Developing a new Subduction Zone Initiative: The SZ4D Research Coordination Network

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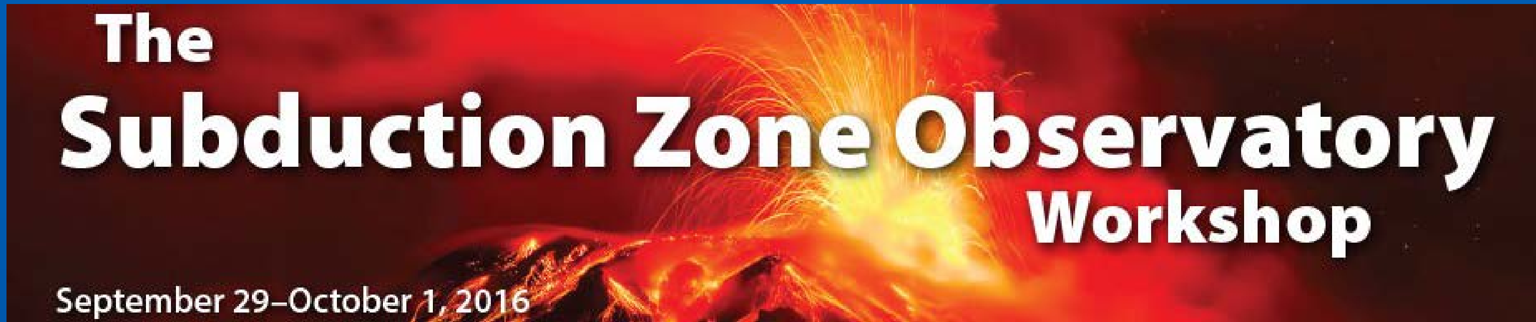
& SZ4D RCN Steering Committee



350 Applicants & 242 Total Attendees

67 Early Career Scientists & Students

45 from 21 Non-US Countries

32 Break-out Groups

>60 White Papers

Key Themes Emerged from the Boise Workshop:

- Focus on the Fundamental Processes that Underlie GeoHazards
- 4D Datasets – Time-Evolving Phenomena
- International Coordination/Opportunities
- Modeling (and Experimental!) Collaboratories
- Sampling over Geologic Time

SZ4D Initiative Vision Document

Lead Authors:
Jeff McGuire, WHOI
Terry Plank, LDEO

with 21 others & contributions from many more

https://www.iris.edu/sz/sz4d.pdf

A focus on targeted experiments to make the next big leaps in understanding of the processes underlying subduction geohazards

Comprehensive suites of measurements taken in the same place and over the same time

Three Key Components:

- *interdisciplinary science program*
- *community infrastructure/instrumentation program*
- *modeling (and lab/experiment) collaboratory*

> "The SZ4D Initiative seeks to invest in multidisciplinary observatories where data from evolving systems can be captured in sufficient resolution to observe their fundamental physics and chemistry."

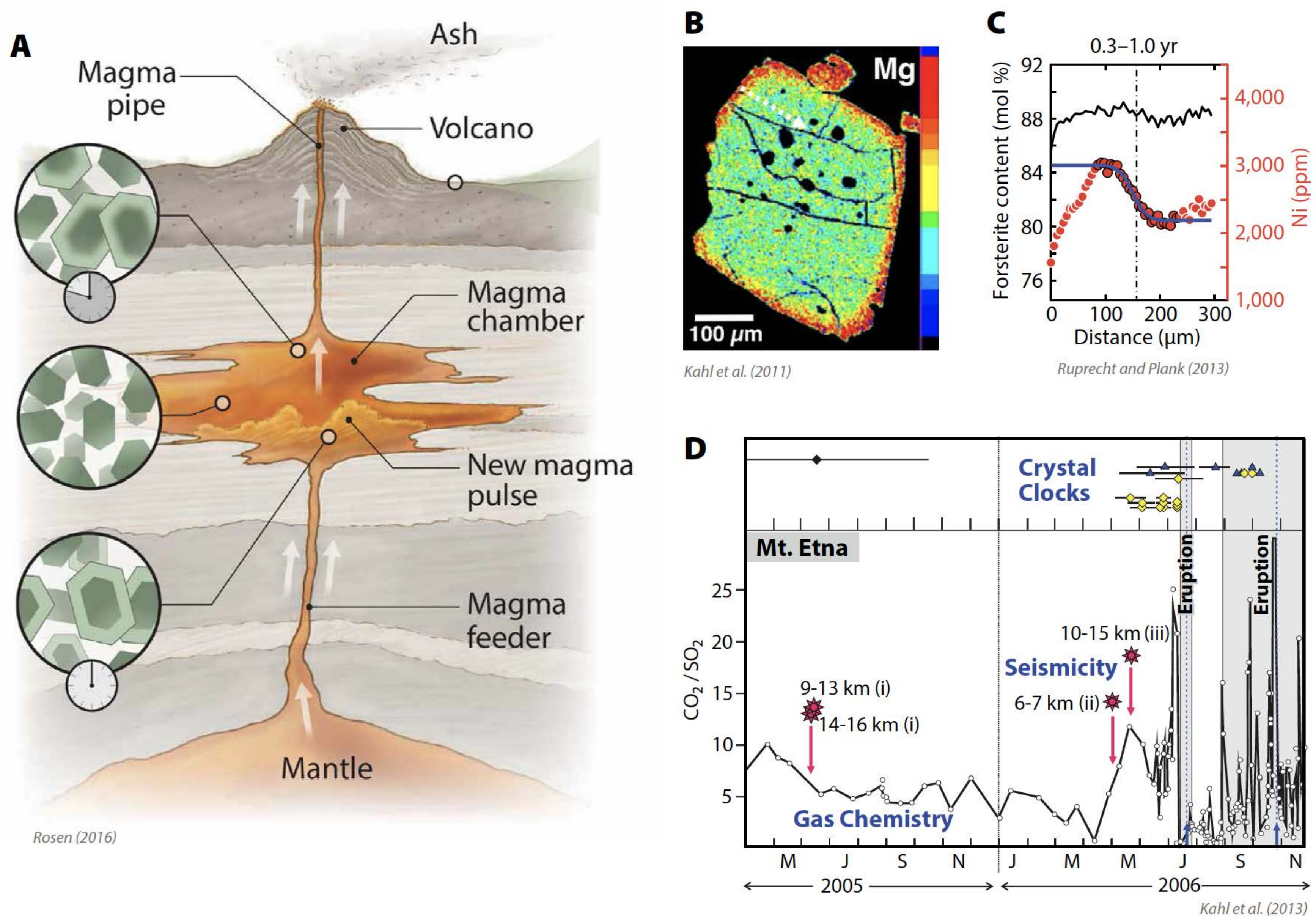
Increase our predictive understanding of Eruptions, Tsunamis, Earthquakes, and Landslides by:

