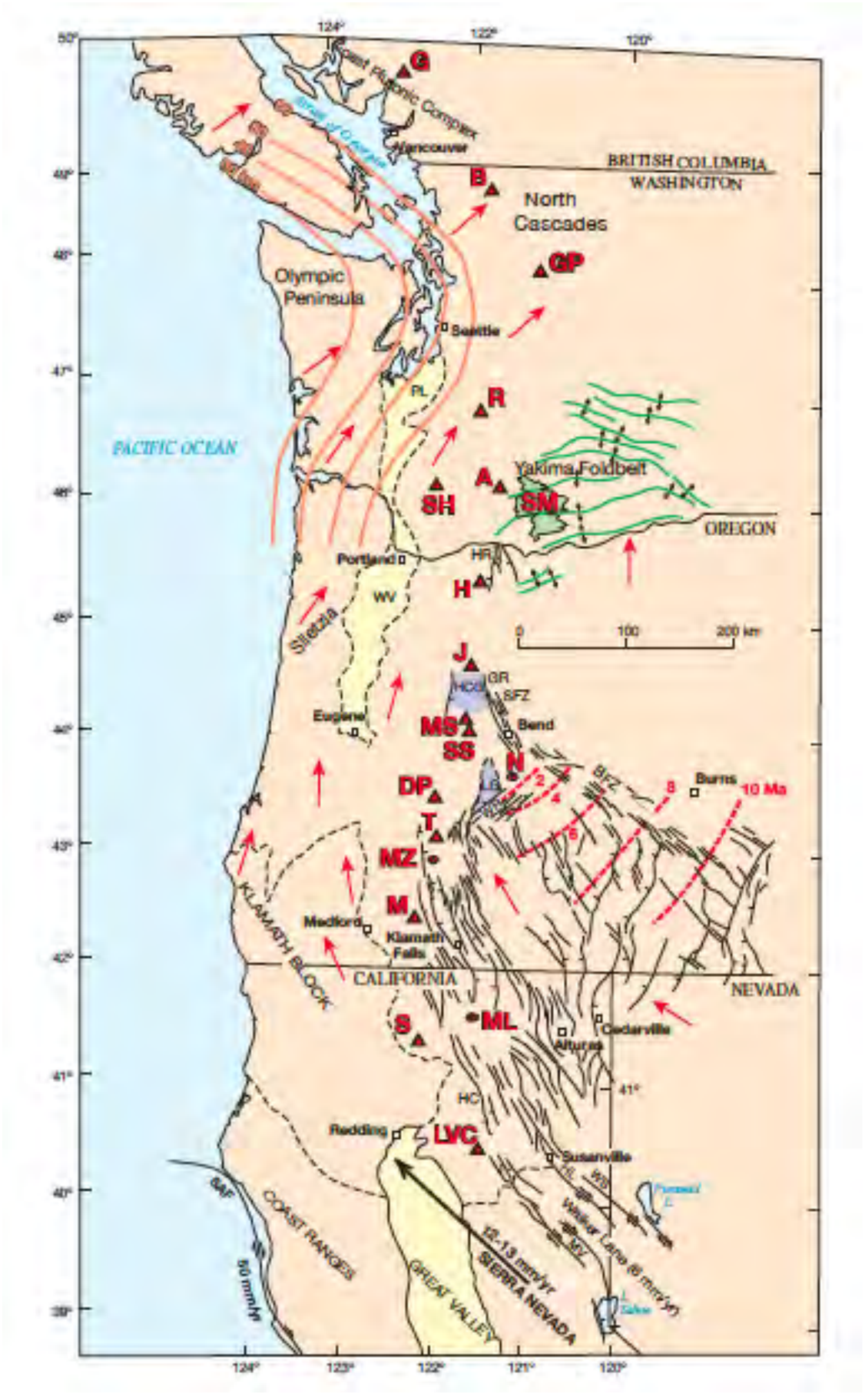
Evolved edifices account for >80% of Quaternary erupted volume (Shasta)
~ 65-70% (Lassen)

Post-glacial volcanism



Number Volume

By volume, Mount Shasta accounts for 24% of the volume

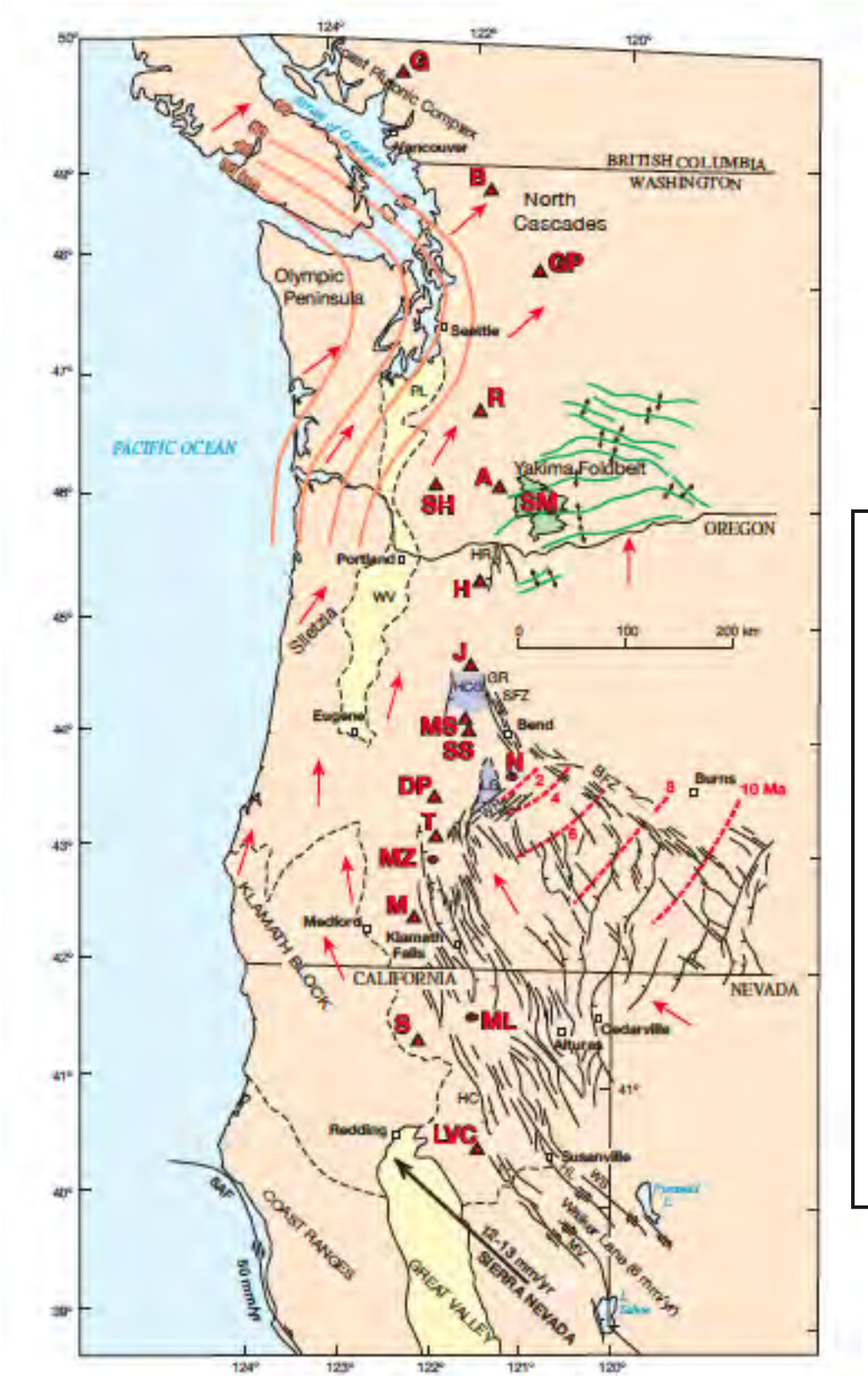


- Mafic volcanoes are closely spaced, are remarkably continuous through Oregon

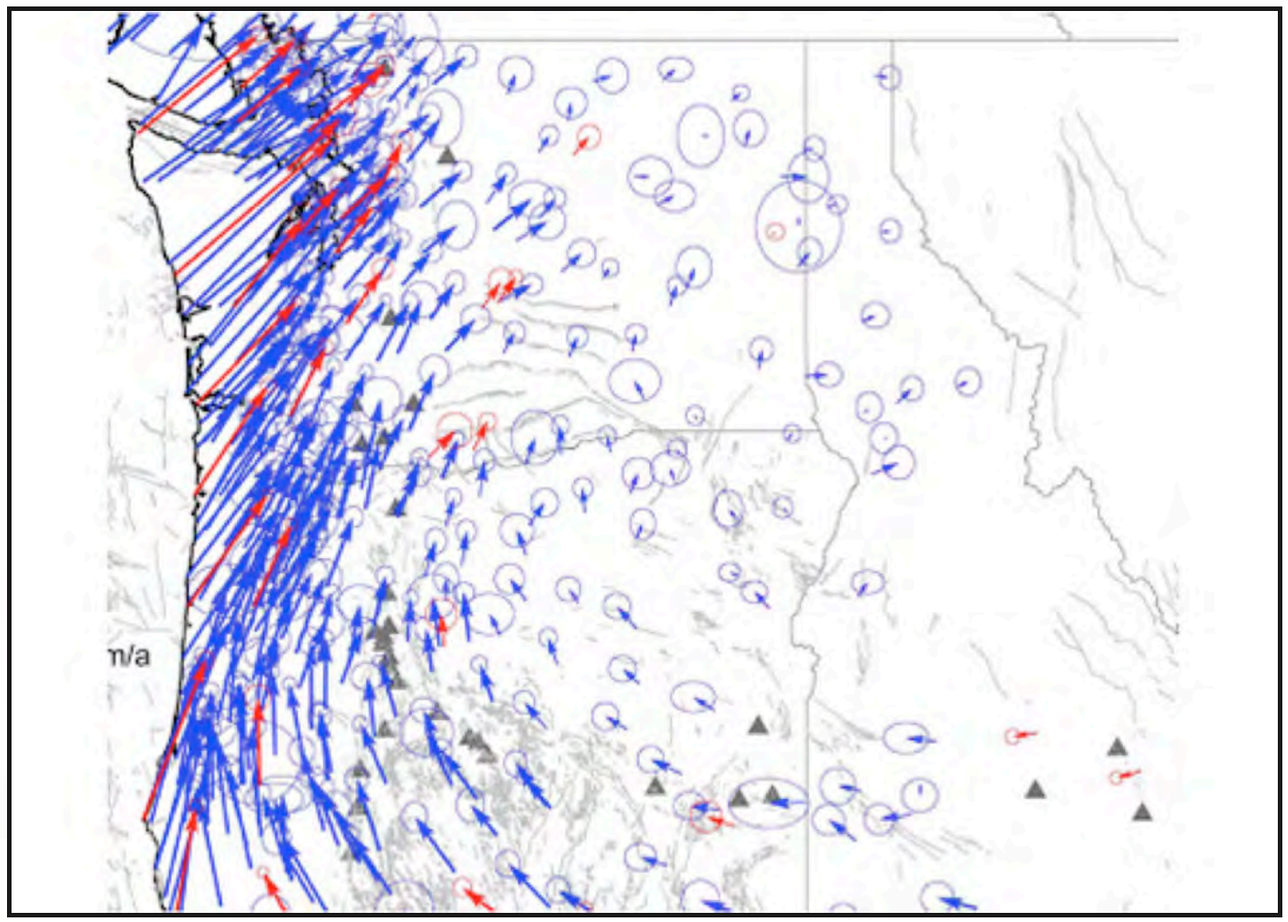
- There are several along-arc gaps that lack Quaternary volcanism

- Three major rear-arc volcanic fields (Simcoe, Newberry, Medicine Lake) are widely separated

Related to the ‘relative penetrability’ of the lithosphere (tectonic controls)?

