Ongoing GeoPrisms Aleutian Volcano Research

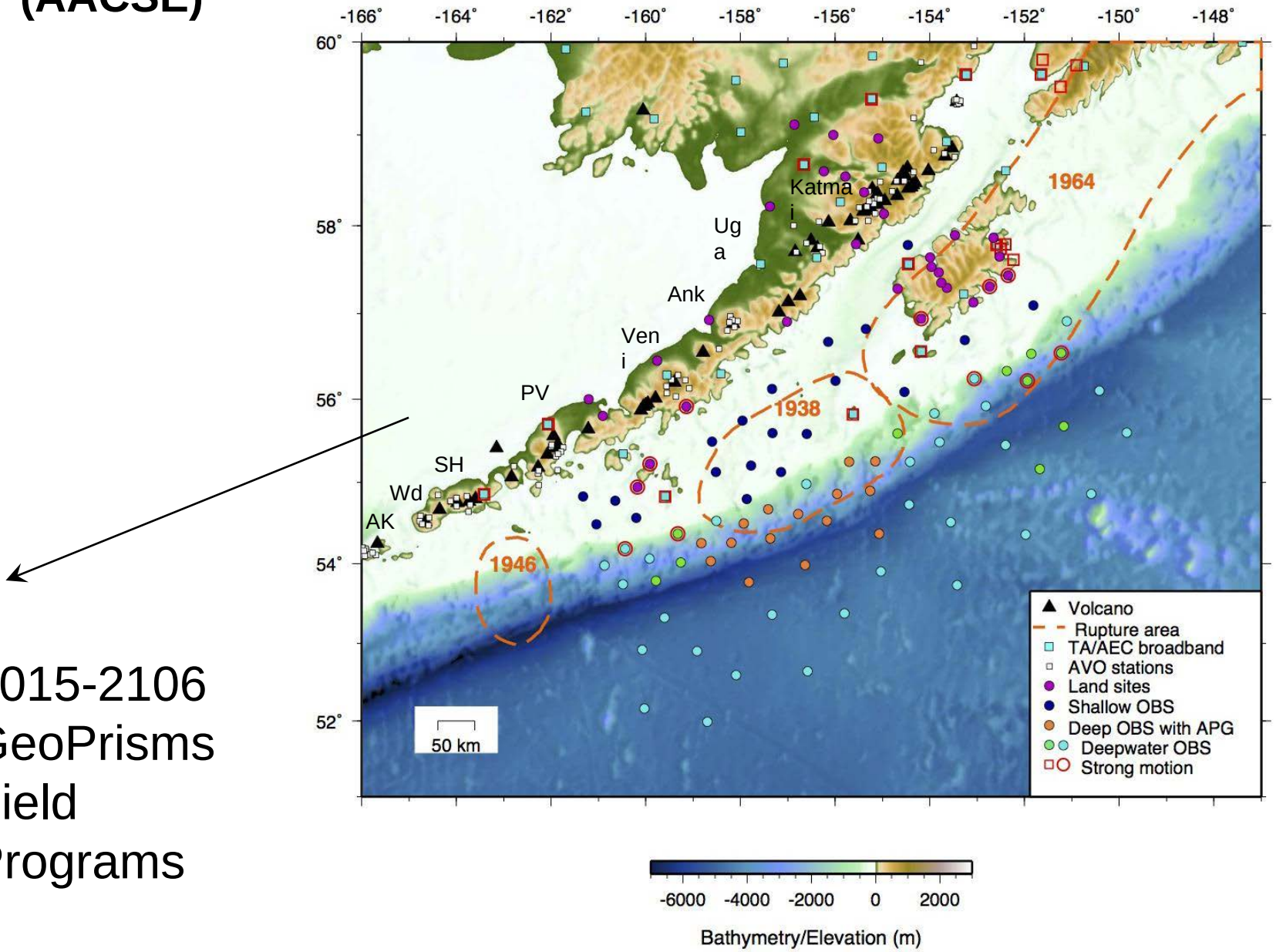
Cleveland Volcano,
Islands of Four Mountains,
Alaska.
Photo: Anna Barth

With Contributions From:
Daniel Rasmussen (LDEO)
Diana Roman (DTM-Carnegie)
John Power & Matt Haney (USGS, AVO)
Elizabeth Cottrell (Smithsonian)

“Slab to the Surface”

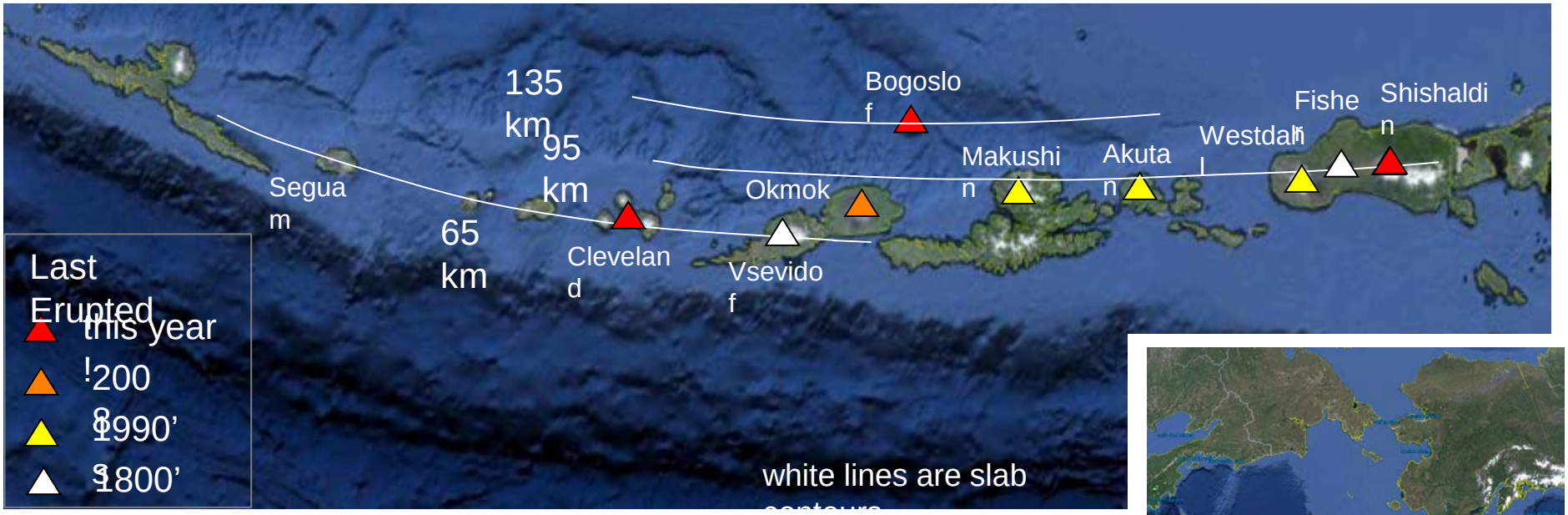
Terry Plank, *Lamont Doherty Earth Observatory of Columbia University*