- *capturing and modeling emergent phenomena*
- *collecting datasets 4D – from real time to geological time*

Volcano Deformation: 1992 – 2000
Seguam, AK

Foreshock (and SSE) sequence preceding
2011 M9.1 Tohoku Earthquake
(NHK & A. Kato)

Examples: Timing of magma recharge prior to eruption



Box 4.1. Time Series in the Run-up to Events

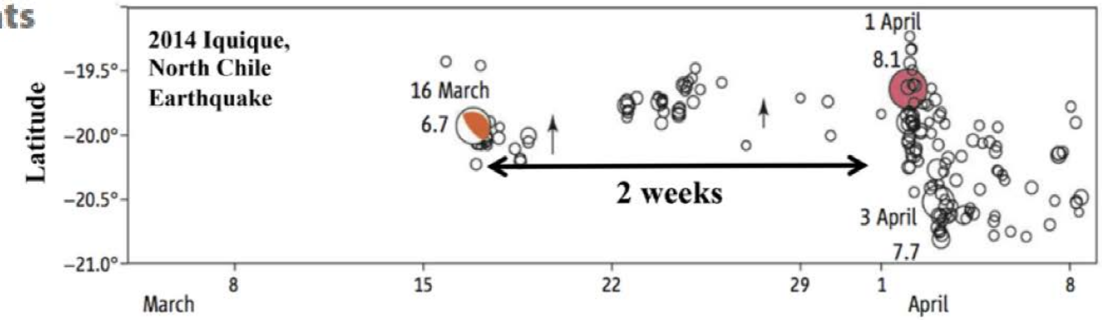
Examples: New observations of run-up to events

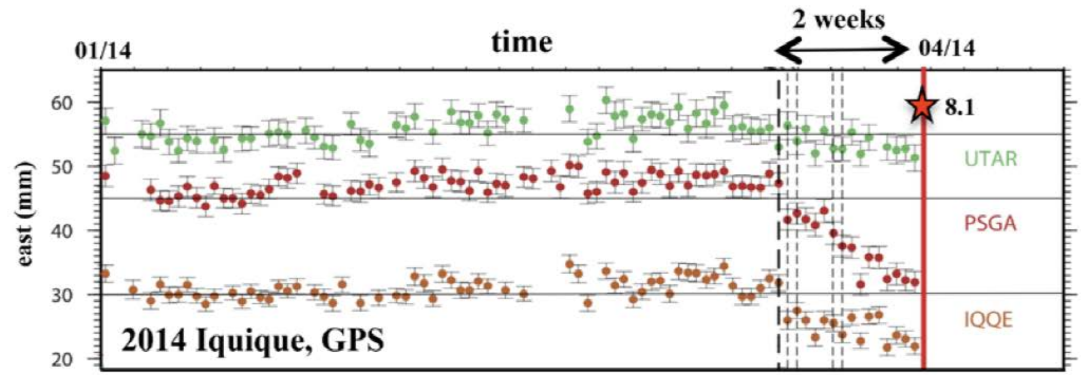
Continuous time series preceding earthquakes and eruptions are revealing emergent phenomena, potential precursory signals, and constraints on the physical conditions that lead to hazardous events

New seismologic and geodetic observations – *often those that extend networks offshore* - are driving this exciting frontier.

SZ4D Vision Document: https://www.iris.edu/sz/sz4d.pdf

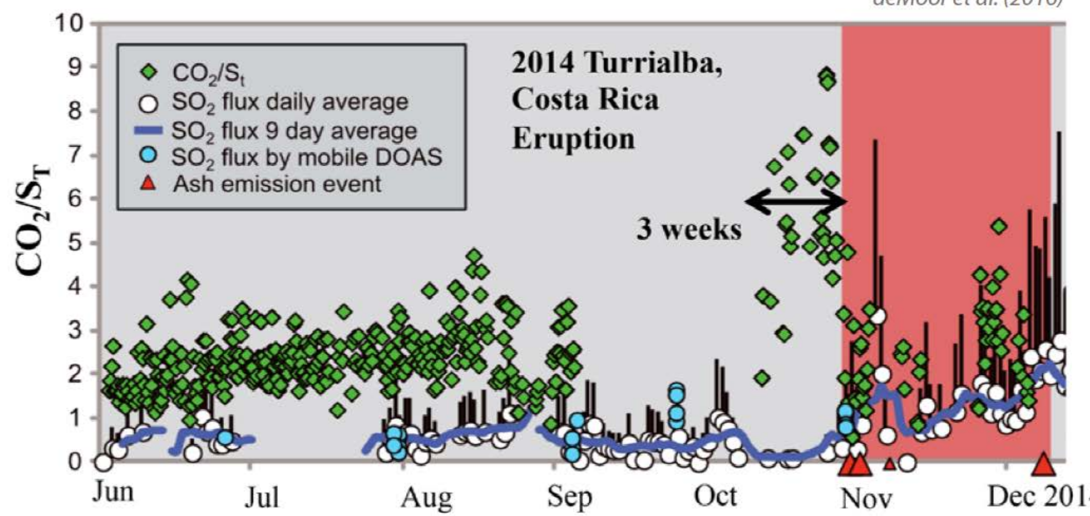
Brodsky and Lay (2014)