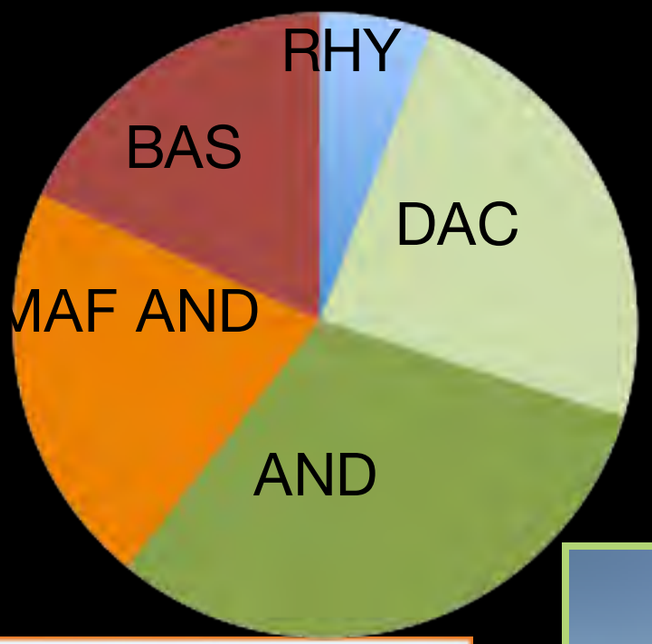


Must also explain close proximity in space and time of small (monogenetic), intermediate (centuries to millenia), and large (< 1Ma) volcanic centers



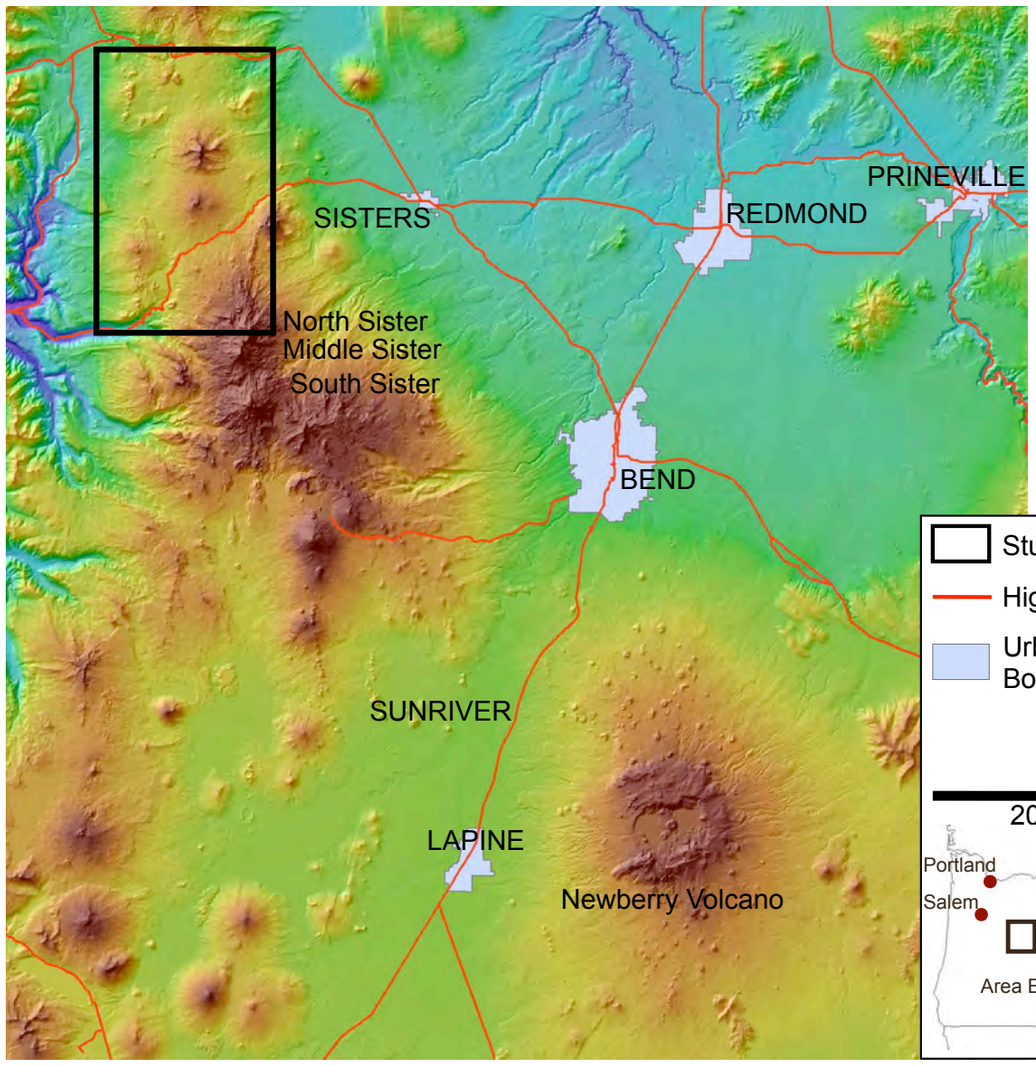
http://www.pnsn.org

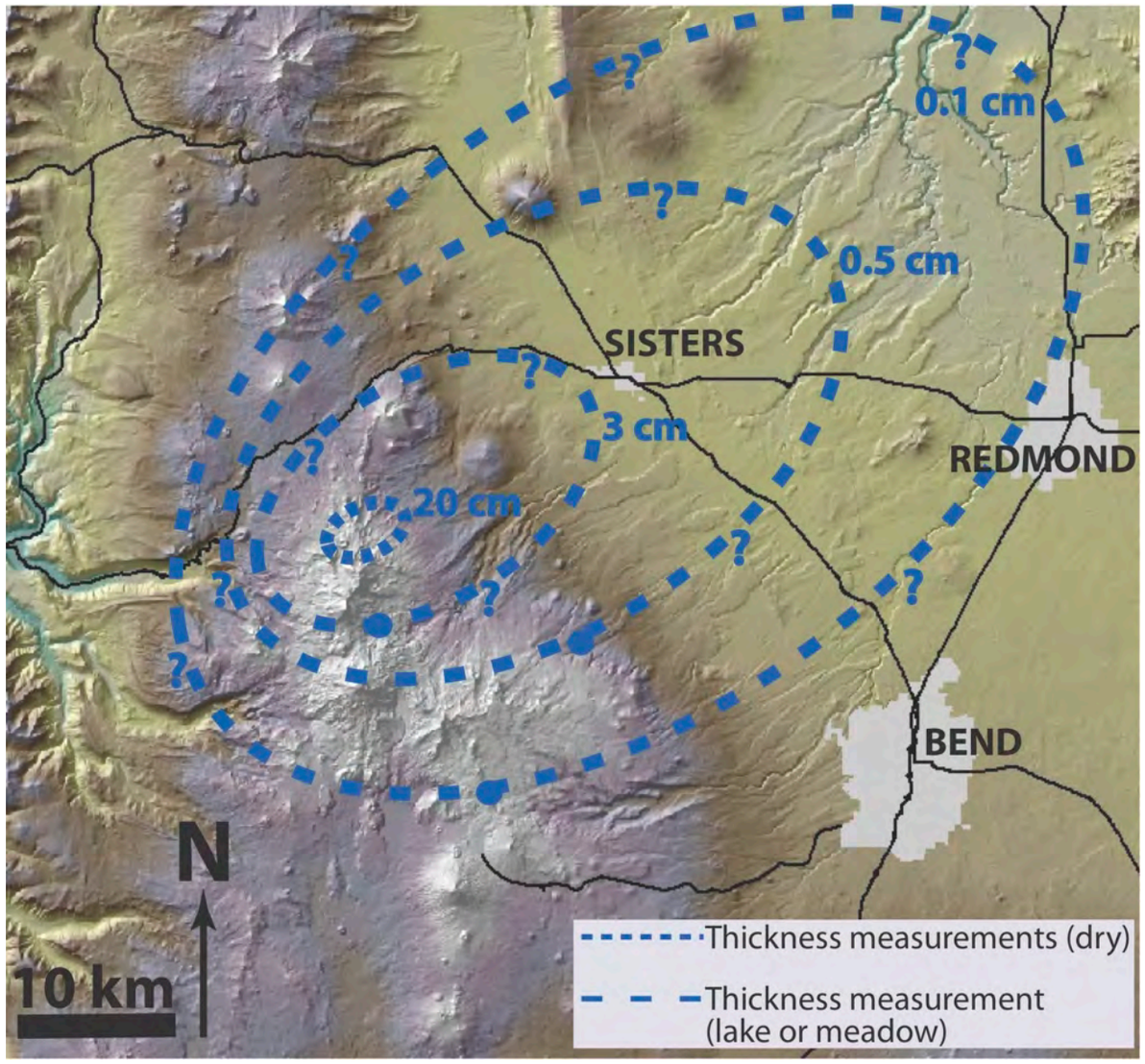
Postglacial eruptions (137 total)



Central Oregon

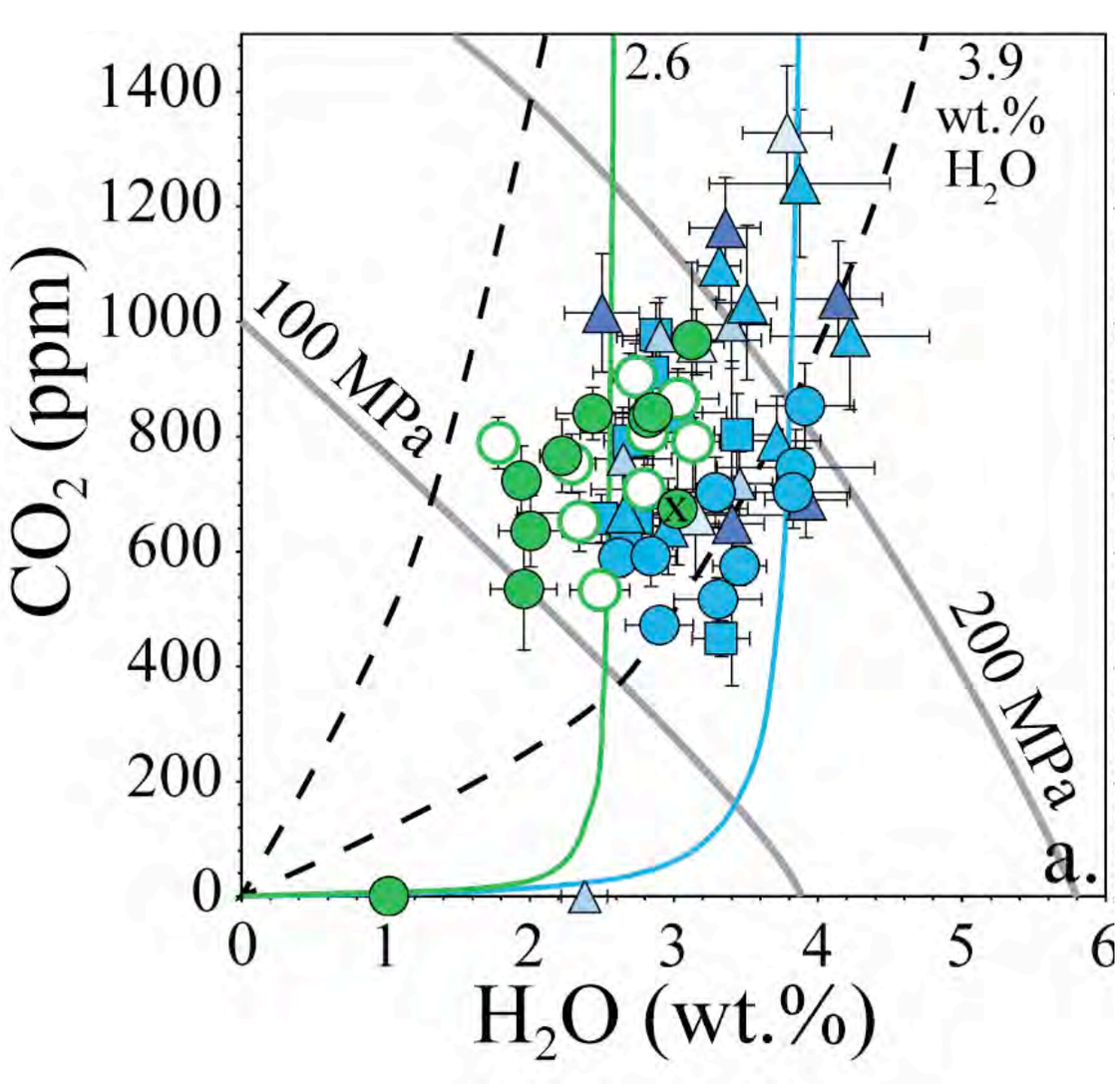
- small-intermediate volume
- limited tephra deposits
- crystallization at ~ constant pressures
- magma transferred from upper crust

