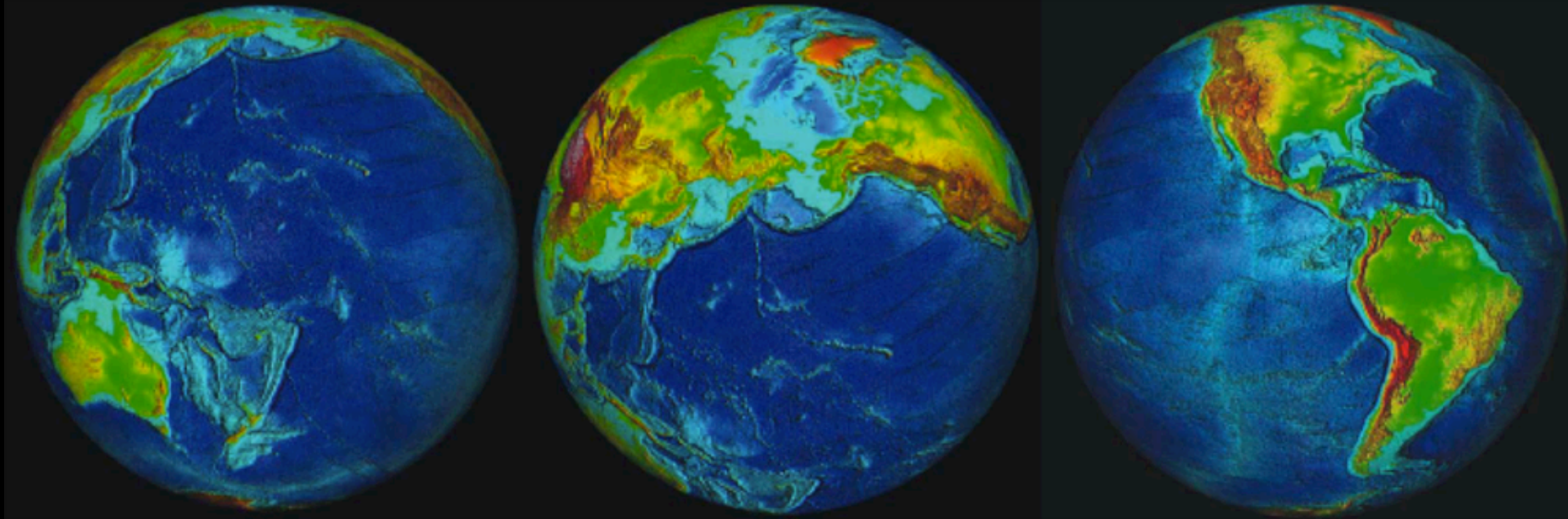


Subduction Zone Observatory: Concept(s) and Opportunities

Anne Meltzer



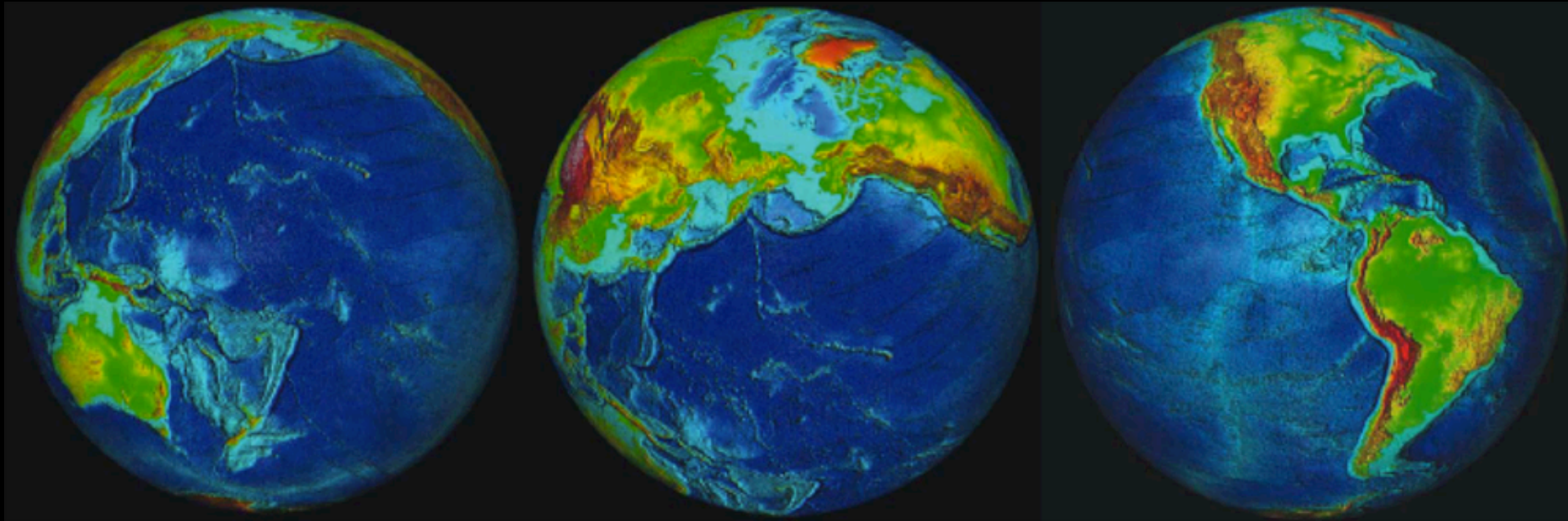
With contributions from: Geoff Abers, Susan Beck, Magali Billen, Andy Fressetto, Jeff Freymueller, Katherine Kelley, Onno Oncken, Ray Russo, Doug Weins, Bob Woodward, John Vidale, and many others