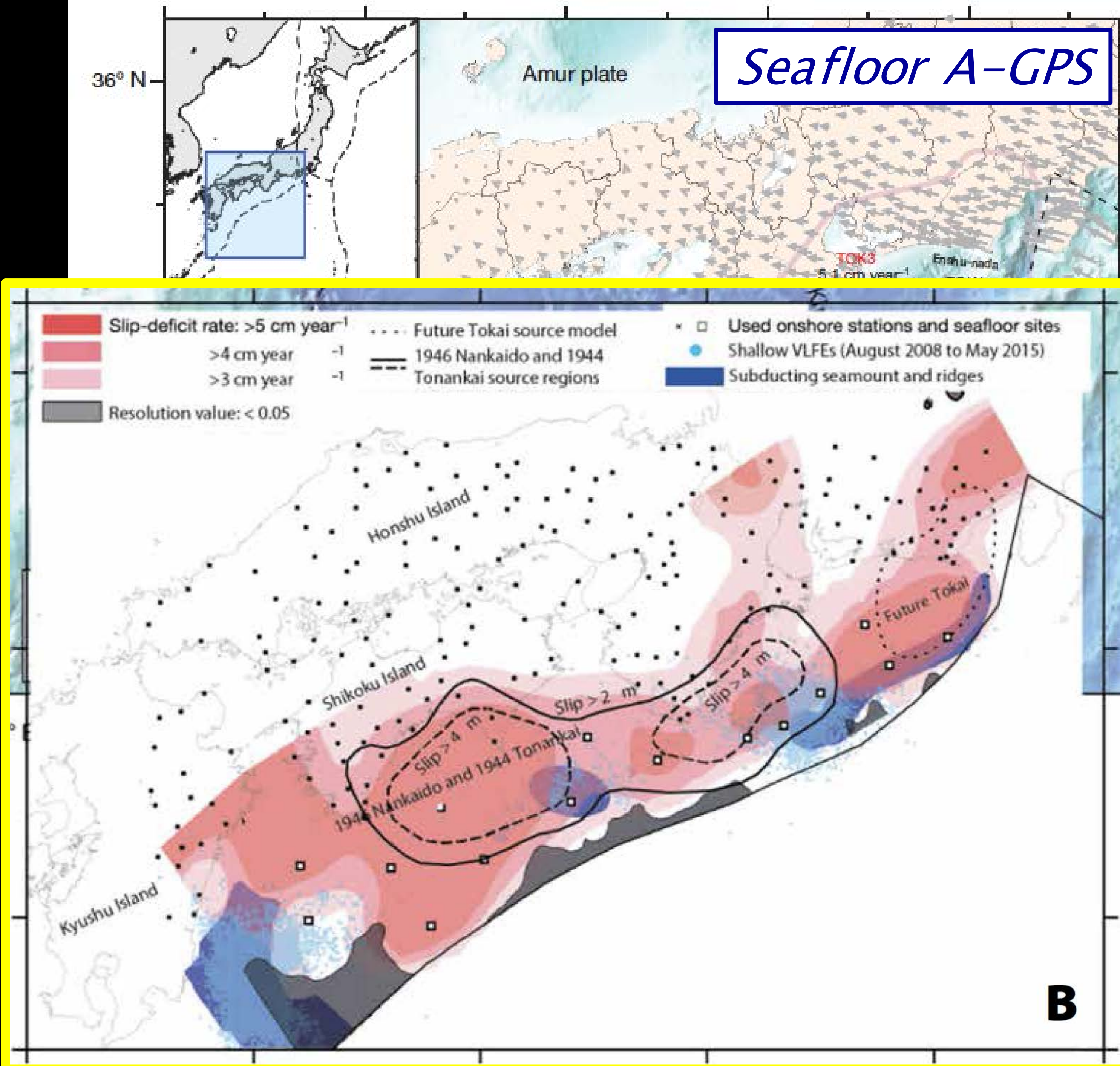




Ruiz et al. (2014)

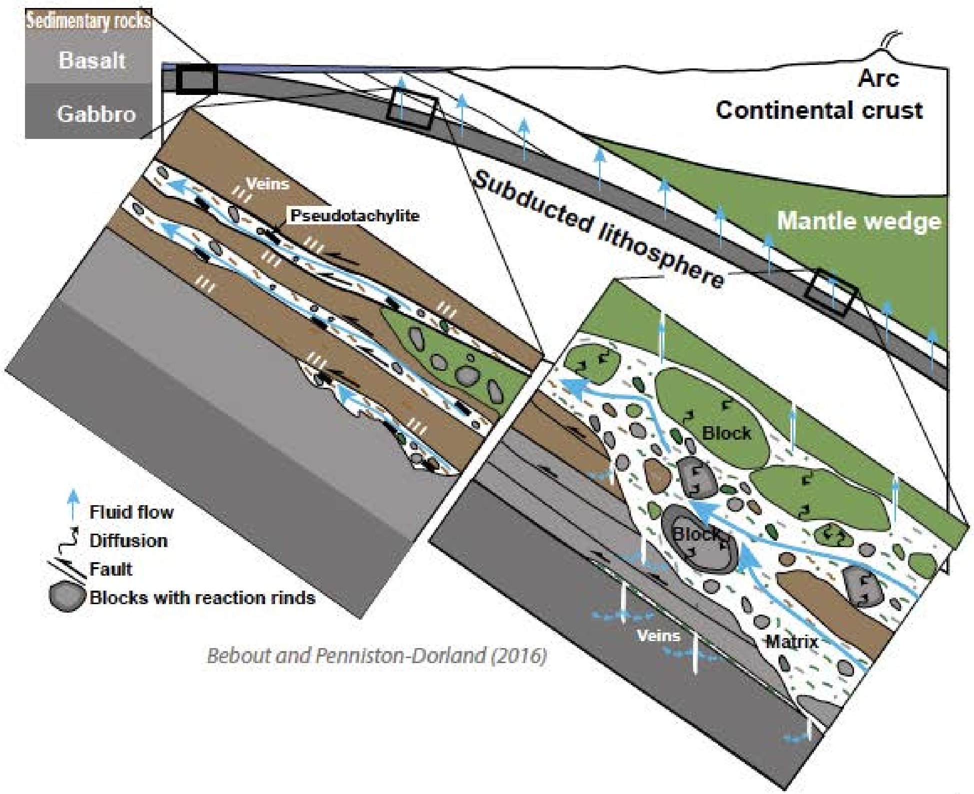
deMoor et al. (2016)