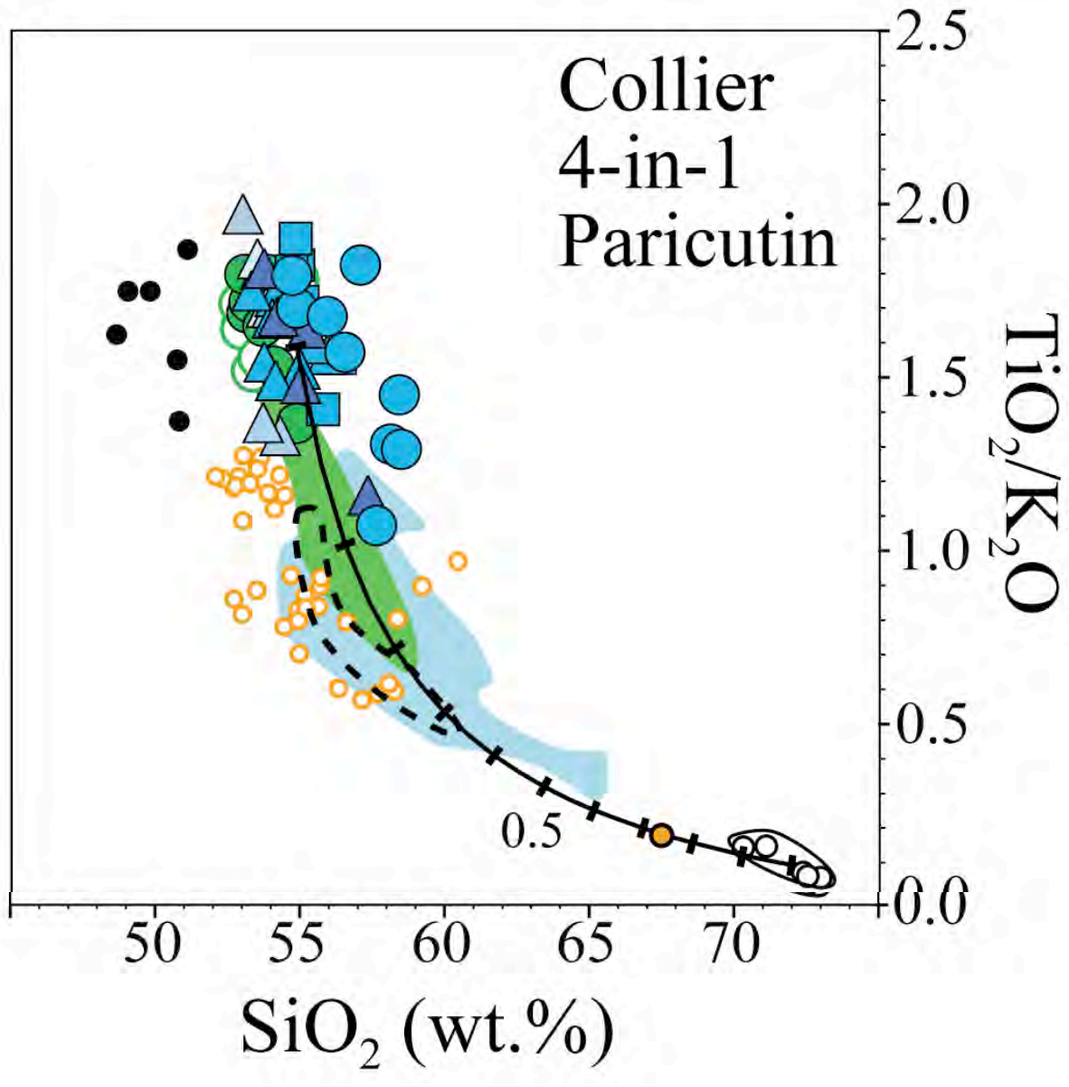




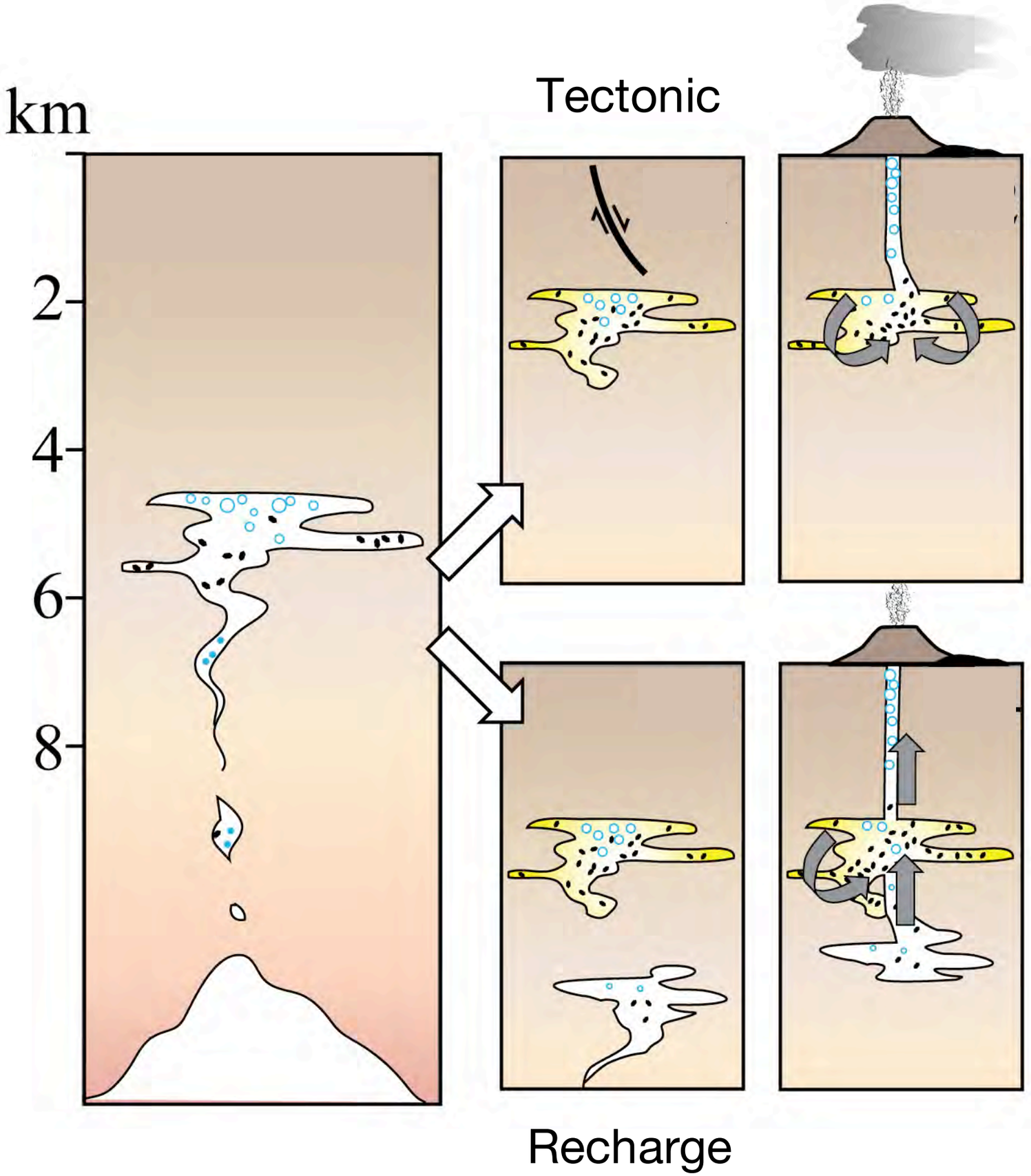
How do magma transport and storage conditions affect eruption style?

Evidence of shallow storage and assimilation





Ruscitto et al. (in prep.)

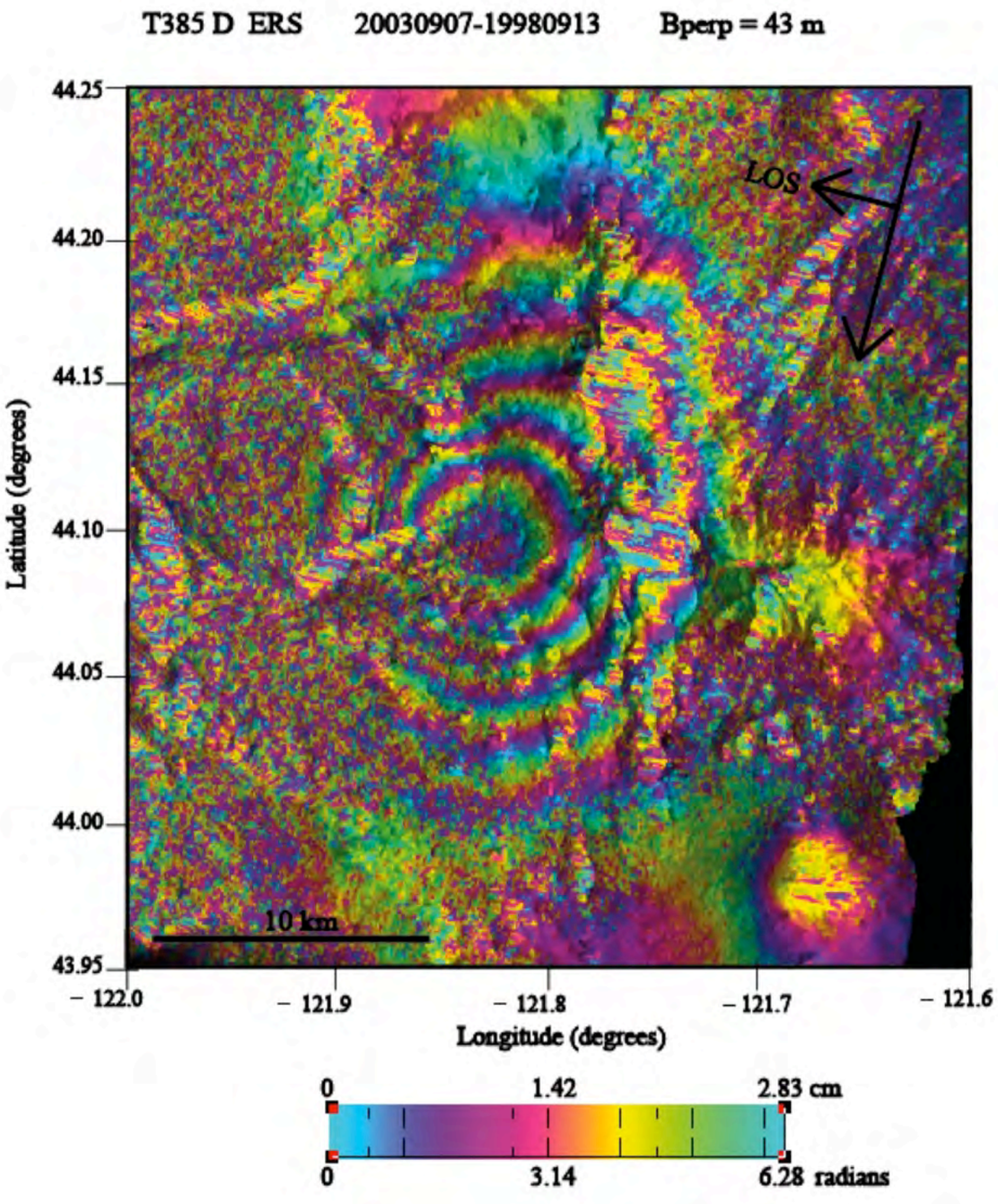


Ruscitto et al. (in prep.)