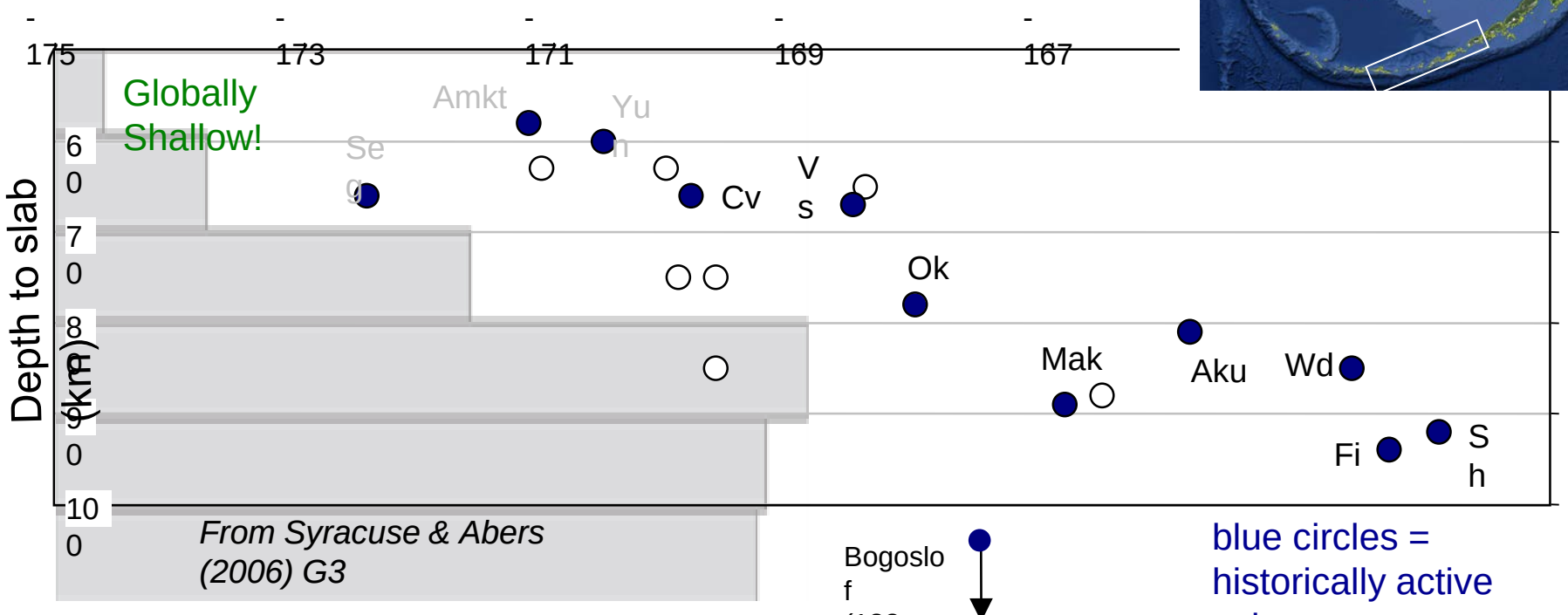
Alaska Amphibious Community Seismic Experiment (AACSE)



2015-2106 GeoPrisms Field Programs

Eastern Aleutians: Depth to the Slab Varies Smoothly Along Strike



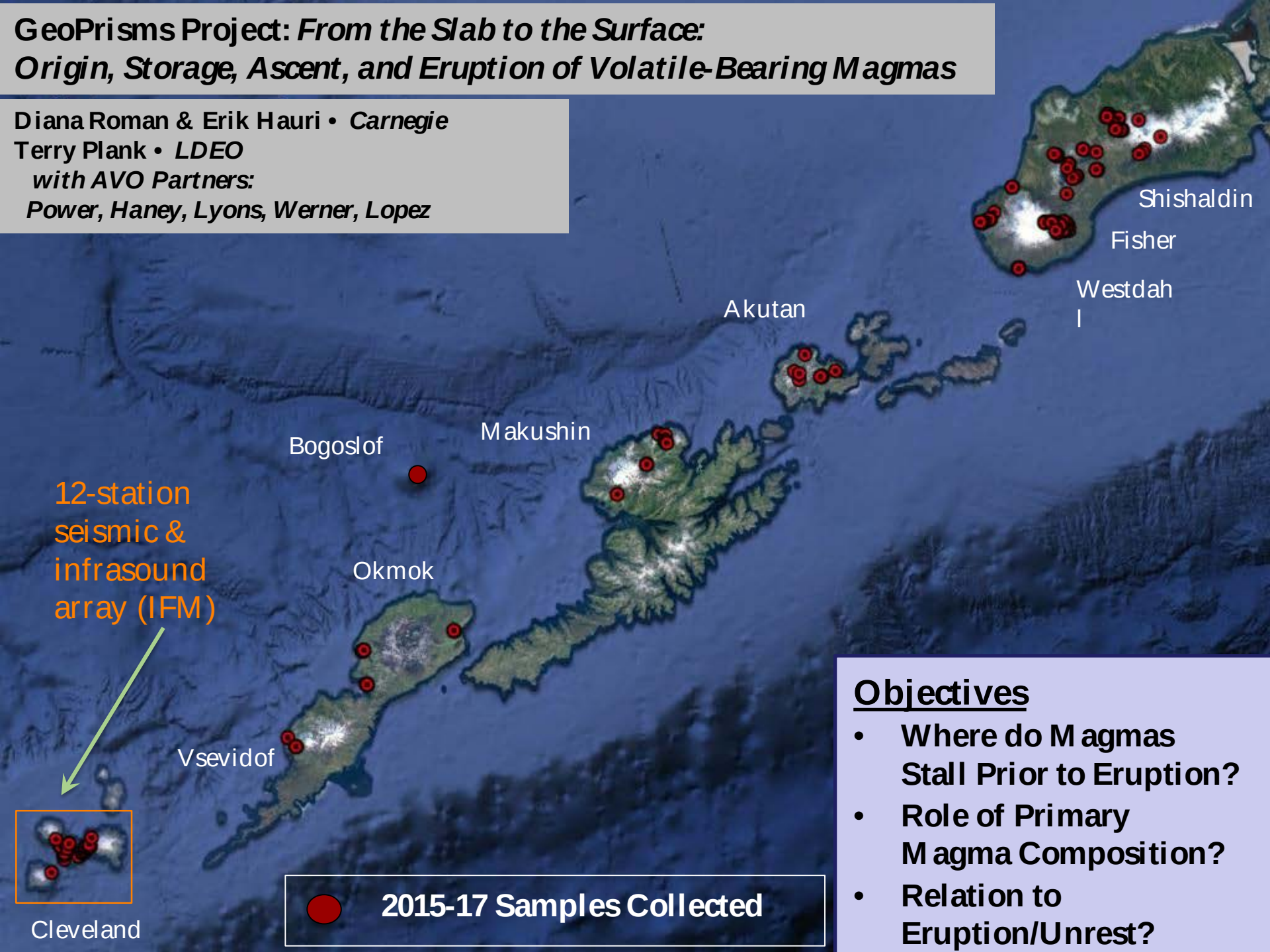


NSF/GeoPrisms-AVO/USGS-Deep Carbon Obs. Joint Expeditions

2016 Team on the Maritime Maid with the Maritime Helicopter (Initial Deployments were in

GeoPrisms Project: *From the Slab to the Surface: Origin, Storage, Ascent, and Eruption of Volatile-Bearing Magmas*

Diana Roman & Erik Hauri • *Carnegie*
Terry Plank • *LDEO*
with AVO Partners:
Power, Haney, Lyons, Werner, Lopez



Objectives

- **Where do Magmas Stall Prior to Eruption?**
- **Role of Primary Magma Composition?**
- **Relation to Eruption/Unrest?**

Three Nuggets:

1. The Run-Up to Eruption: Shishaldin 1999

2. The Depth of Magma Stalling: Cleveland 2015/6

3. Connecting the Volcano to the Slab

Cleveland Steams from the Maritime Maid

June 12, 2017: Kim Angeli. AVO Image

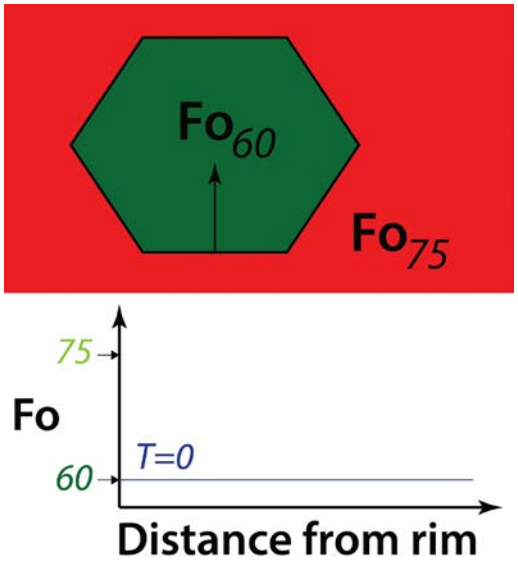
1. The Run-Up to Eruption: Shishaldin 1999

Shishaldin 1999

Photo: McGimsey, R. G.