Yokota et al., *Nature*, 2016

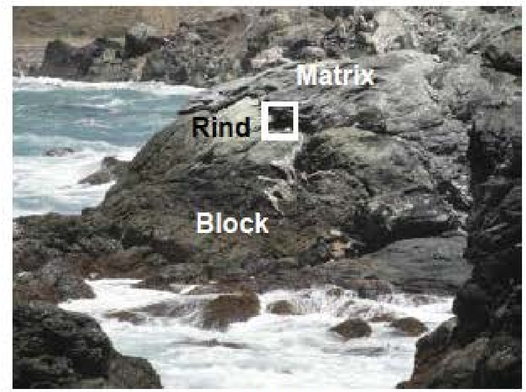
Box 4.7. Probing the Plate Interface from the Megathrust to the Mantle Wedge



Bebout and Penniston-Dorland (2016)

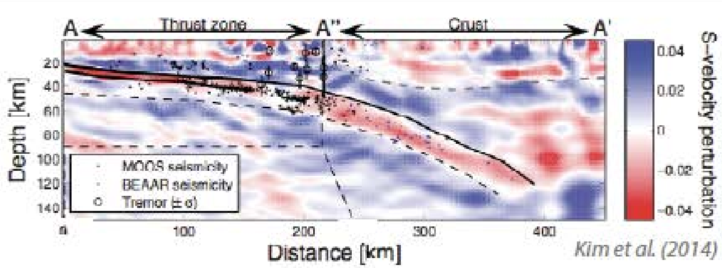
Probing the Plate Interface

Exhumed rocks



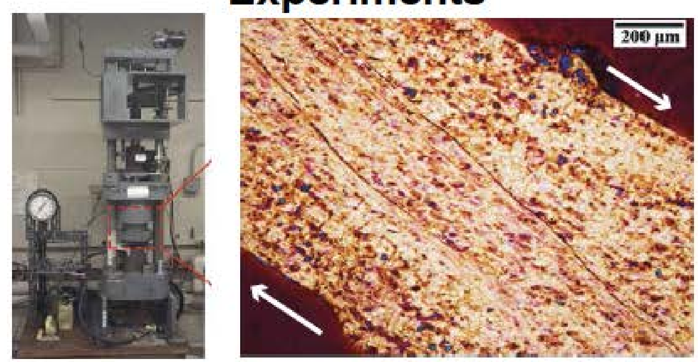
Penniston-Dorland et al. (2014)

Seismic Imaging



Kim et al. (2014)