Suggests that upper crustal magma storage regions are fed by small batches of magma;

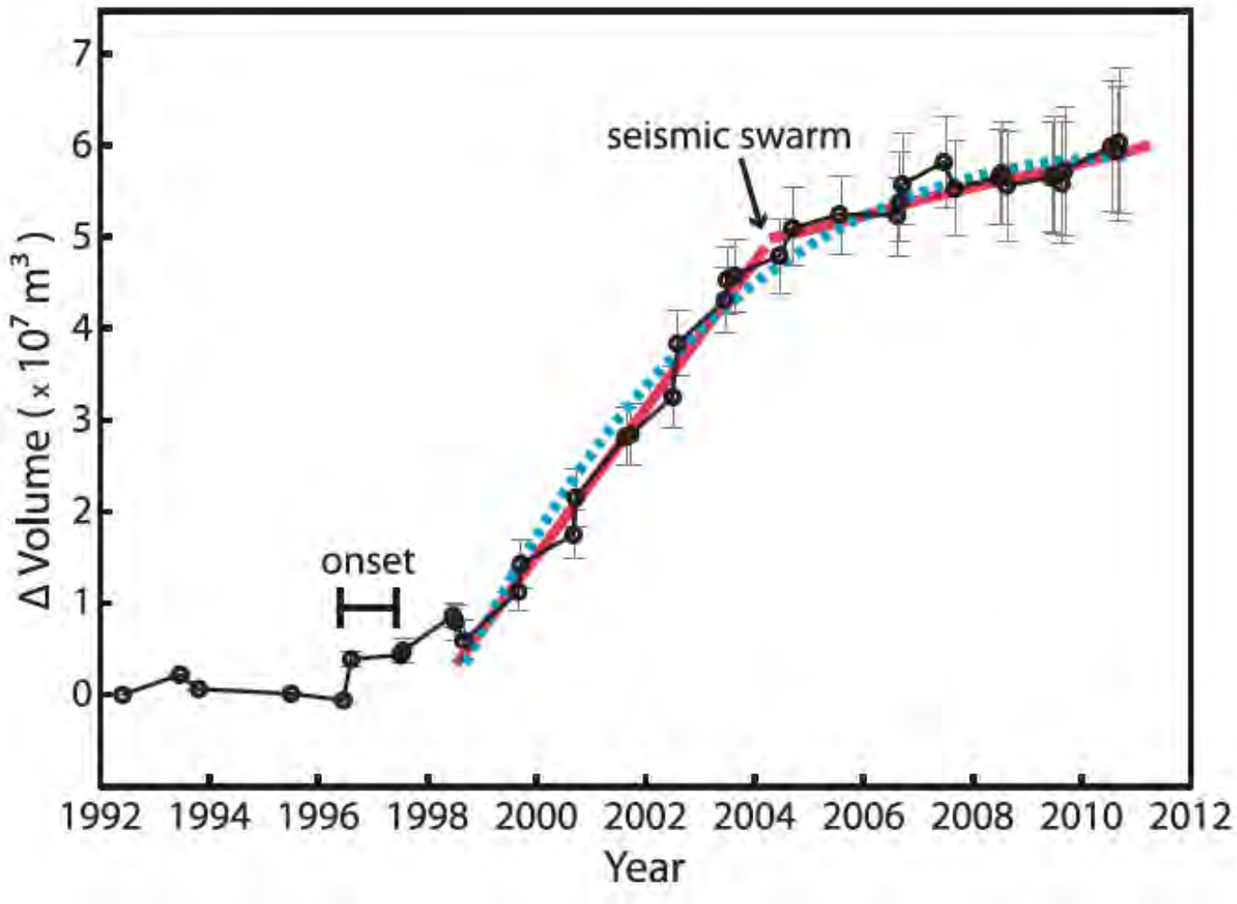
eruptions may be triggered by either tectonic or recharge events

Evidence of shallow intrusion - S. Sister



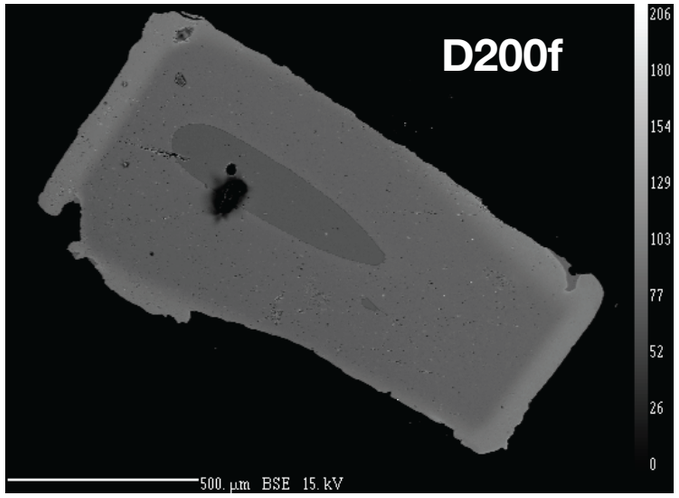
Can be modelled as a sill at 7 km (~150 MPa)

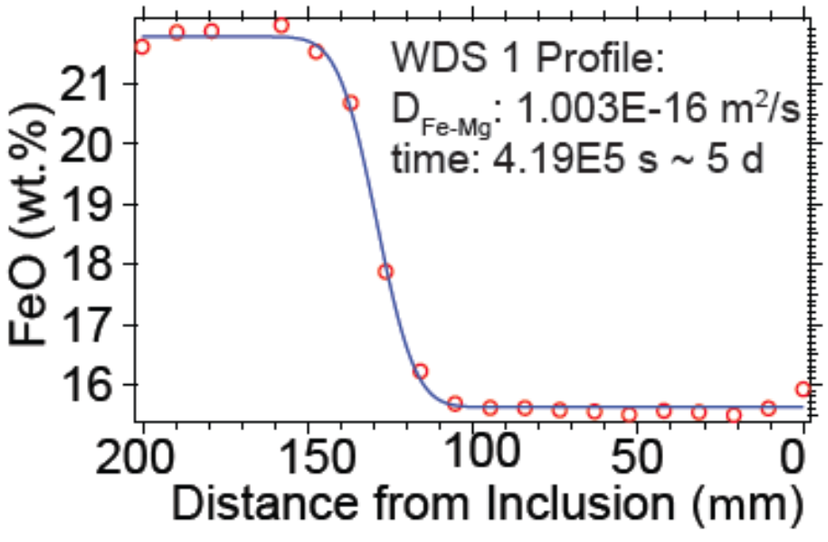
Volume: ~ .06 km^3

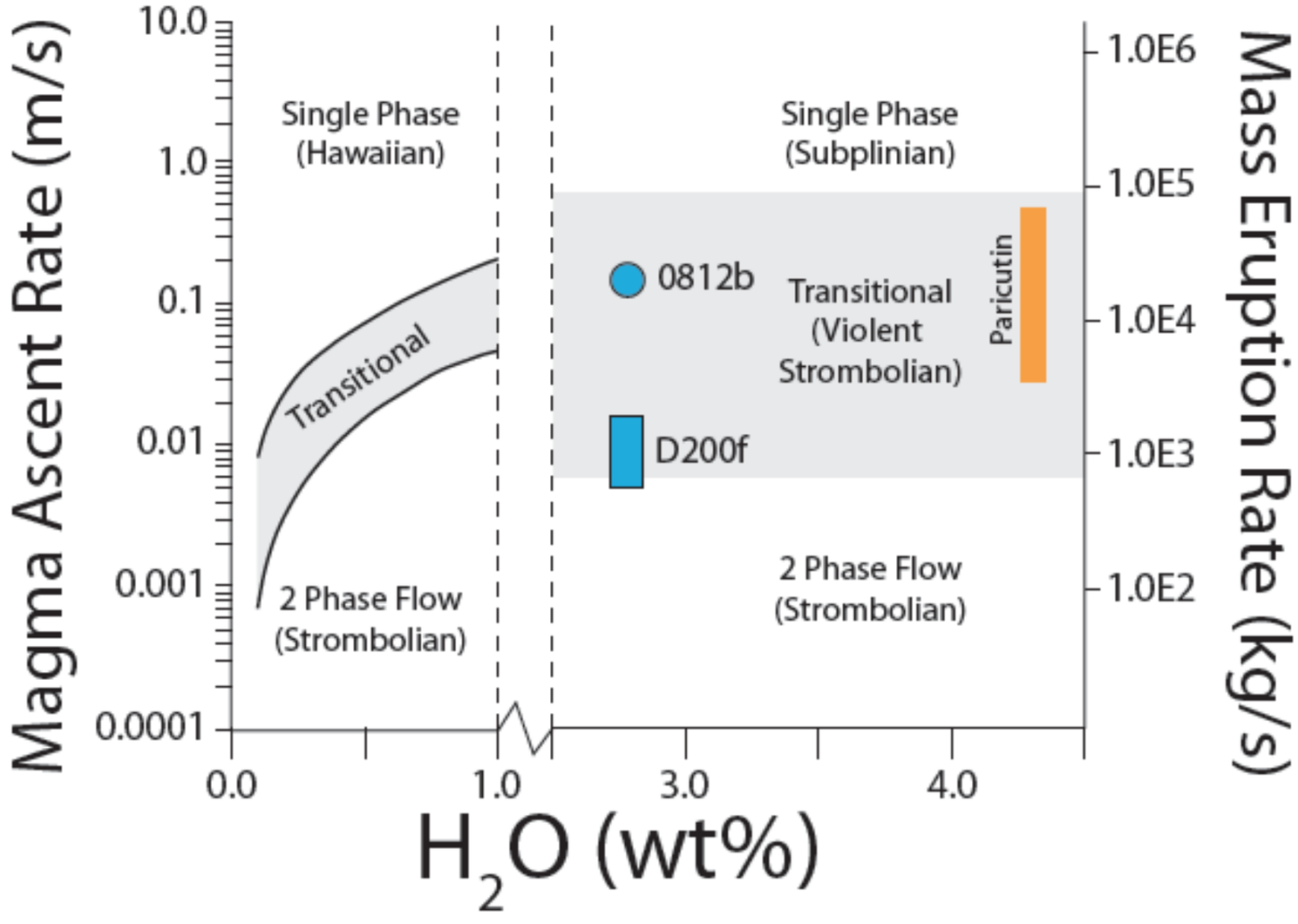


Riddick & Schmidt (2011)