VEI 3 Eruption
No Clear Deformation
Abundant Seismicity

"Crystal Clocks"



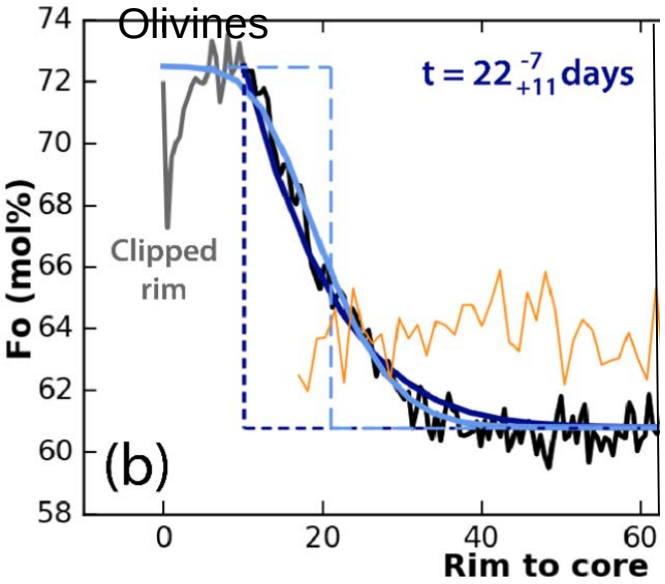
Fo = forsterite composition of olivine
= Mg/(Mg+Fe)

Mixing Event: Recharge Magma Drives Crystal to Increase in Fo

Crystal Resides, Then Erupts

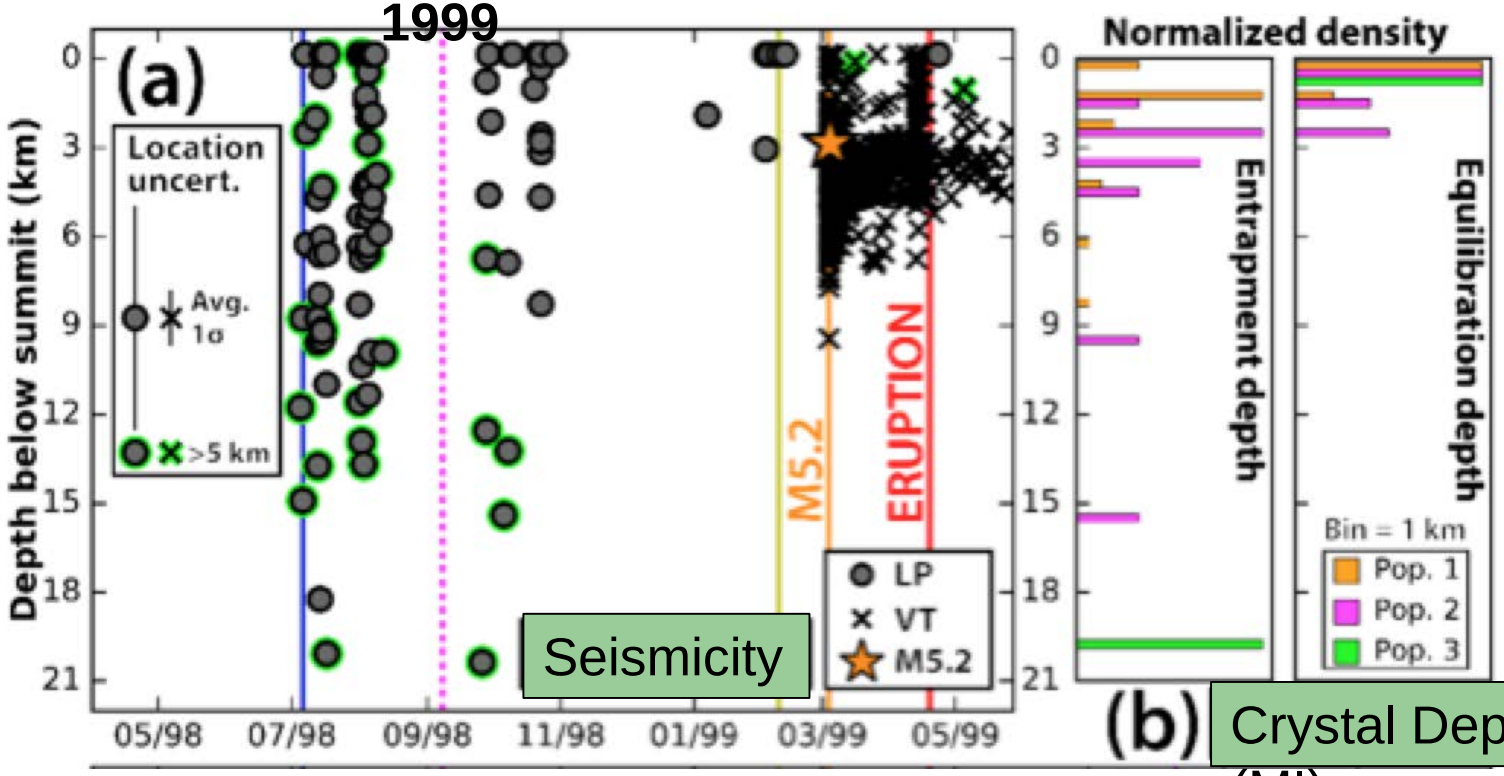
Shape of Profile Reflects Mixing-to-Eruption Timescale