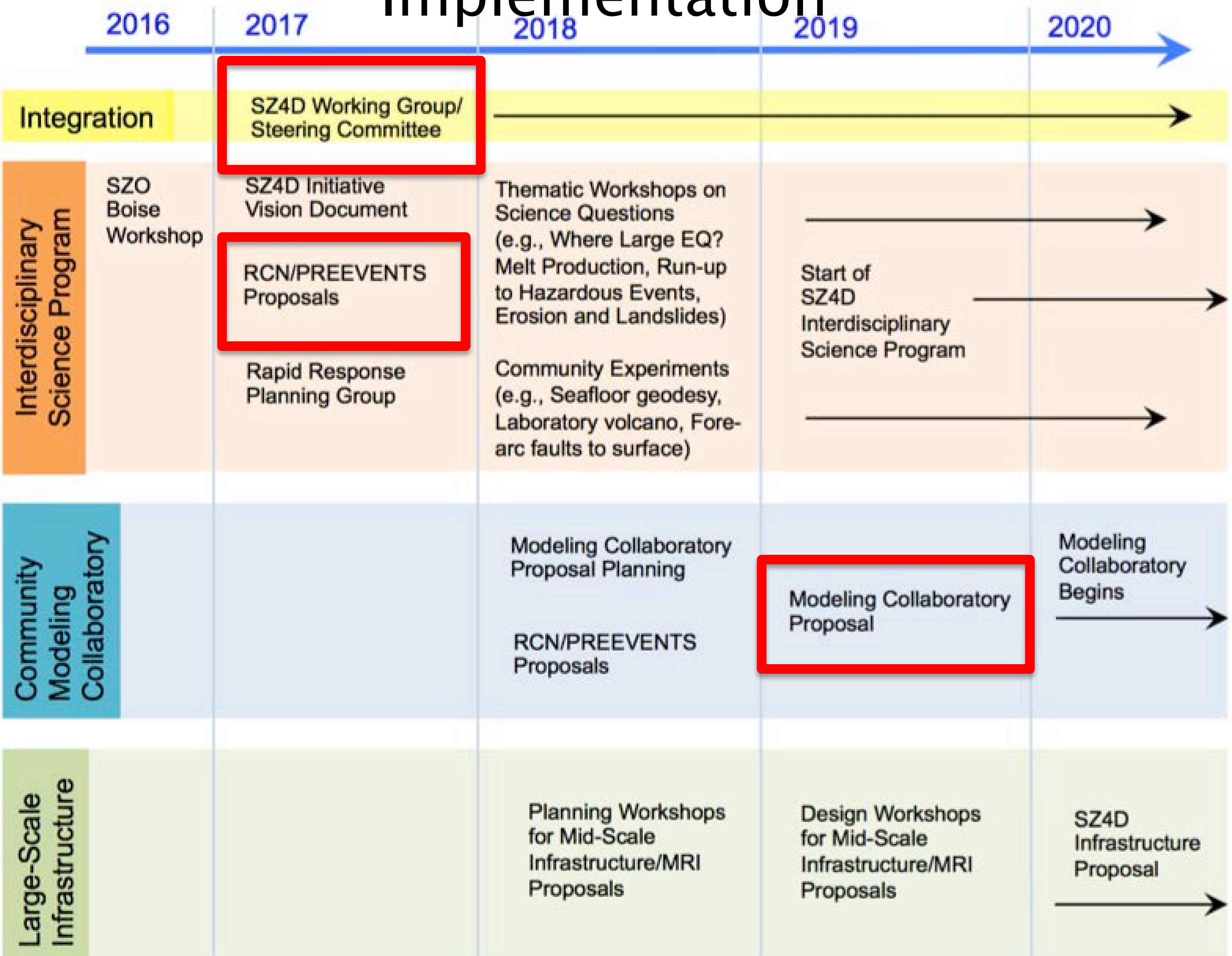
Experiments



Proctor and Hirth (2016)

SZ4D Vision Document: https://www.iris.edu/sz/sz4d.pdf

SZ4D Timeline for Development and Implementation



Major Components of SZ4D Planning now funded by NSF

- SZ4D “Umbrella” RCN and Steering Committee (H. Tobin)
- SZ4D “Modelling Collaboratory” (T. Becker)
- SZ4D “Community Network for Volcanic Eruption Response: CONVERSE” (T. Fischer)

Total NSF commitment of more than $1 million for SZ4D planning activities

Support from 5 different EAR & OCE Programs

The 2017 SZ4D Vision Document laid out the broad objectives: *Science of processes underlying subduction- related hazards*

Detailed planning for a potential SZ4D Program begins

NSF Research Coordination Network (RCN) funded in late 2018

Steering Committee:

Harold Tobin *(Chair),* Diego Arcas, Emily Brodsky, David Chadwell, Allison Duvall, Melodie French, Matt Haney, George Hilley, Diego Melgar, Sarah Penniston- Dorland, Terry Plank, Diana Roman, Donna Shillington, Christy Till, Doug Wiens

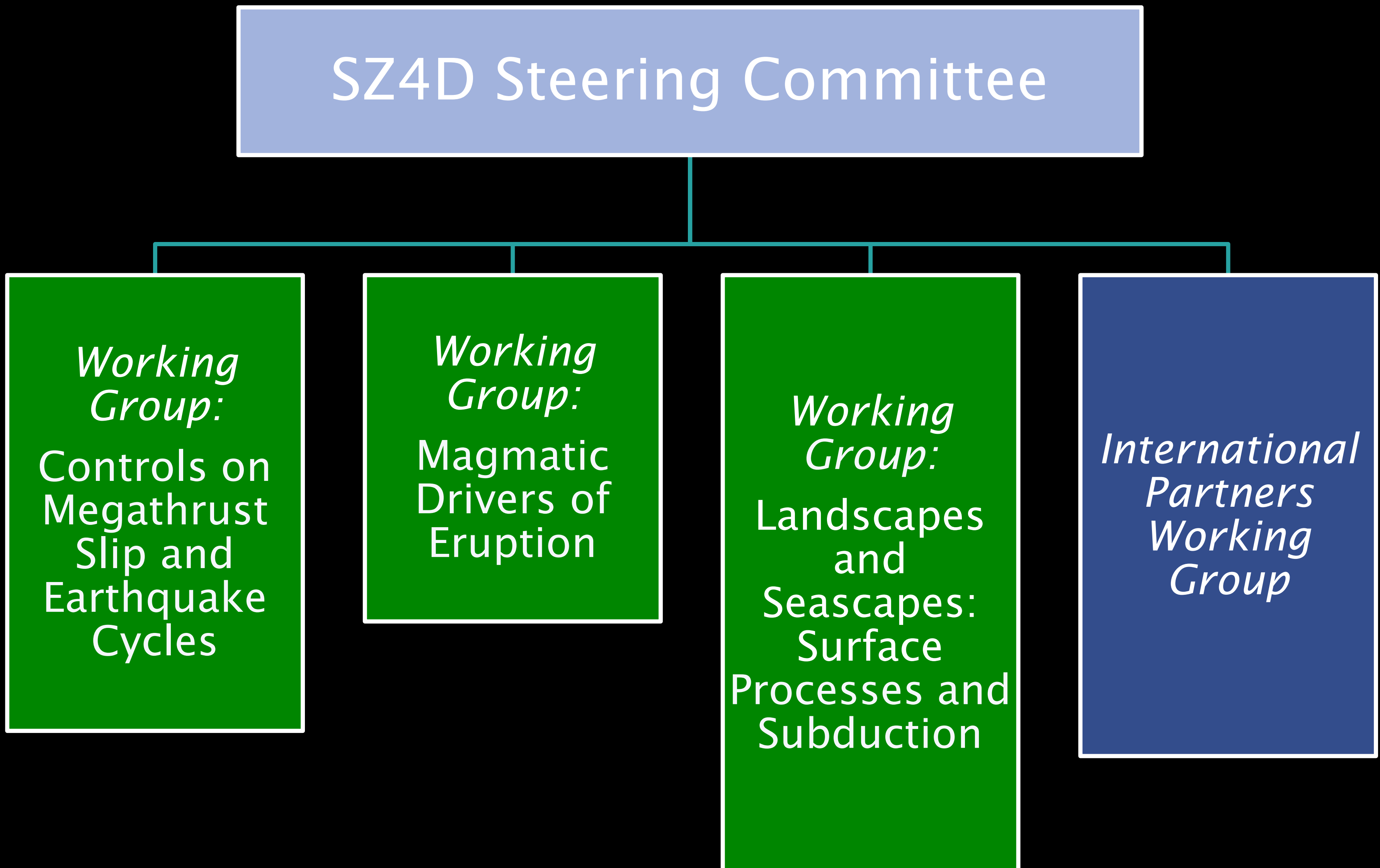
SZ4D RCN Activities – Span 3 Years:

- Communication (web, news, etc.)
- In- reach (research community) and Out- reach (broader science community, agencies, stakeholders, and public)
- Sponsor and facilitate Working Groups to develop & design SZ4D program

SZ4D - RCN Goals

- Over 3 years, turn the "Vision" into an Implementation Plan for an SZ4D Initiative
- The scale and scope is an open and complex question (infrastructure? Research funding program? What else?)
- Build the community with Thematic Interest Groups and Working Groups with detailed charge to design a program
- Work with partners and funders to design a viable and compelling program and make the case for it (NSF, NASA, NOAA, USGS, IRIS, UNAVCO, international partners & more)

RCN GOAL: Over 3 years, turn the "Vision" into an Implementation Plan



What is SZ4D? What isn't it?

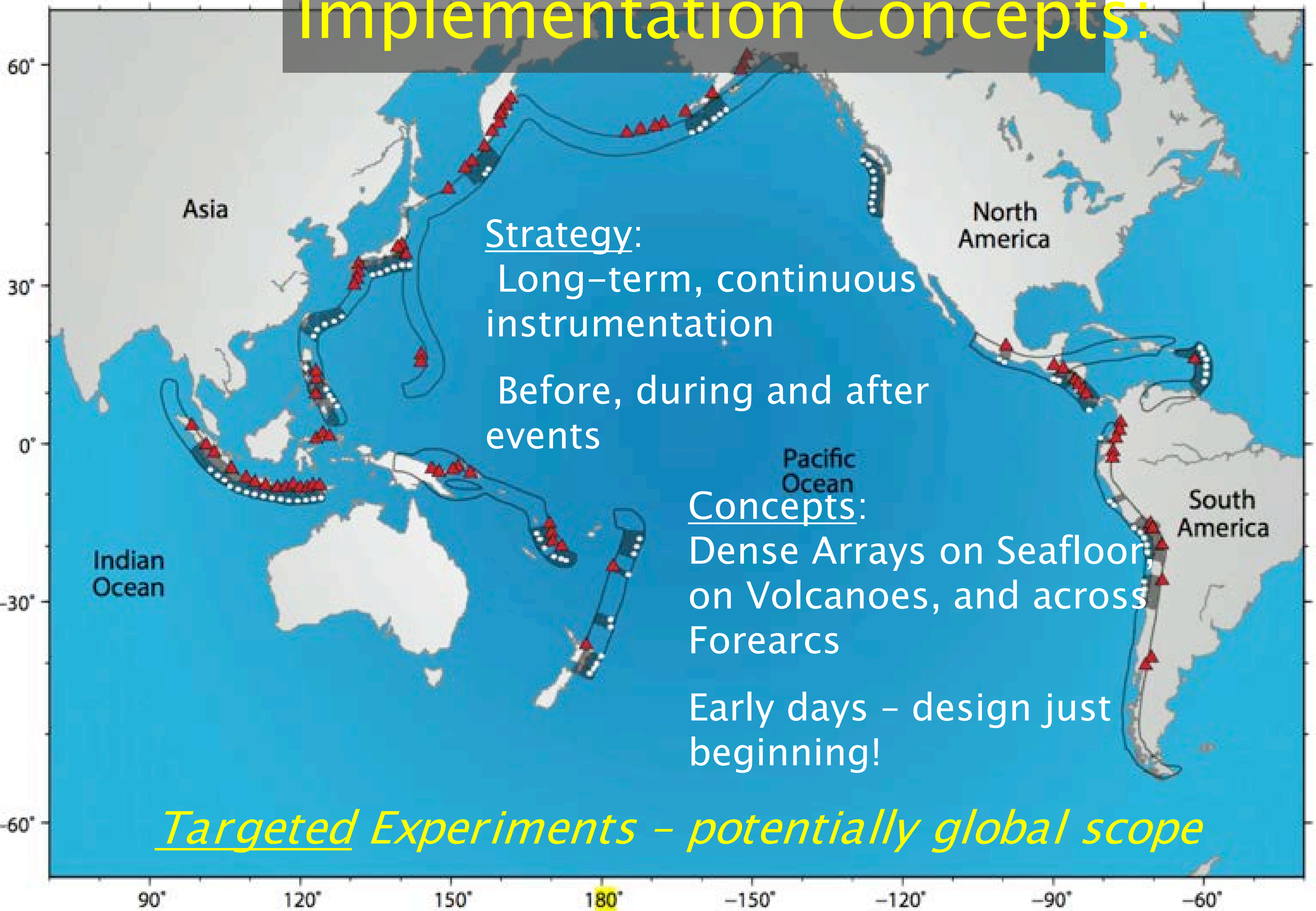
SZ4D aspires to be (one of) the *Next Big Thing(s)* in the post- Earthscope, post- GeoPRISMS world…

…but at the same time, <u>not</u> simply "Earthscope 2" or "GeoPRISMS 2."