Once triggered, magma ascent is rapid

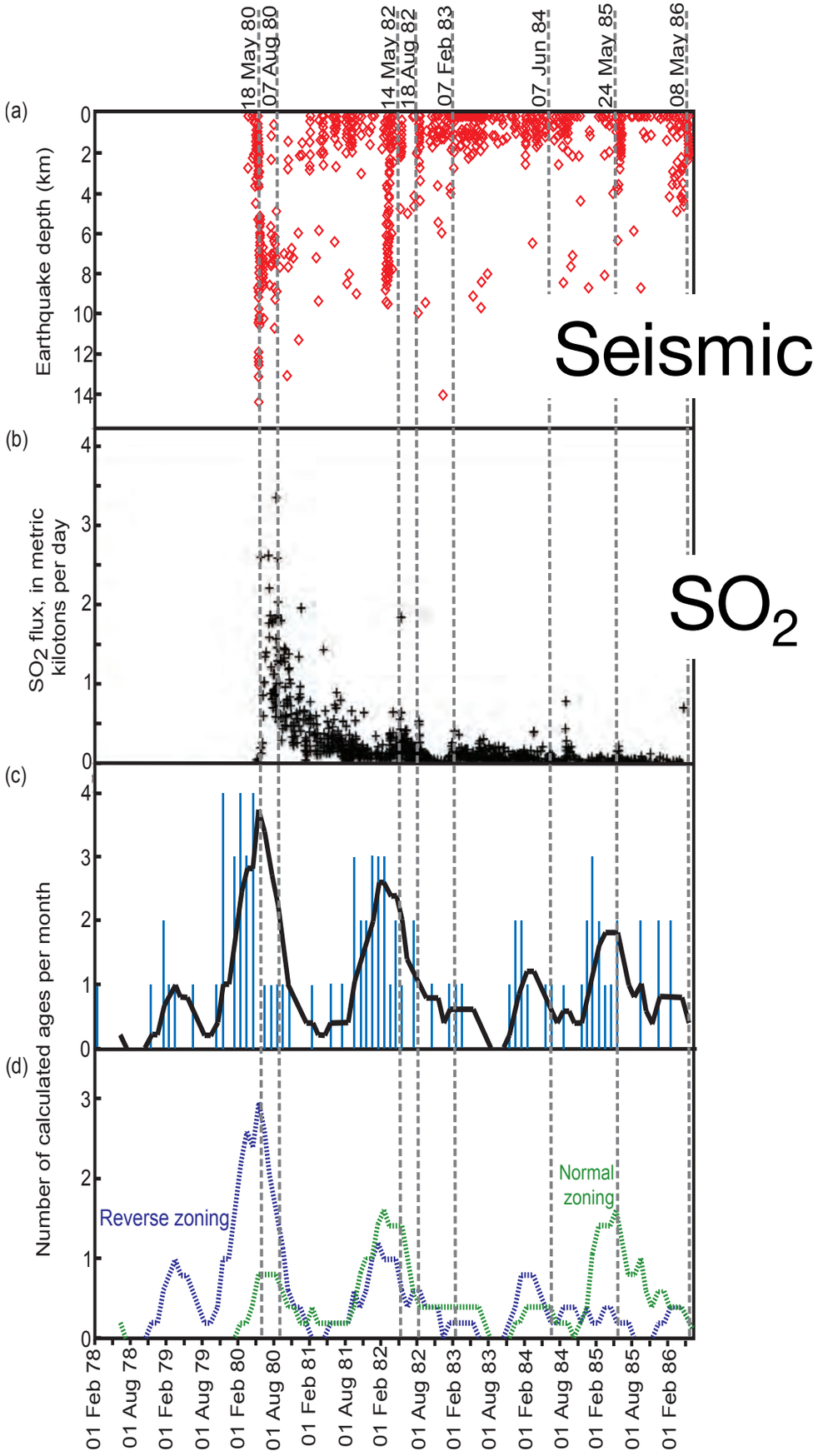






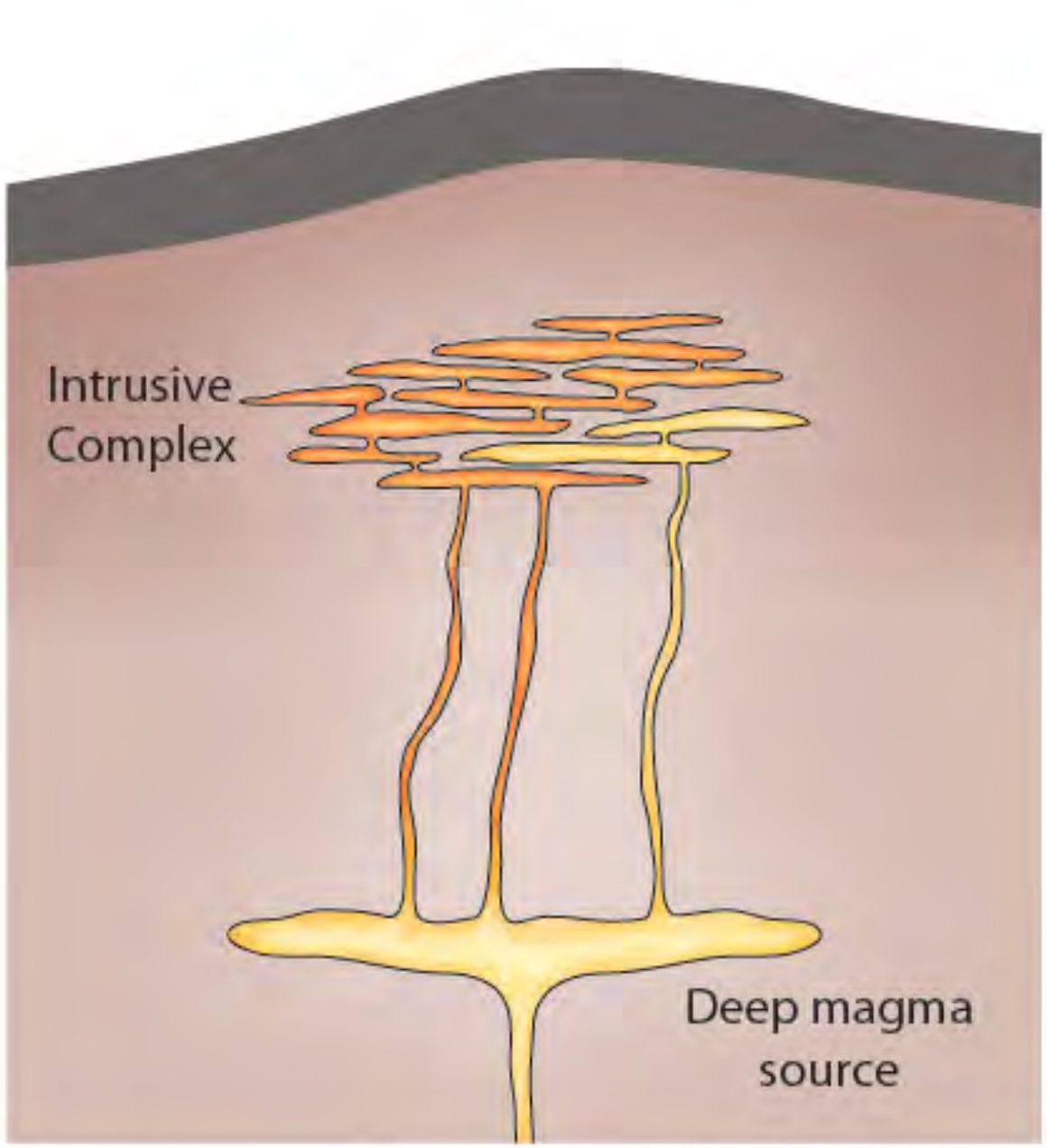
Ruscitto et al. POSTER

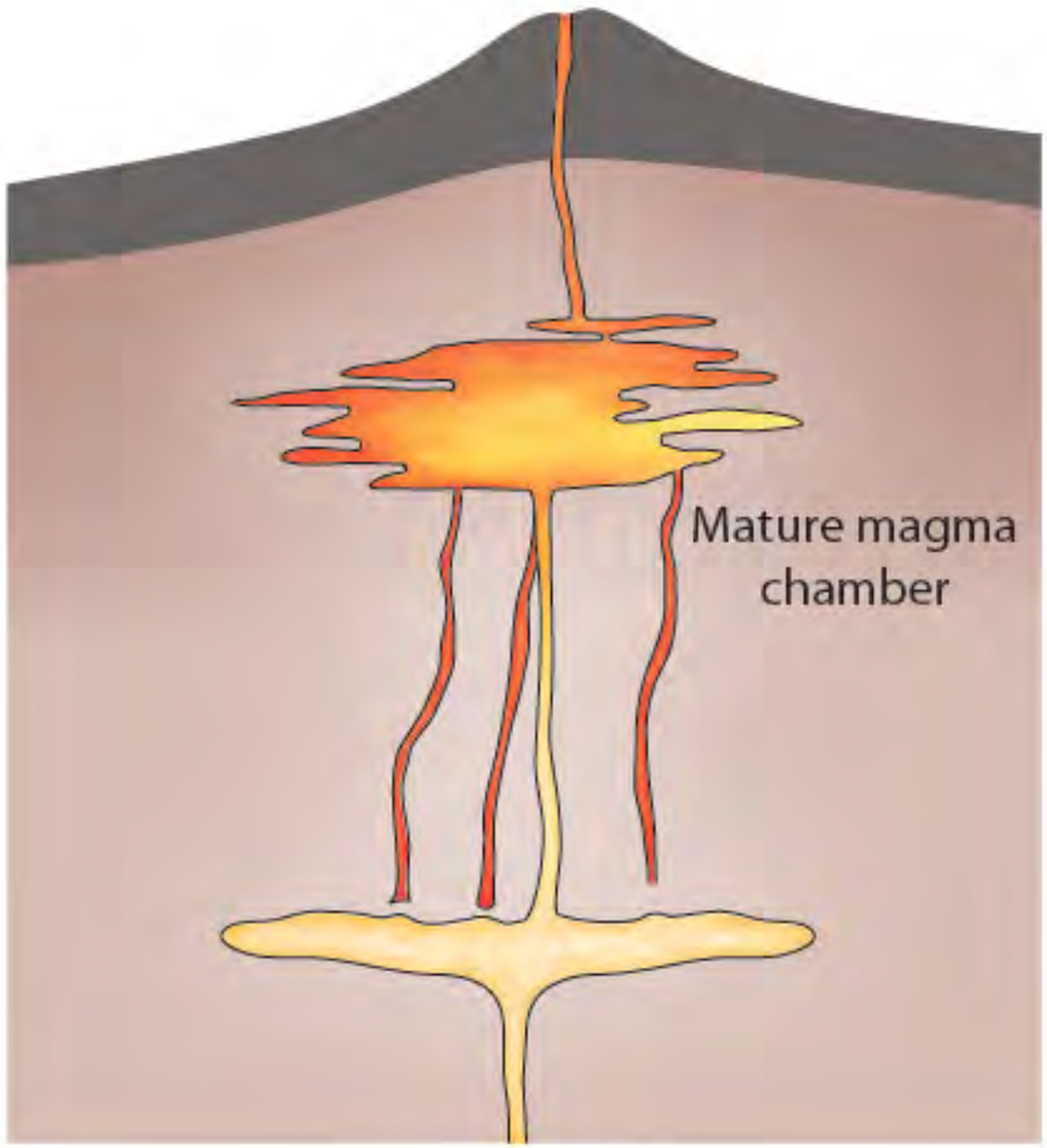
Diffusion time scales record both magma recharge and gas fluxing