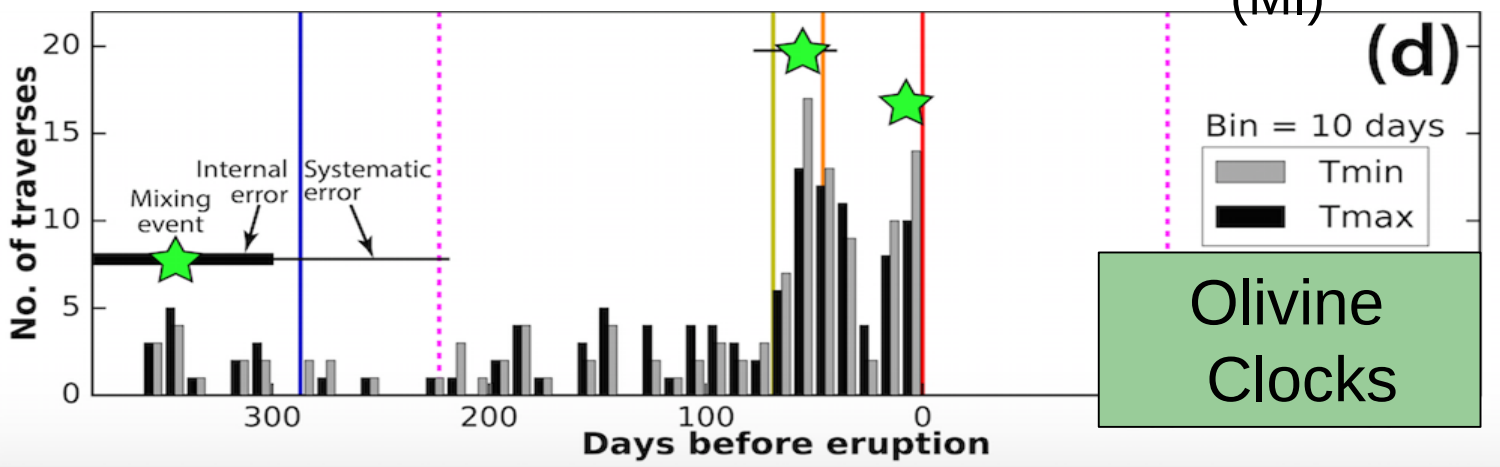
Chemically Zoned Olivines



This Olivine Crystal Erupted 22 days After a Recharge Event

1. The Run-Up to Eruption: Shishaldin 1999



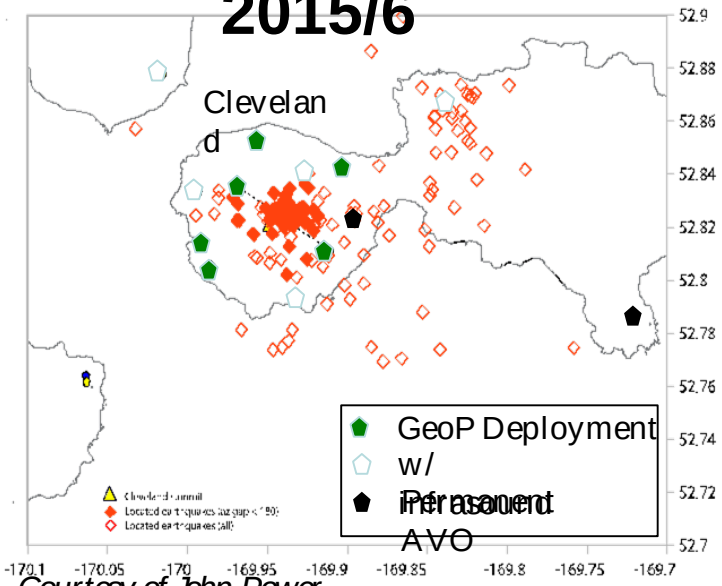


Seismic Events Relate to Magma Recharge

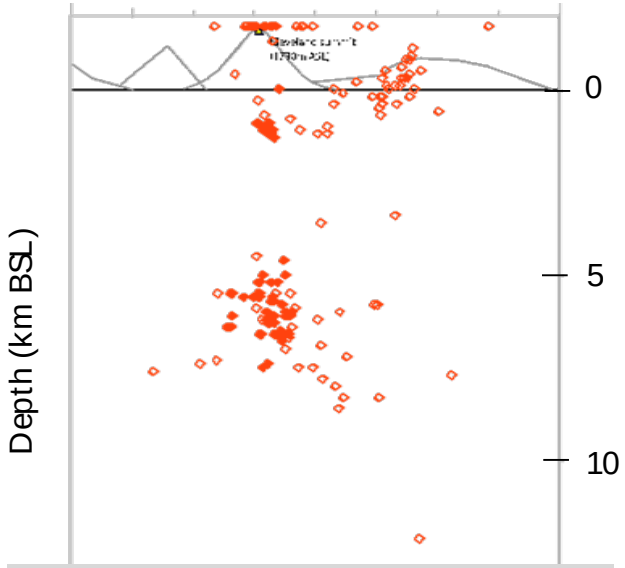
Over 9 Months of Run-up

Rasmussen, Roman, Hauri, Plank, Bodnar, Power – EPSL in

2. The Depth of Magma Stalling: Cleveland 2015/6



Courtesy of John Power

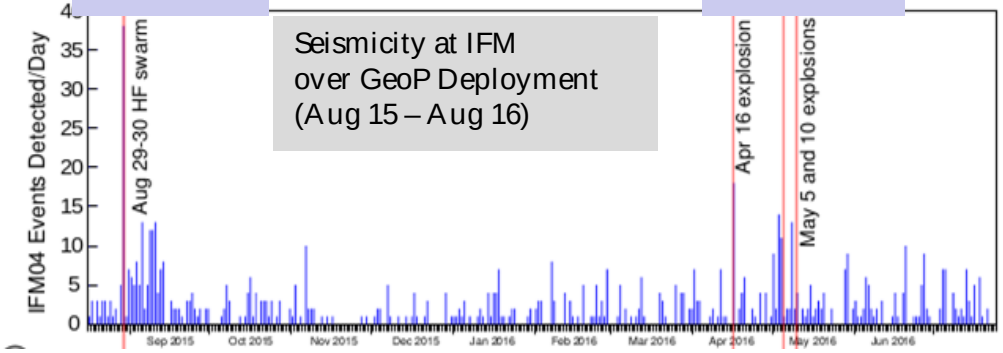


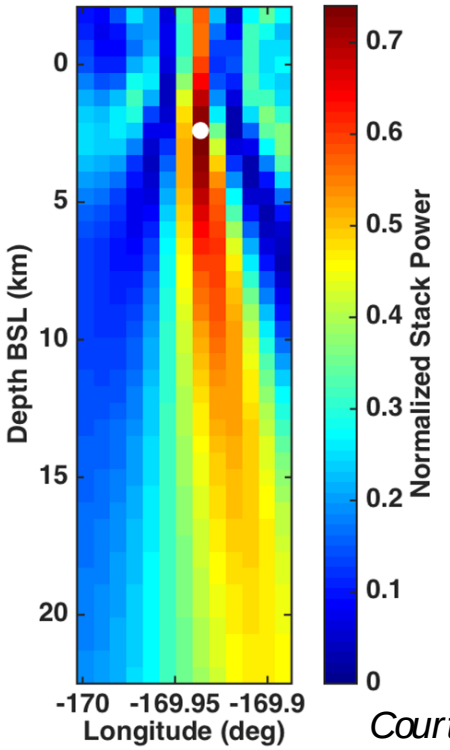
VT Earthquakes Cluster at 5-7 km Beneath Cleveland Volcano

Aug 2015 Swarm

Spr 2016 Eruptions

Seismicity at IFM over GeoP Deployment (Aug 15 – Aug 16)