*A focus on **targeted experiments** to make the next big leaps in understanding of the **processes underlying subduction geohazards***

Comprehensive suites of measurements taken in the same place and over the same time

Implementation Concepts:



<u>Strategy</u>:

Long-term, continuous instrumentation

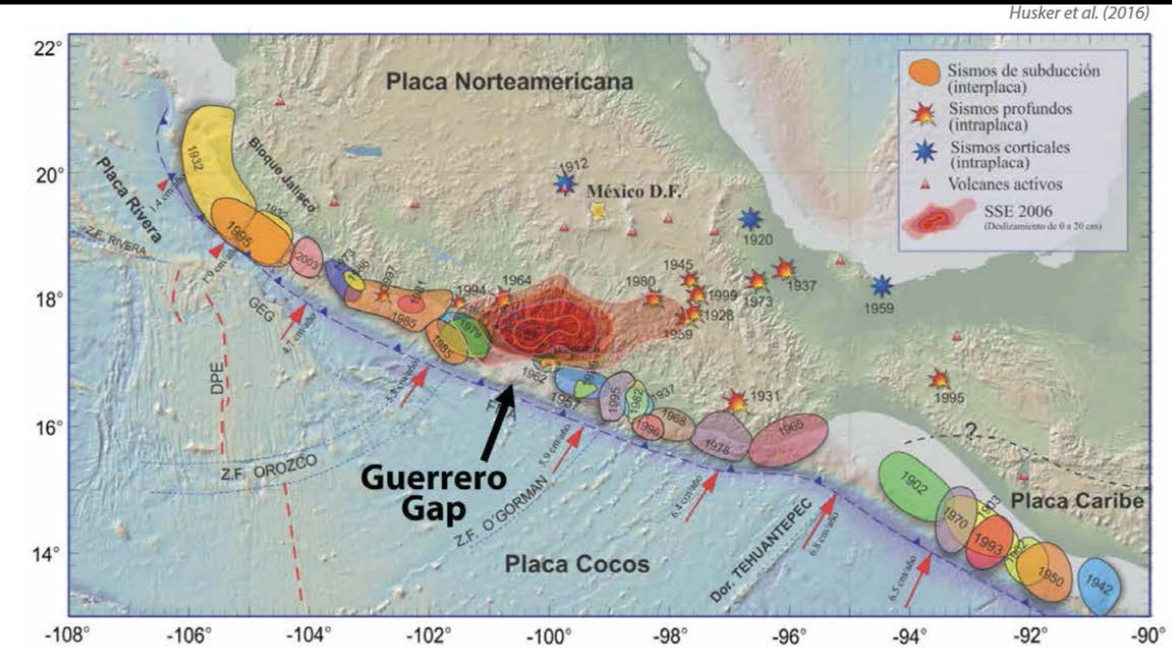
Before, during and after events

<u>Concepts</u>:

Dense Arrays on Seafloor, on Volcanoes, and across Forearcs

Early days - design just beginning!

<u>Targeted</u> Experiments - potentially global scope

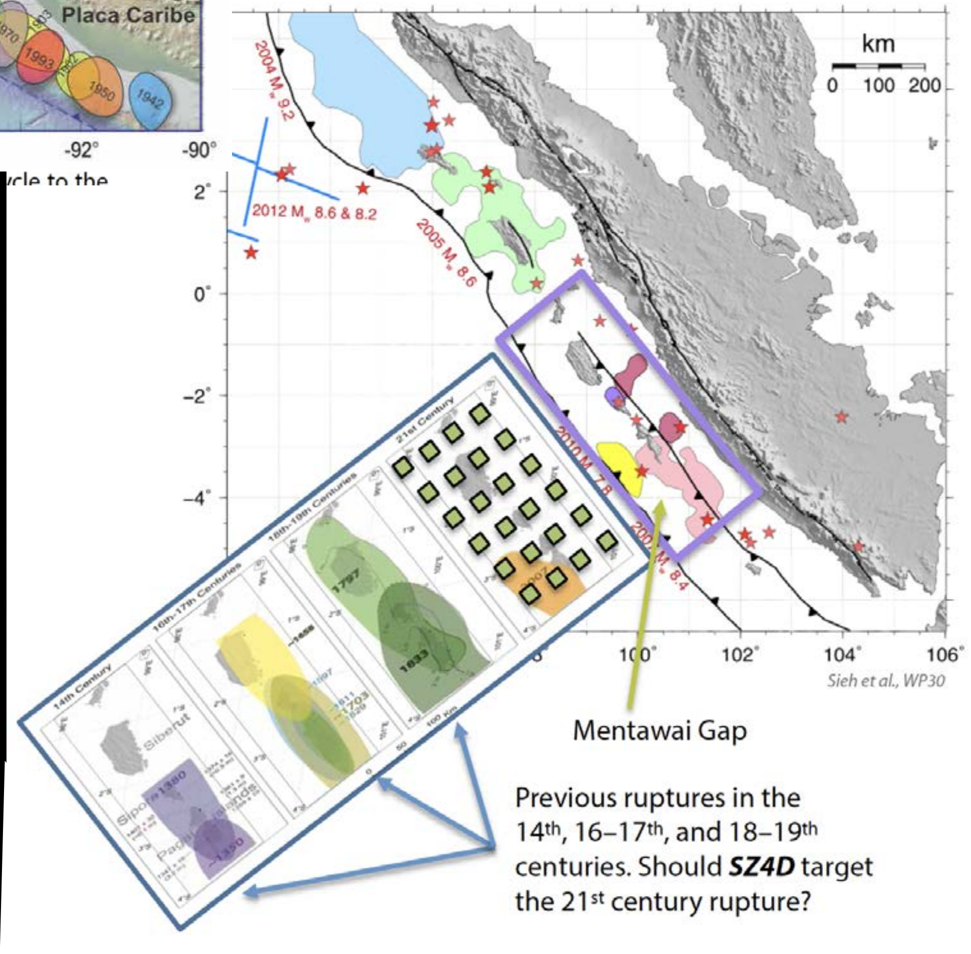


Seismic Gap Observatory

Onshore –offshore integrated network (as close to real-time as practical)

- Seismic network w/ OBS
- GNSS / A-GNSS / OBP
- Active source seismic and hi-res bathymetry
- Geohistory (coastal history, offshore drilling, etc.