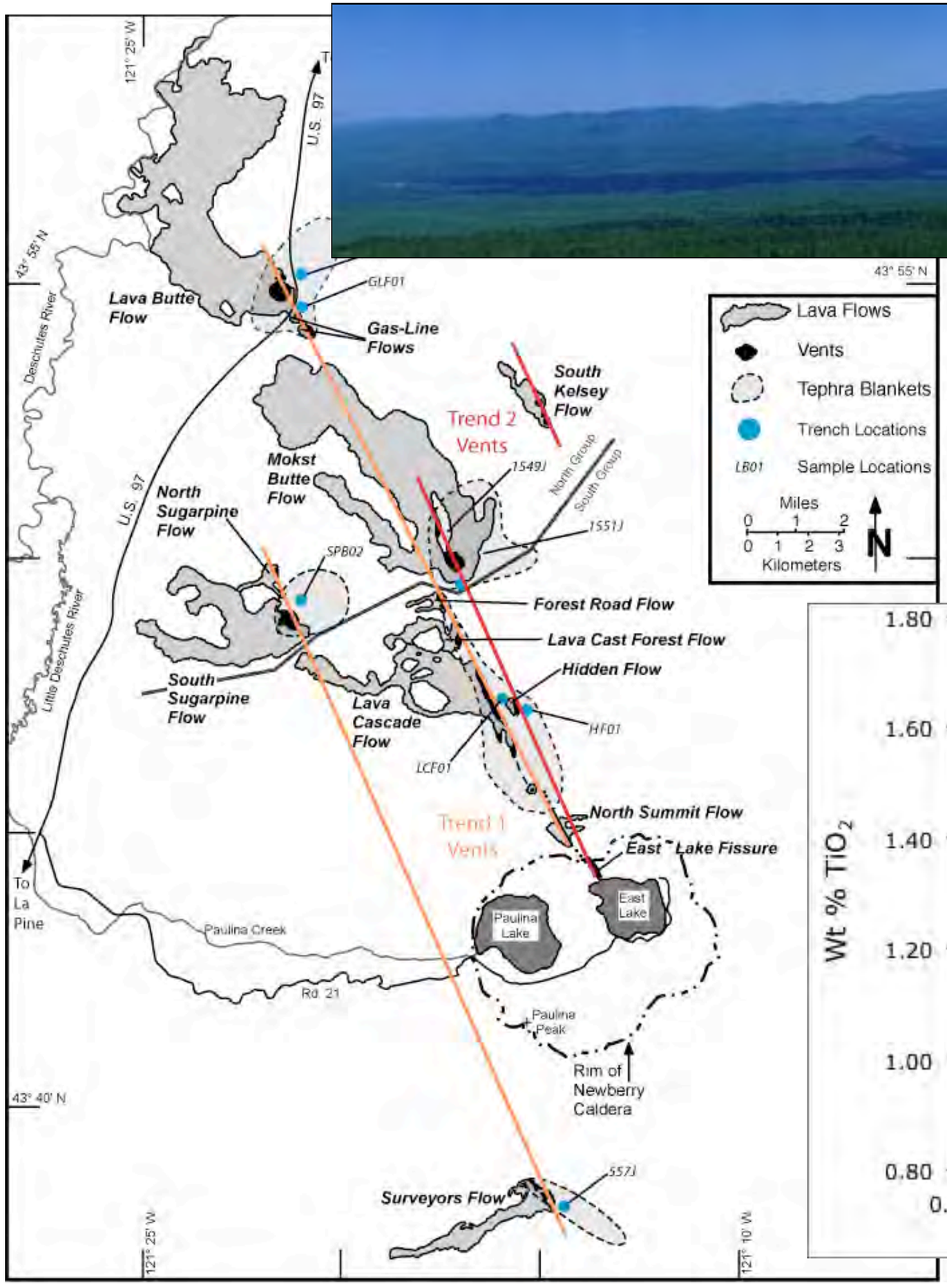


Saunders et al. (in revision)