Courtesy of Matt Haney

Back-Projection of Long Period Event 3 hours before April 2016 Explosion

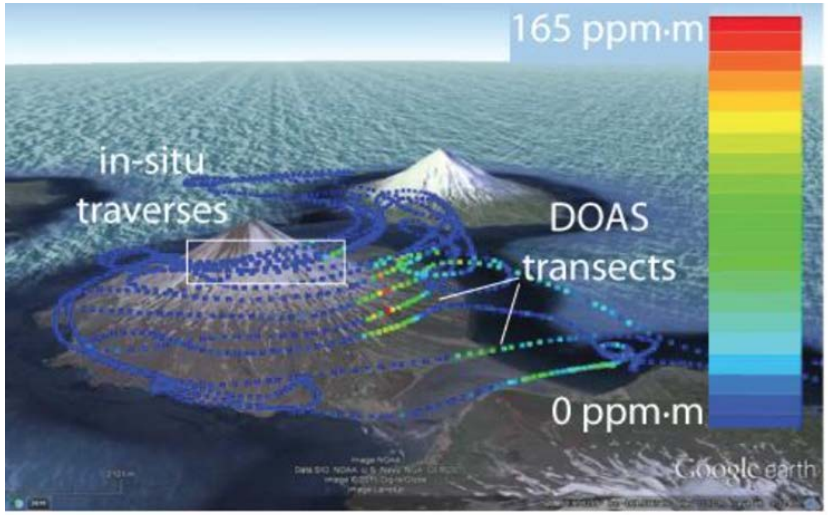
Shallower Depth of 2.5 km BSL

2. The Depth of Magma Stalling: Cleveland 2015/6

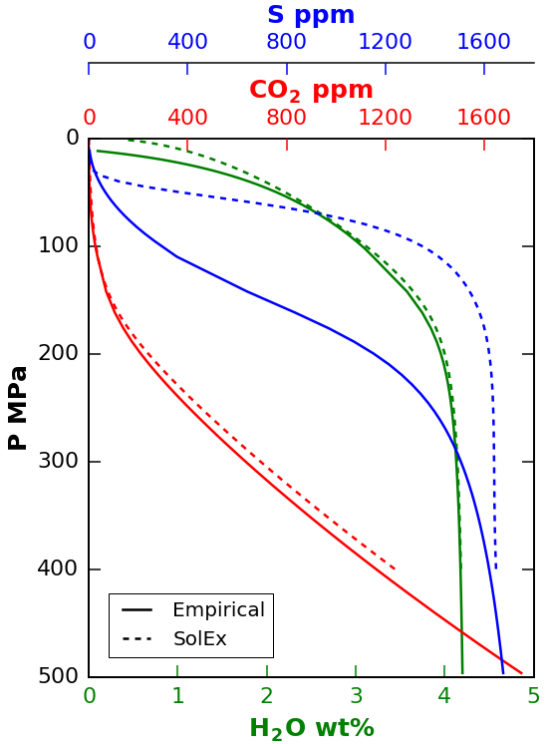
Re-homogenizing the Melt Inclusion:
Accurate Pressure of Entrapment

see Rasmussen this AGU! Friday 8:45 am V51G

SO_2 *emission rate*



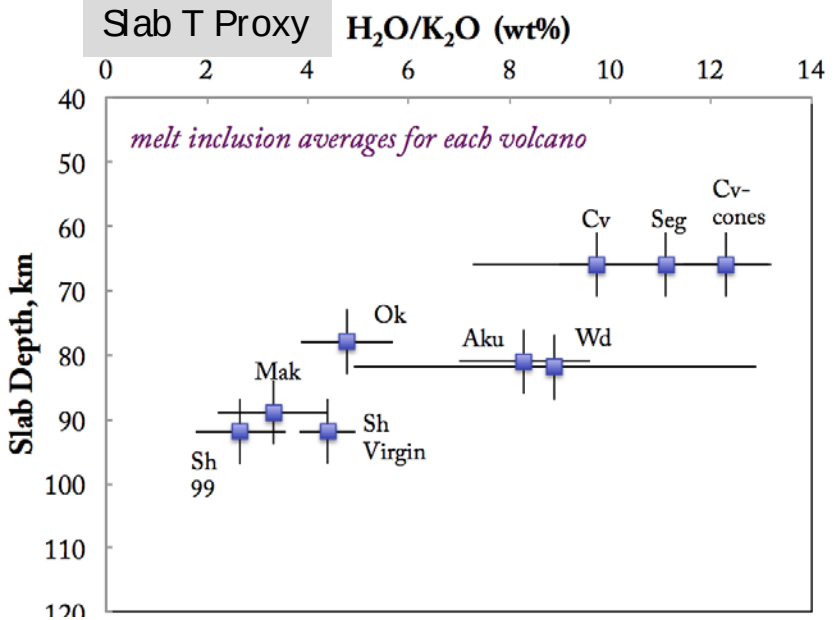
see also Werner et al. (2017) JVGR



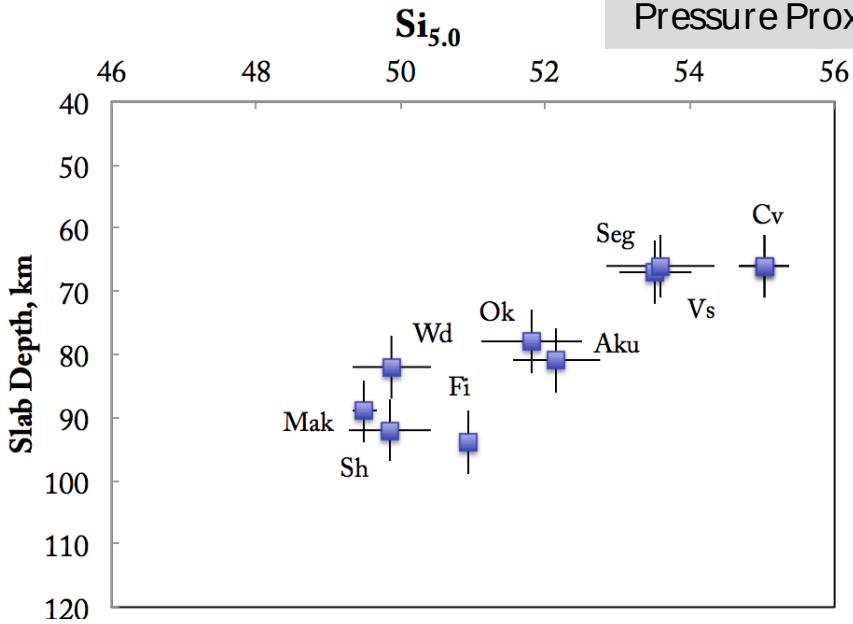
Using Melt Inclusions to Define Depth (P) of Magma Degassing