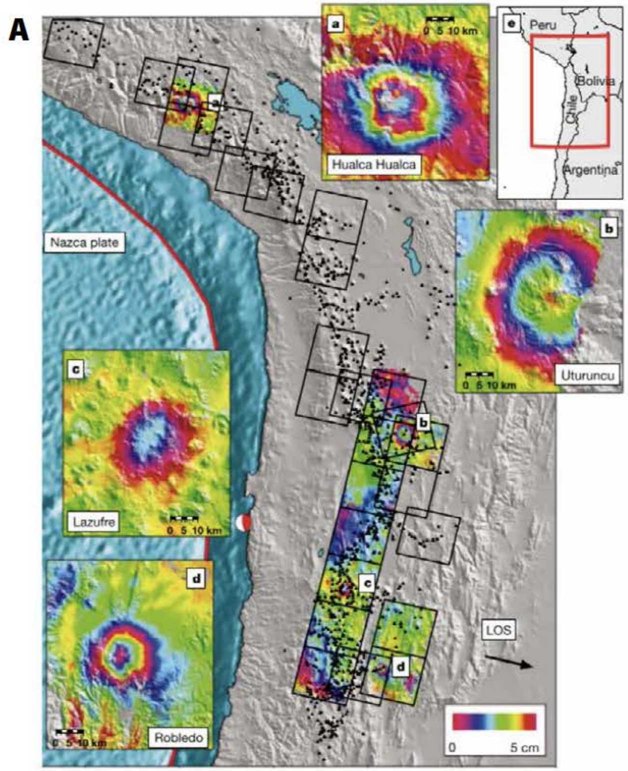
How broad a region / how many regions are needed to likely capture events on decadal scale?



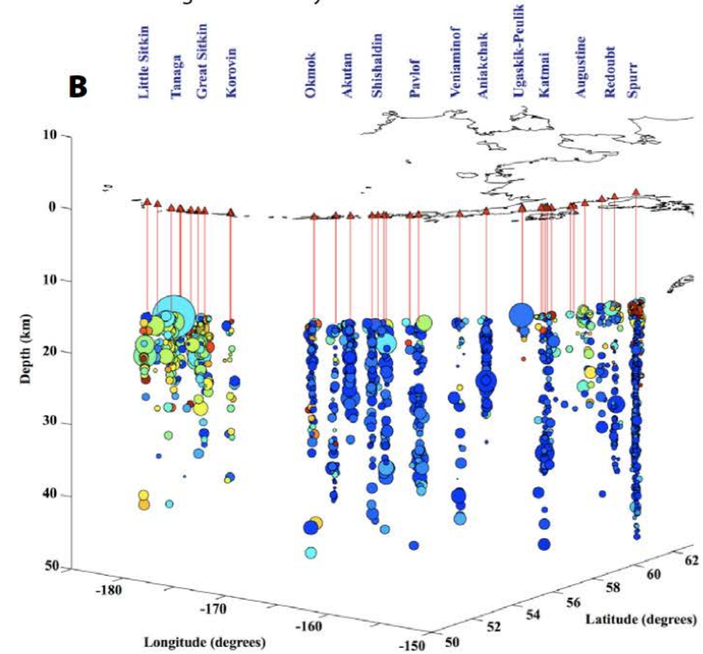
Arc- scale volcano observatory

- SAR (new NISAR)
- Seismic network
- Gas sensing
- Geo-history

Select location where activity is high and systematic data can capture eruptive process on decadal scale

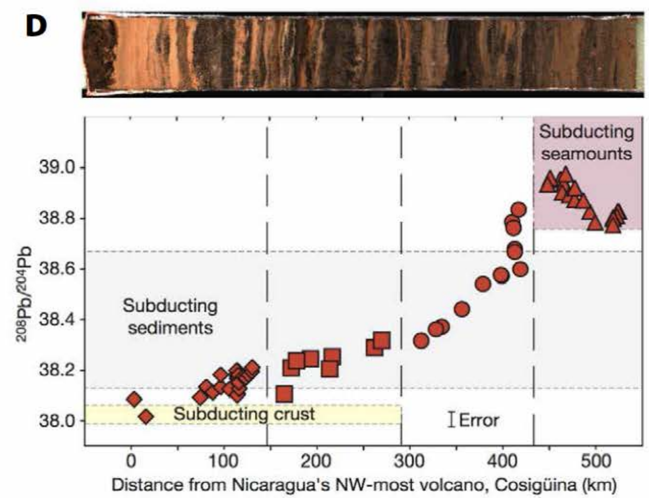


(A) Arc-scale detection of volcanic deformation in the central Andes from 1992–2000 using satellite-based synthetic aperture radar interferometry. Black triangles show 1,113 volcanic edifices, four of which (insets a–d) were found to be actively deforming. *From Pritchard and Simons (2002)*



(B) Lower crustal and upper mantle seismicity beneath volcanoes along the Aleutian arc. The history of these sequences suggests a link between volcanic unrest and deep magmatic processes that occurs on time scales of weeks to months. *From Power et al. (2013)*

(C) Deployment of a multi-gas sensor at Masaya Volcano, Nicaragua, as part of the Deep Carbon Observatory's DECADE initiative. *Photo credit: Alessandro Aiuppa and Marco Liuzzo (INGV)*



(D) Lake core (0.5 m) of last ~1500 years of explosive eruptions (dark layers) at Akutan Volcano, Aleutians. Pb isotope variations in Nicaragua-Costa Rica lavas observed 500 km along strike. *From Hoernle et al. (2008)*

Some key points:

SZ4D aspires to be (one of) the *Next Big Thing(s)* in the post- Earthscope, post- GeoPRISMS world

- The challenge is to create something genuinely new, *not* Earthscope II or GeoPRISMS– the Sequel.

- A science program, physical investment in infrastructure and observation, and modeling and experimental collaboratories are all envisioned. Scale (i.e., $$) and balance remain to be determined.

Sign up for our mailing list and watch for a call for nominations to Working Groups very soon