Development of magma reservoirs



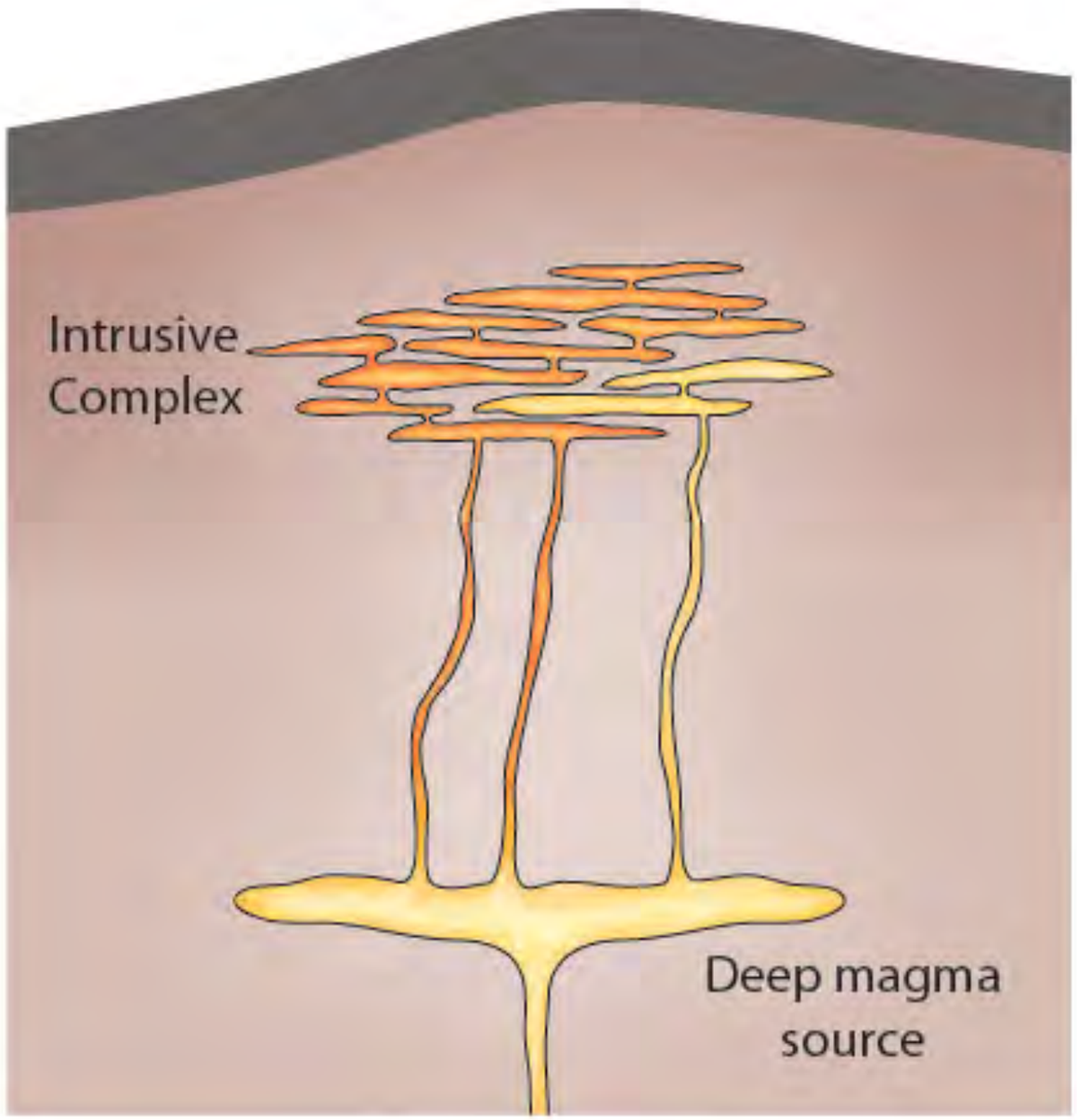


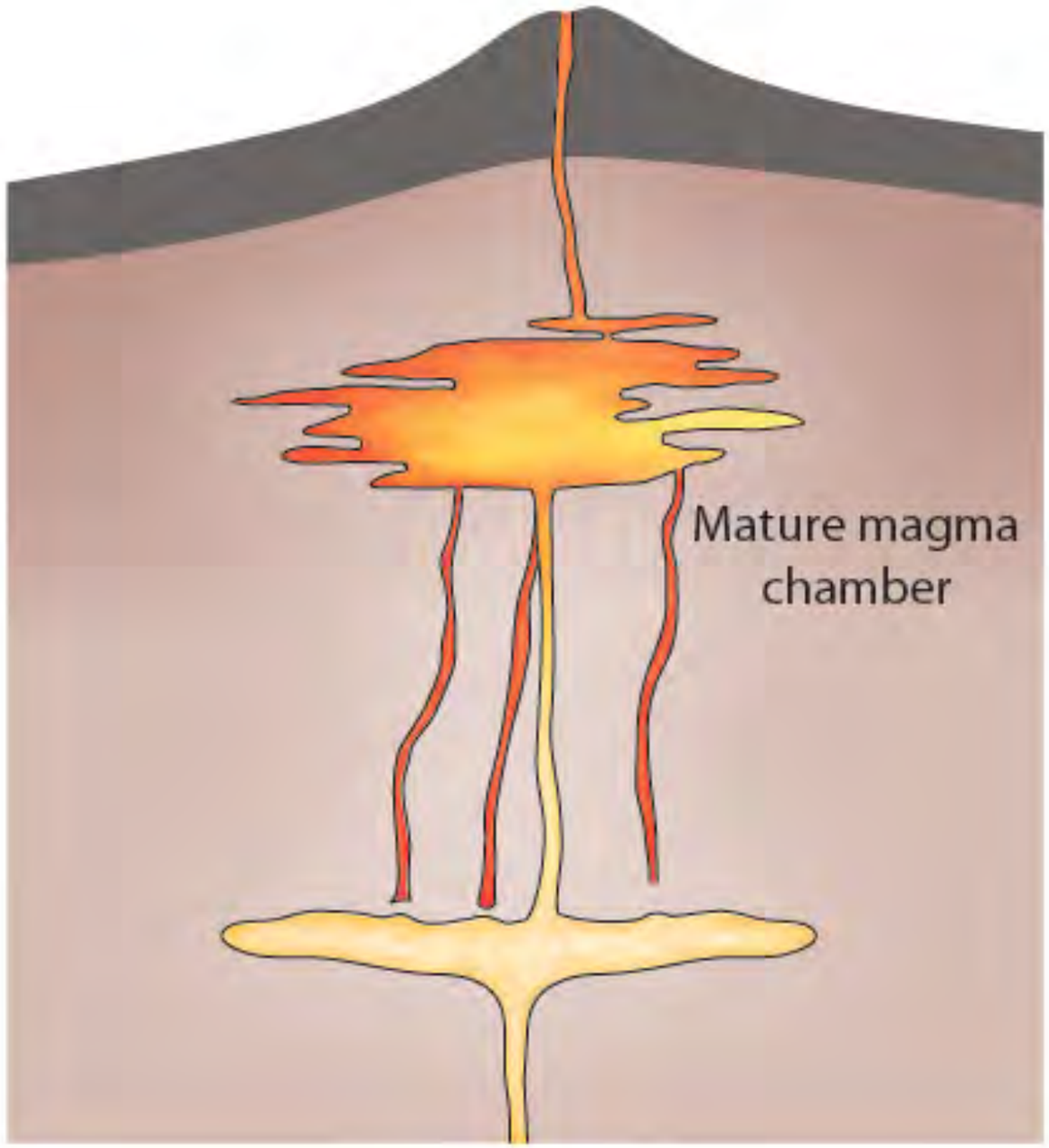


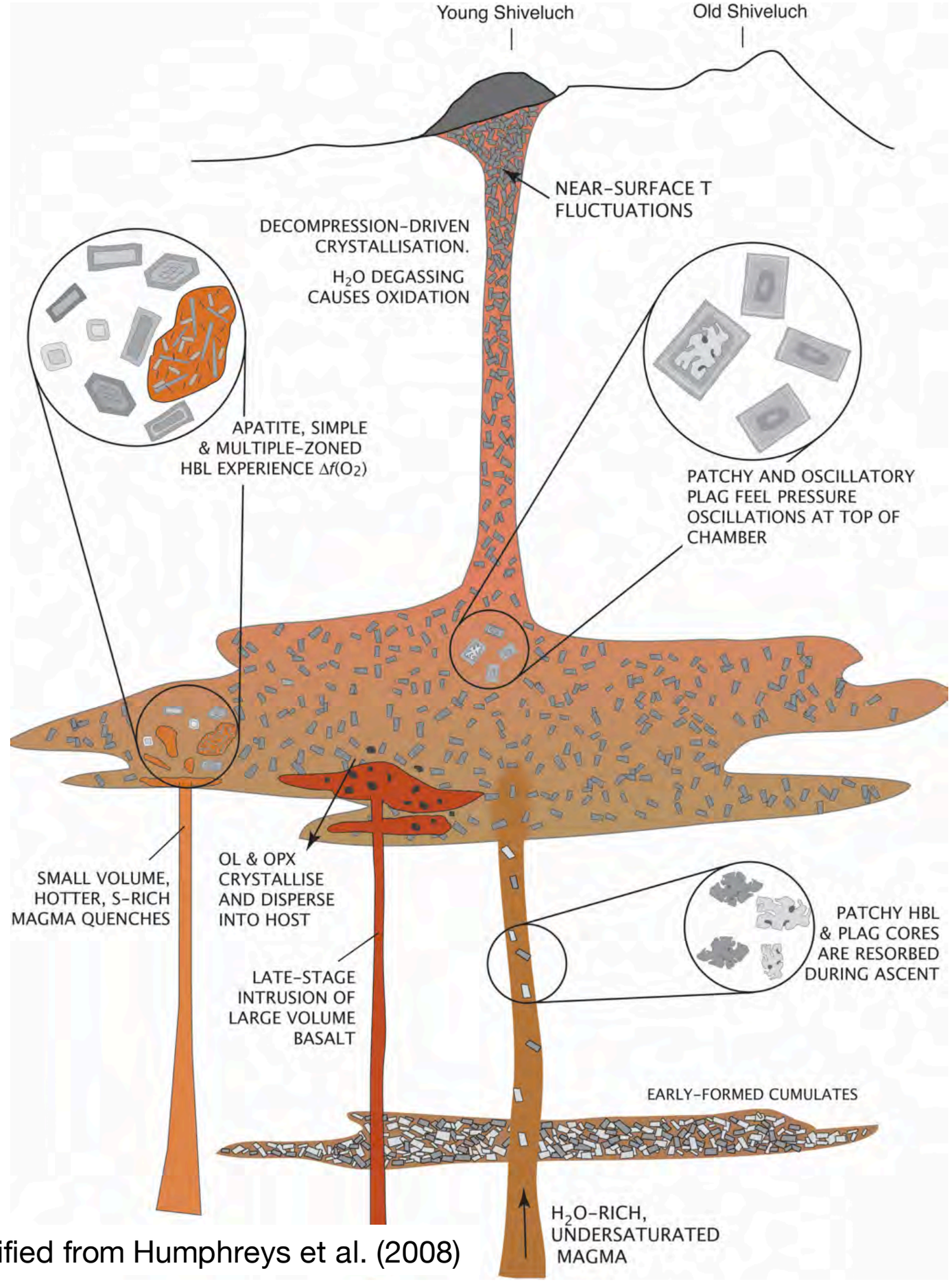
Newberry Volcano
c. 7000 ybp

Mckay et al. (in prep.)

Development of magma reservoirs

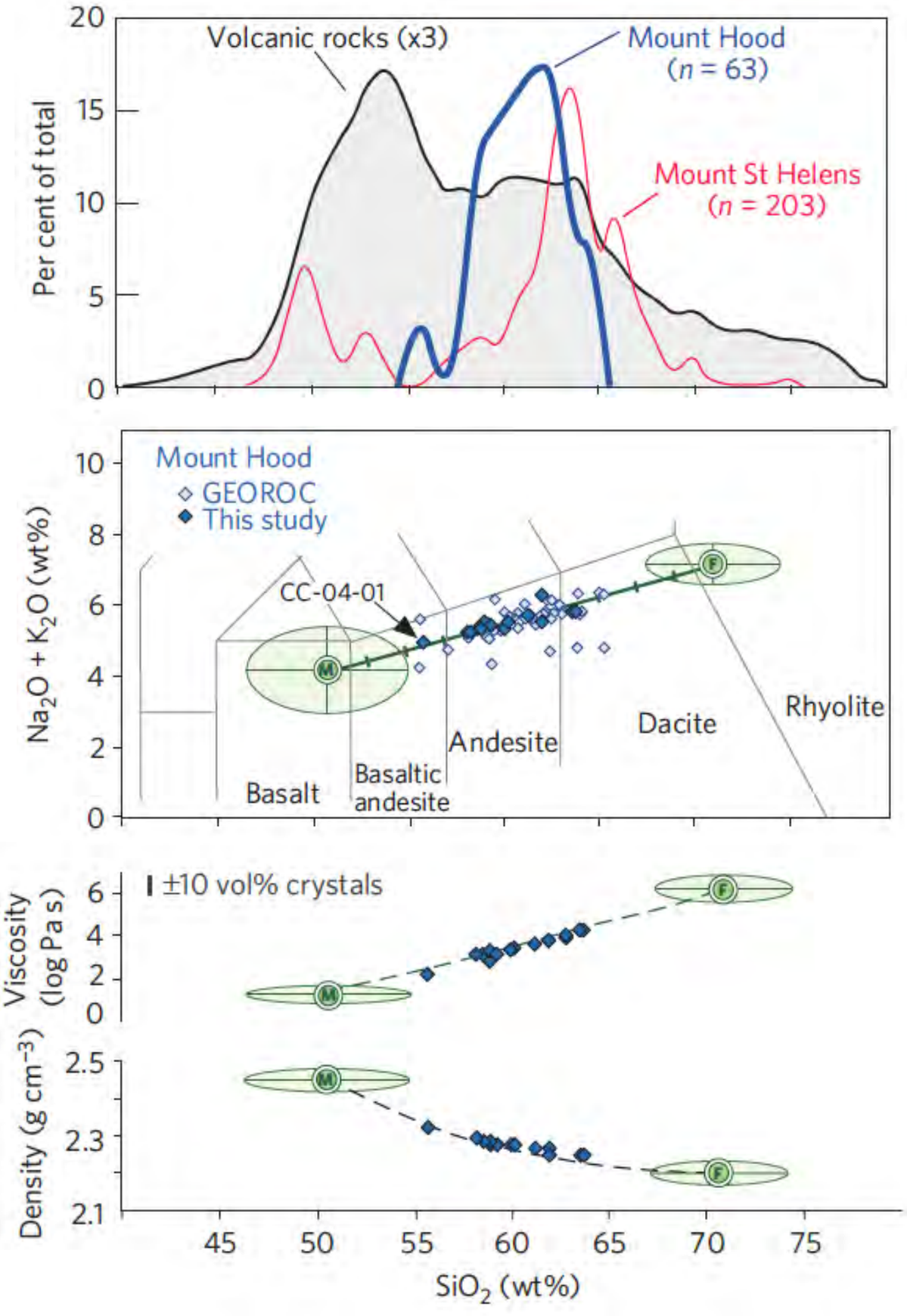




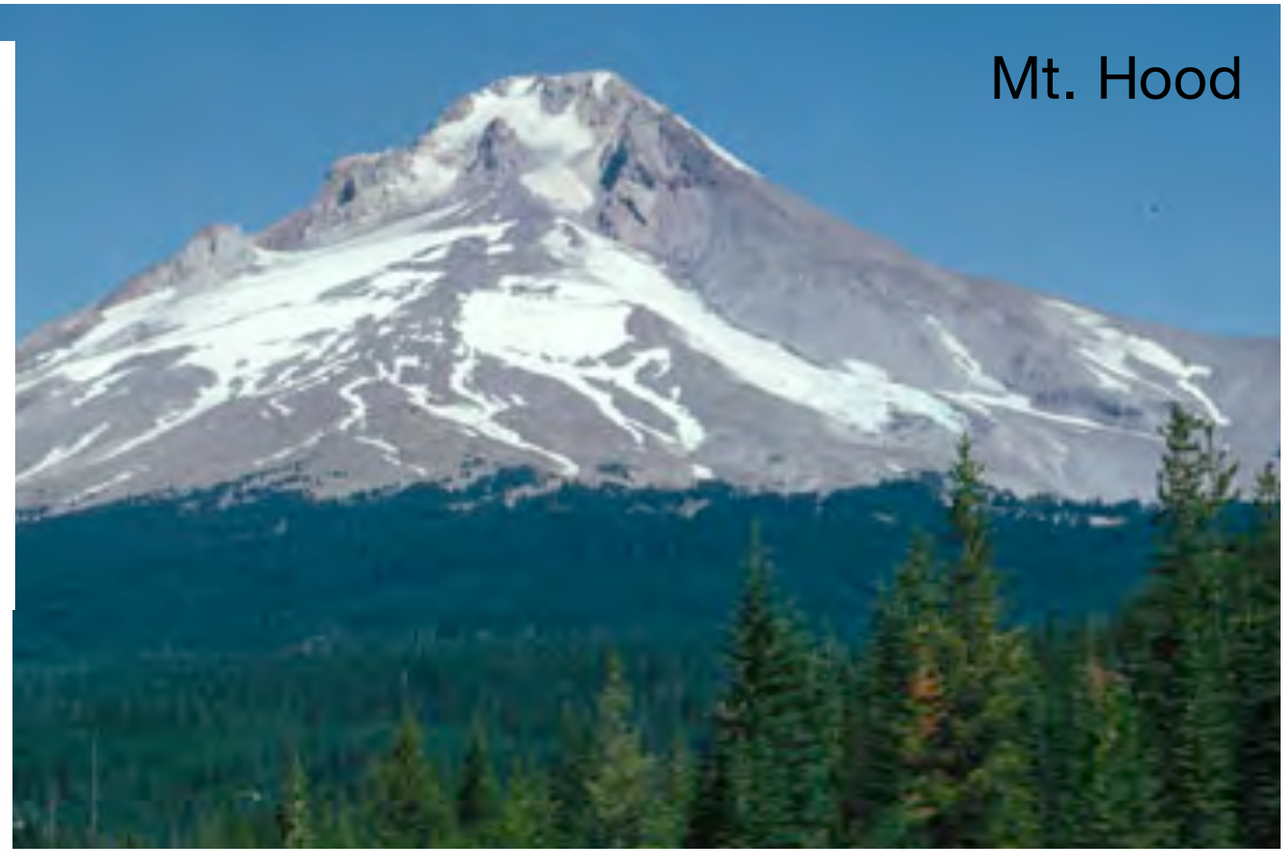


modified from Humphreys et al. (2008)

Once developed, subvolcanic magma storage systems play a complex role in magma evolution and eruptibility



Kent et al. (2010)



Magma storage systems as sites of recharge, mixing and homogenization...

Eruptions modulated by recharge volume? frequency?

What is the role of the lithosphere?