3. Connecting the Volcano to the Slab

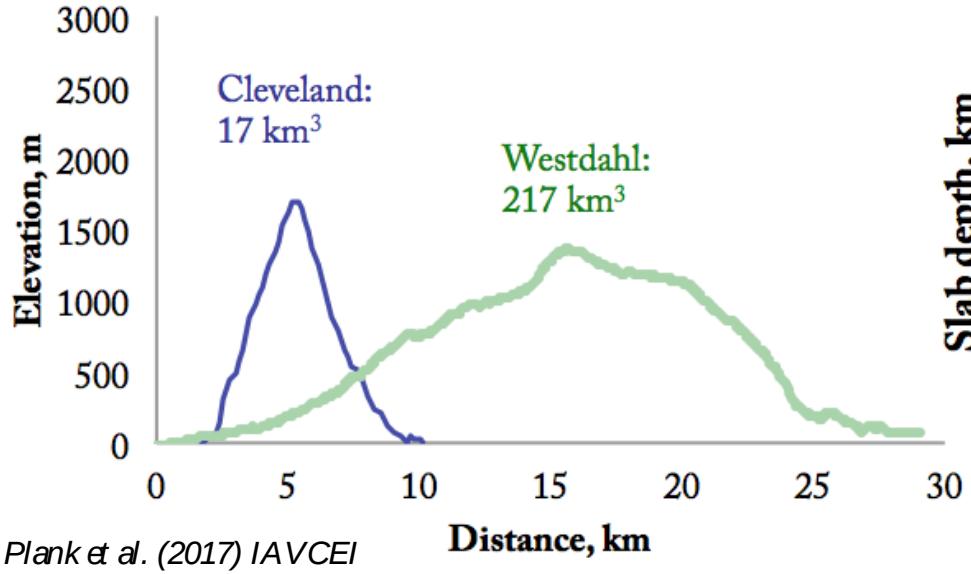
Slab T Proxy

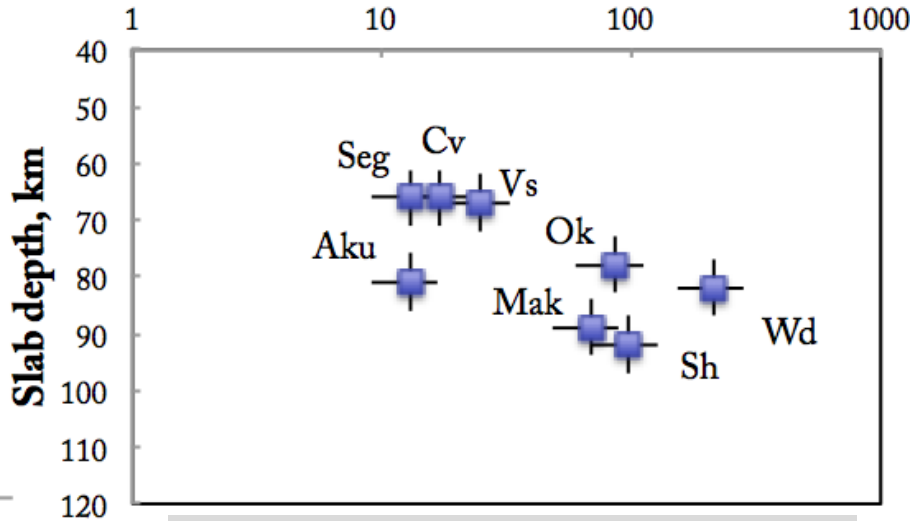


Mantle-Melting Pressure Proxy



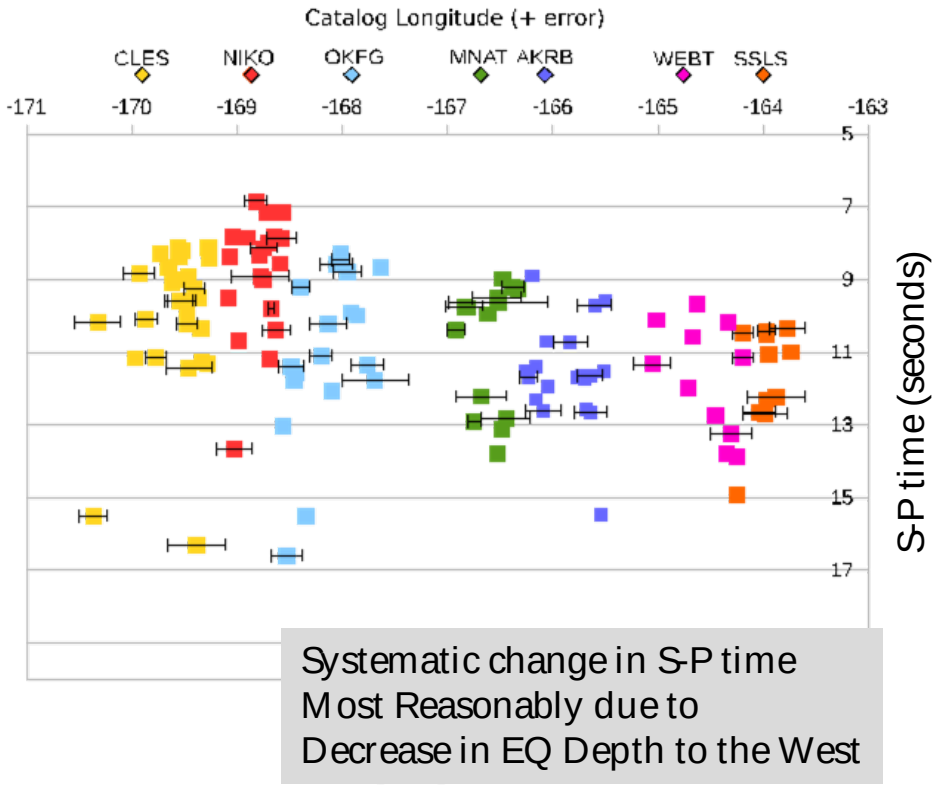
Volcano Volumes!



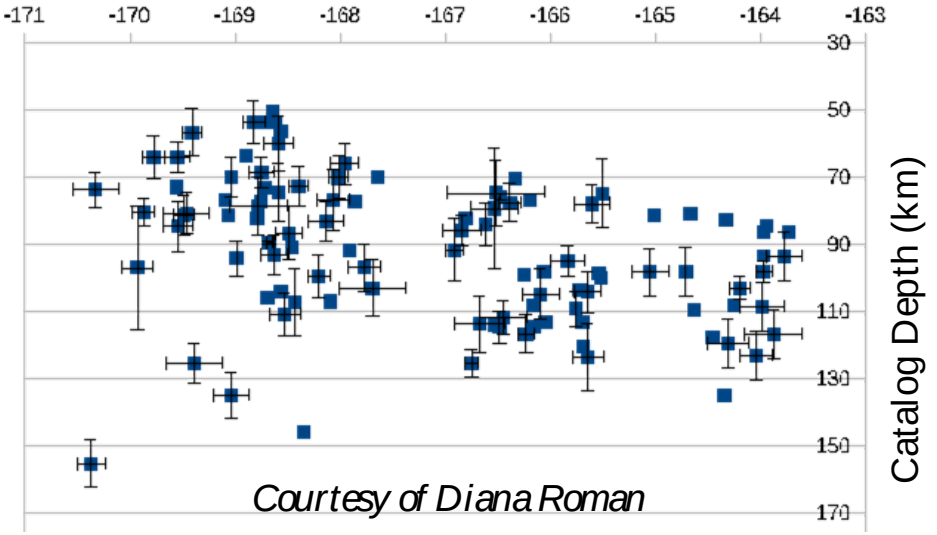


Smaller Volcanoes at Shallower Depths

Plank et al. (2017) IAVCEI

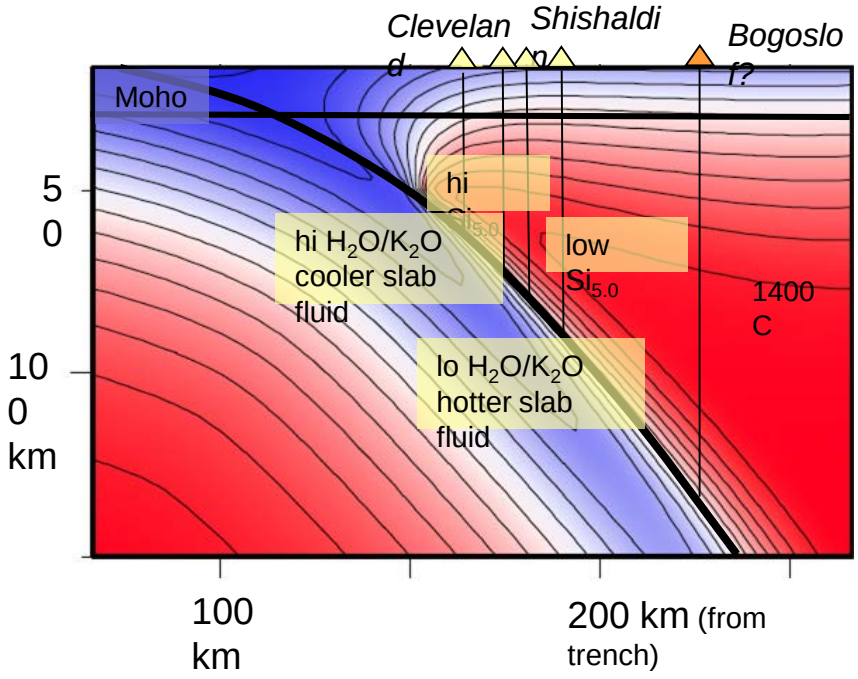


Systematic change in S-P time
Most Reasonably due to
Decrease in EQ Depth to the West