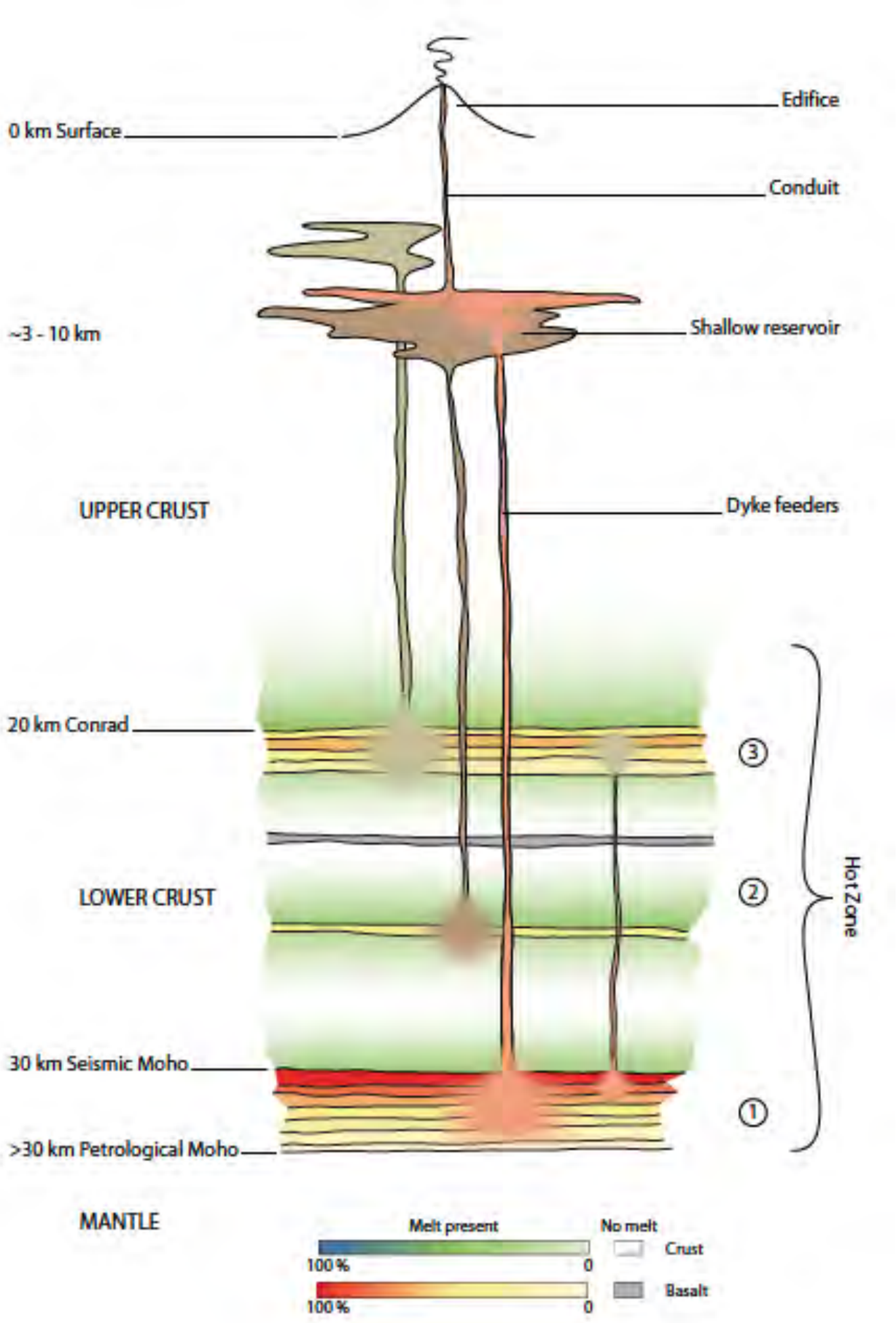
- rates and volumes of magma transfer to upper crust (& surface)

- trapping magma batches

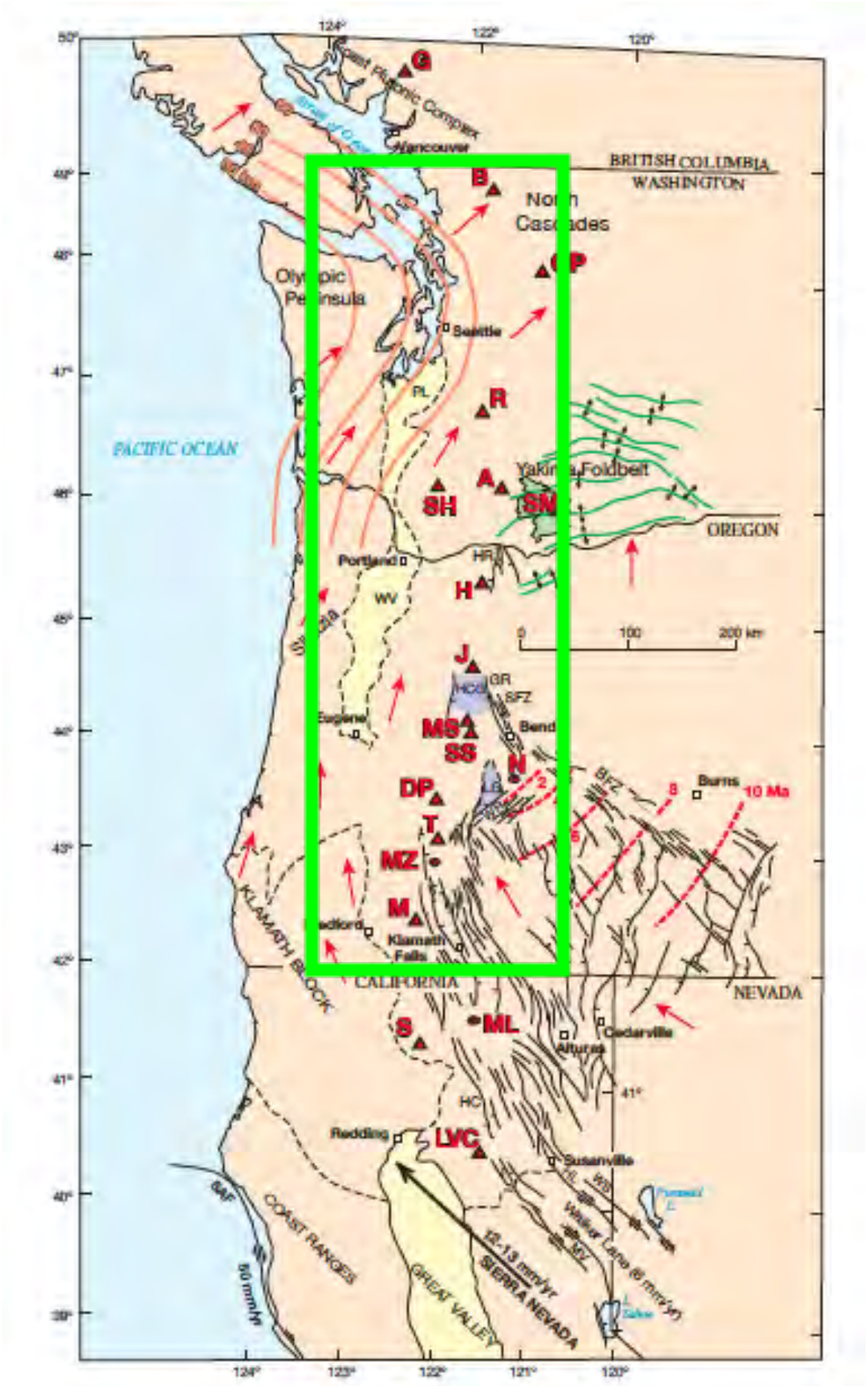
- composition of magma batches

- focusing of magma transport pathways

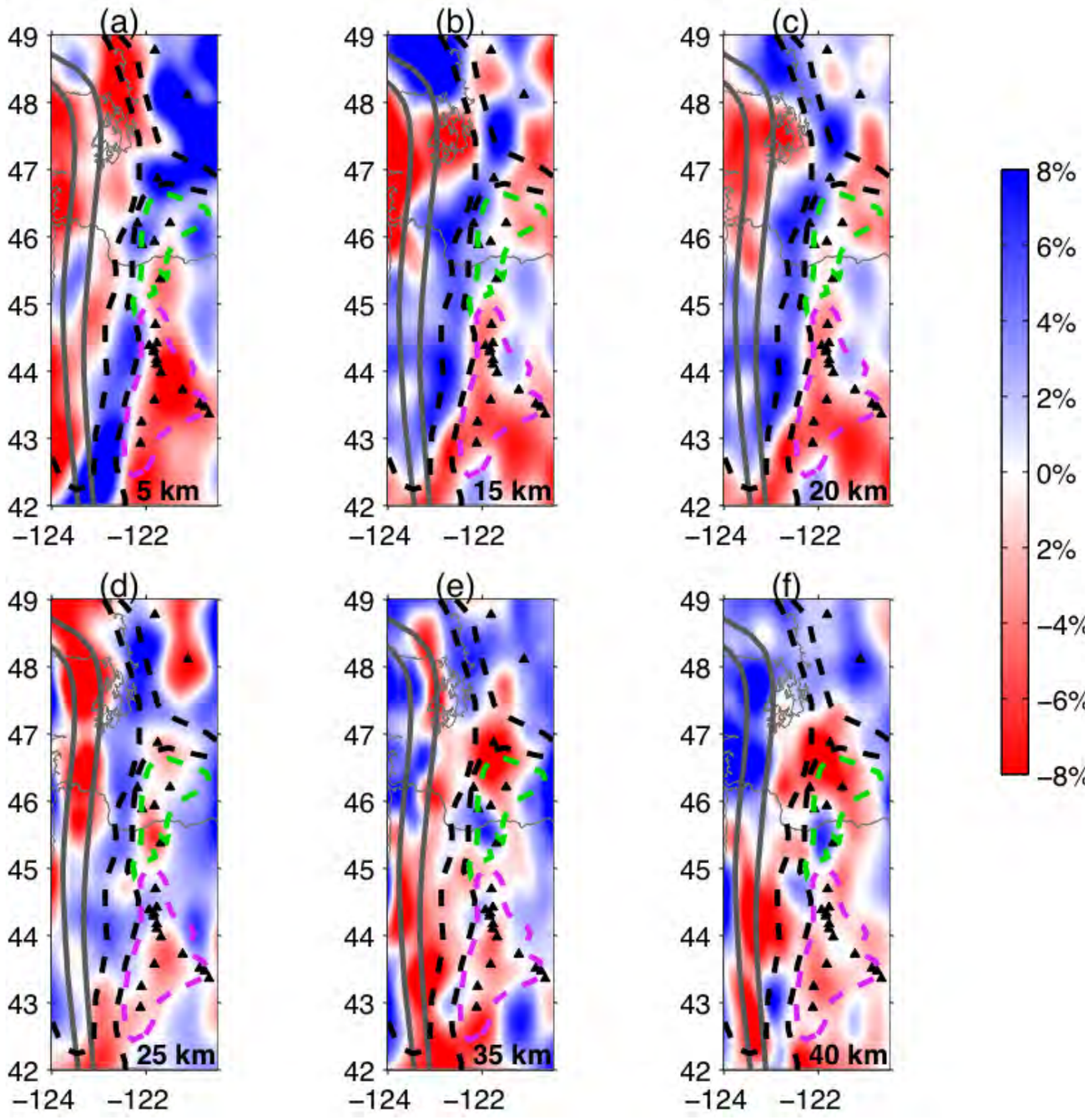
- longevity of individual volcanic centers



Annen et al. (2006)



Washington: volcano-centered, slow in the lower crust & fast in the upper crust (intrusions)



Magmatically active Oregon Cascades: slow at all depths

Gao et al. (2011)