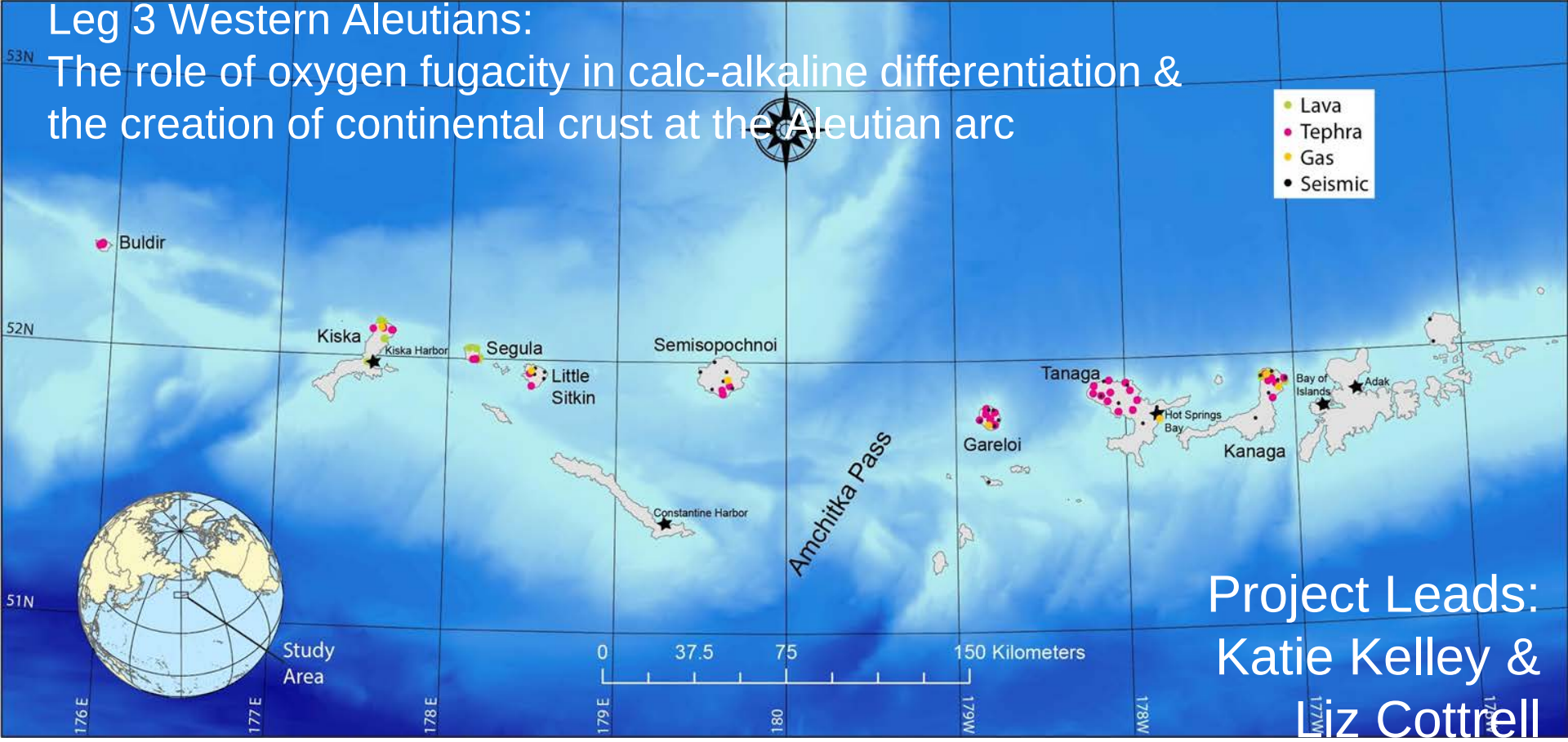
NEIC Catalog – Events within ~ 30 km Volcano Radius
AVO Stations on Volcanoes, Including New Cleveland Station (CLES)

3. Connecting the Volcano to the Slab



Courtesy of Peter van Keken

Leg 3 Western Aleutians:
The role of oxygen fugacity in calc-alkaline differentiation & the creation of continental crust at the Aleutian arc



Project Leads:
Katie Kelley &
Liz Cottrell

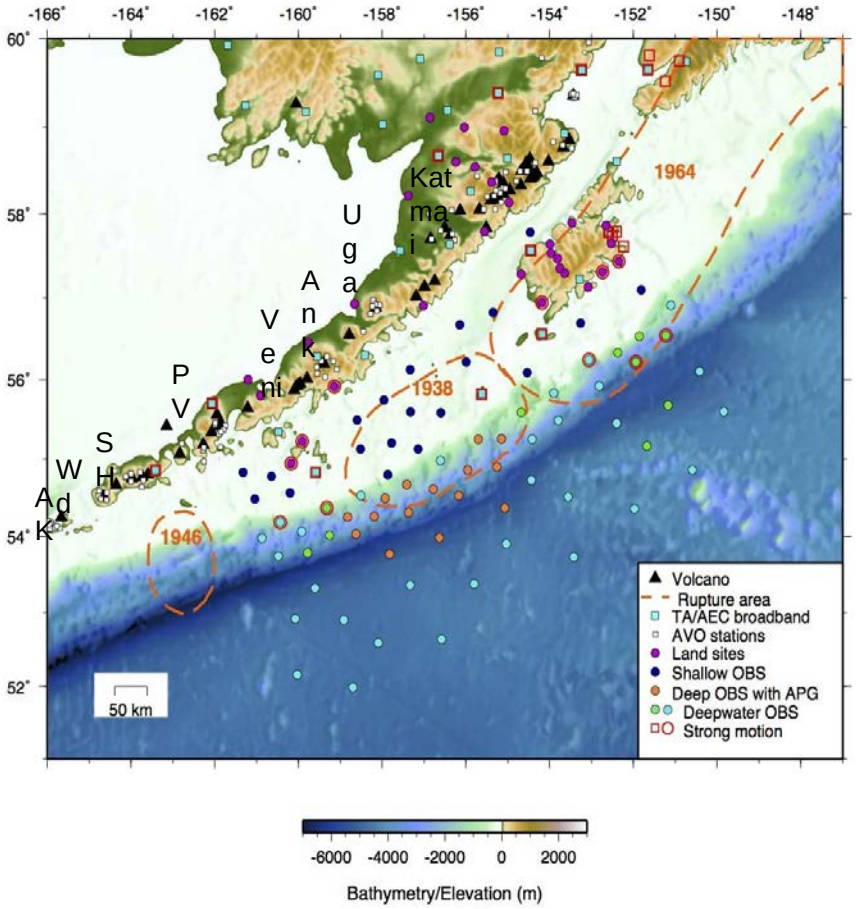

Buldir tephra
Credit: Sheppard

- > 2,700 lbs of **rock** send to AVO, URI, & Smithsonian
- **tephra** from 8 volcanic islands (1st from Buldir, Segula, & Kiska)
- **gas** and spring samples @ Kiska, Gareloi, Kanaga; @ L. Sitkin, Tanaga
- 100% maintenance success at **30 seismic installations**
- new methods for assessment of hydrous melt inclusion **redox** at high flux synchrotron facilities (Cottrell et al., in revision)

(see T23I-03: New constraints on subduction inputs and volatile outputs along the Aleutian Arc. Lopez et al.)

Alaska Amphibious Community Seismic Experiment

Closing Thoughts

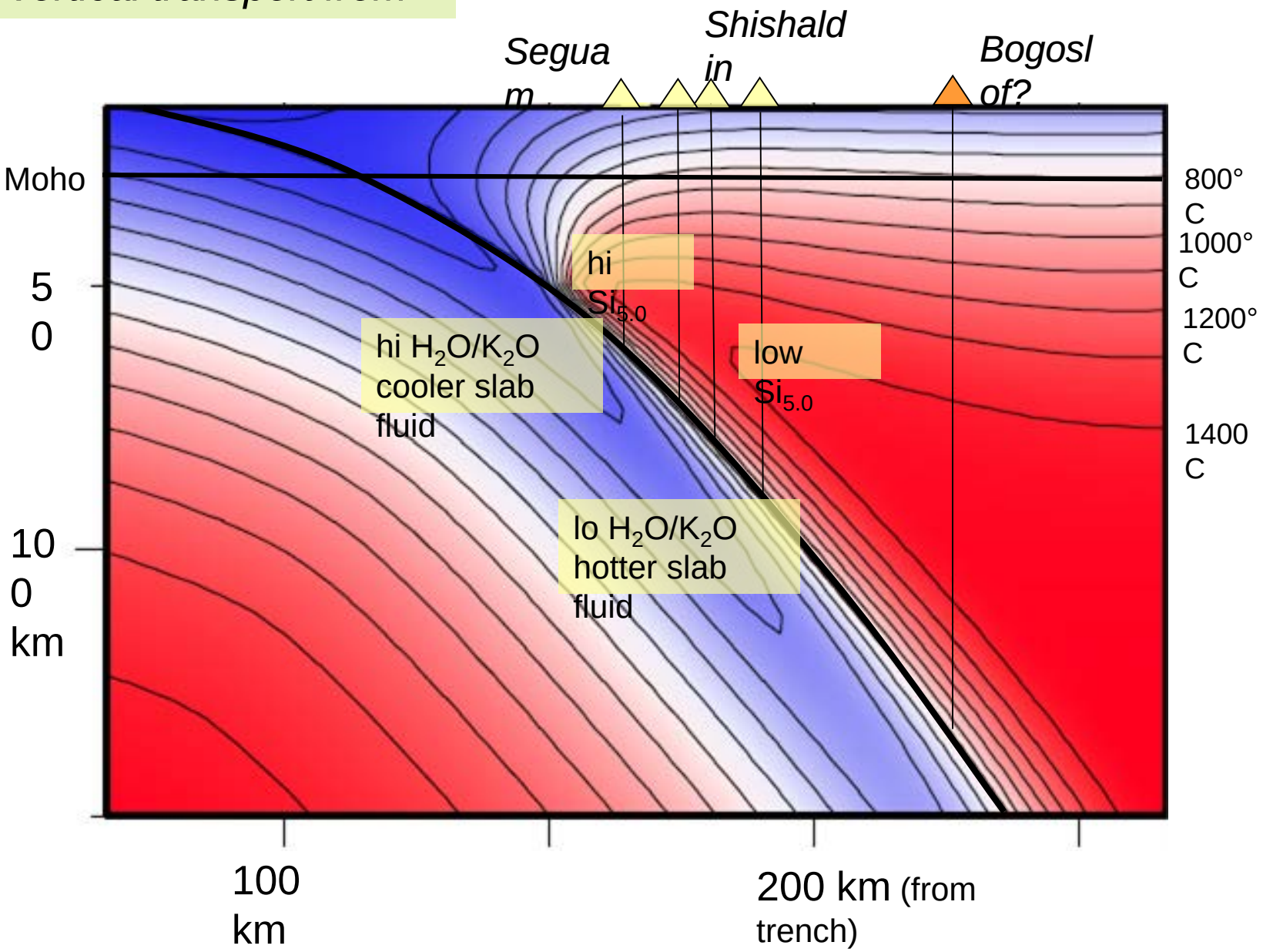


Diana Roman, Carnegie

Graduate student Janine Andrys operates the new rapid-quench HMC cold-seal apparatus at NMNH. Credit: Cottrell

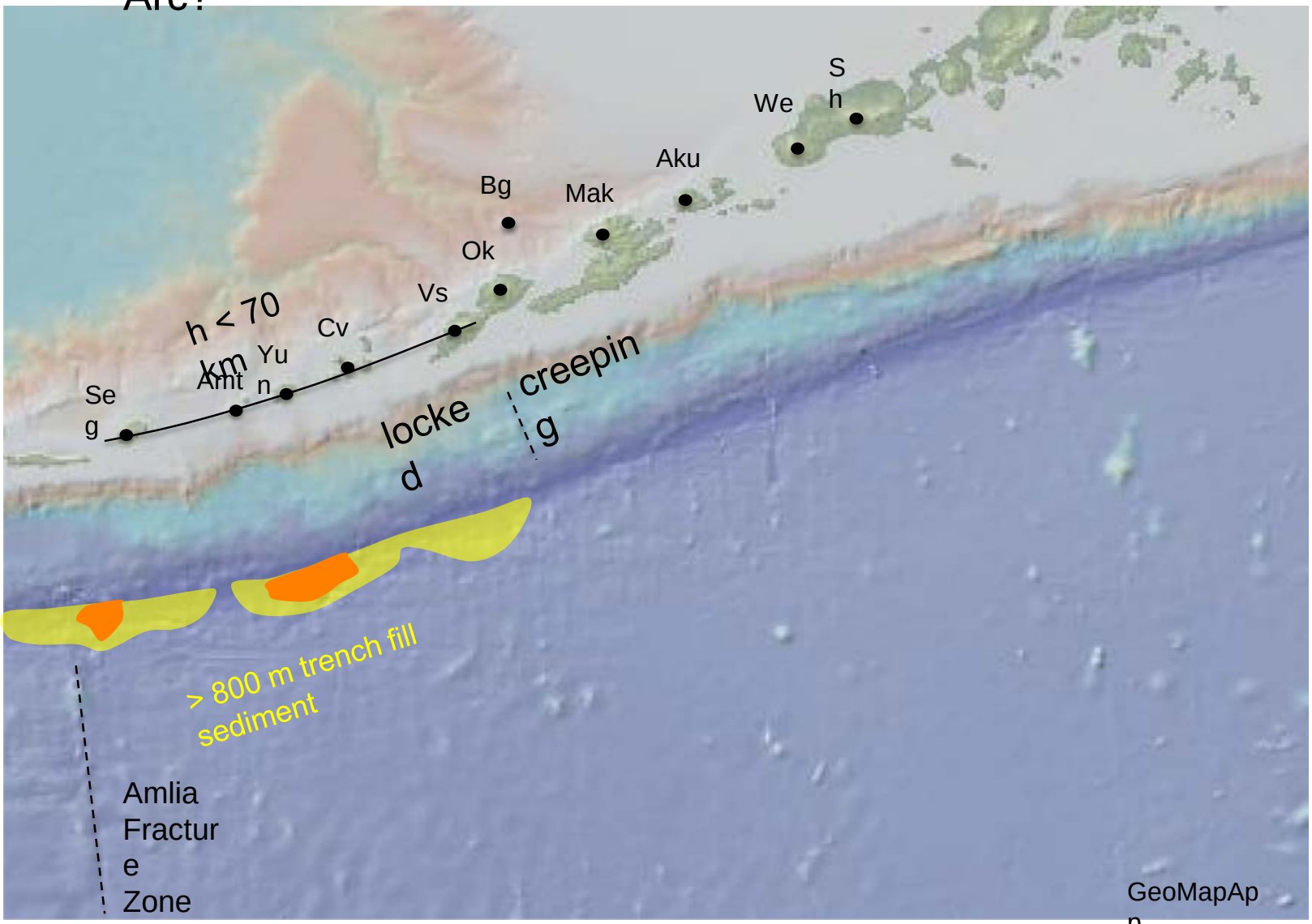
- Experimental program to investigate calc-alkaline differentiation
  - V11B-0343: Calc-Alkaline Liquid Lines of Descent Produced Under Oxidizing Conditions: An Experimental and Petrologic Study of Basaltic Tephras from the Western Aleutians, AK. Waters, Cottrell and Kelley.
- Conference: Experimental Studies of Subduction Zone Processes: Washington University in St. Louis, Missouri, June, 2018

Shallower coupling depth? and ~ vertical transport from slab?



Courtesy of Peter van Keken

Why is Depth to Slab so Shallow in this Sector of the Arc?



Trench Sediment Thickness after Ryan et al. (2011);
Locked vs creeping (Freymueller, pers. comm).

But also....Upper Plate (end of shelf)