Subduction Zone Observatory

concept

an international multi-disciplinary observatory
along subduction zone plate boundaries



Subduction Zone Observatory

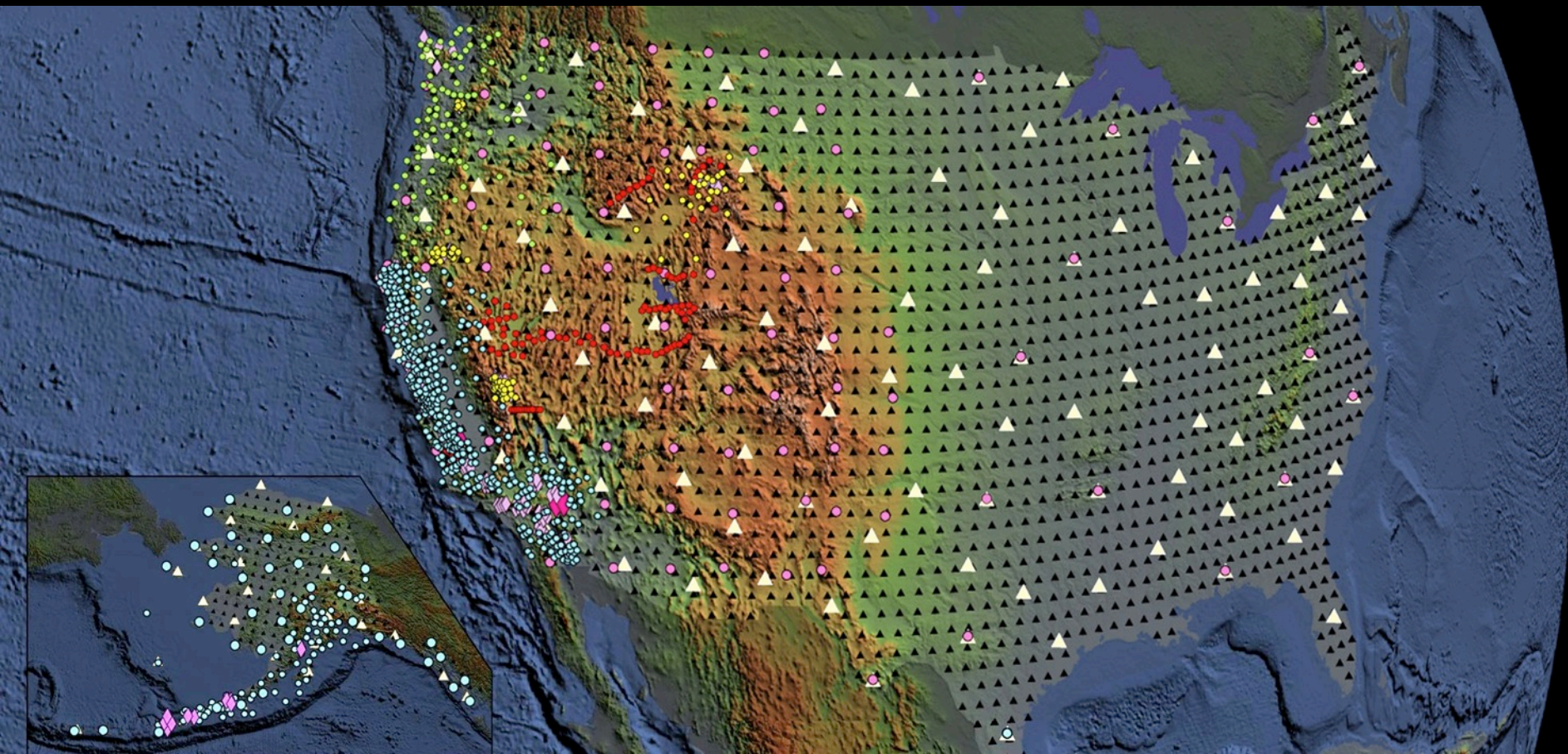
current status....



EarthScope Program

Study the three dimensional structure and evolution of the North American Continent

- 3.2 km borehole into San Andreas Fault
- 1100 permanent GPS stations
- 74 borehole strainmeters
- 6 laser strainmeters
- 78 borehole seismometers
- 100 Permanent seismic stations
- 400 transportable seismic stations occupying 2000 sites
- 20 magnetotelluric campaign systems
- 7 magnetotelluric backbone stations
- 100 campaign GPS stations
- 2146 campaign seismic stations



EarthScope Organization

The EarthScope Observatories

San Andreas Fault
Observatory at Depth
(SAFOD)

Drilling and Core
Repository

Downhole
Observatory

Operated by
Stanford & later
UNAVCO

Plate Boundary
Observatory
(PBO)

Permanent GPS

Borehole
Strainmeter

Laser Strainmeter

Campaign GPS

LIDAR

Operated by UNAVCO
UNAVCO

USArray

Transportable
Array (TA)

Flexible Array (FA)

Reference
Network (RefNet)

Magnetotellurics
(MT)

Operated by IRIS

 IRIS

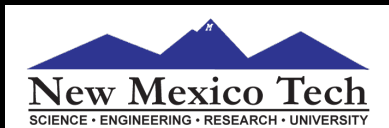
EarthScope is Funded by the National
Science Foundation



EarthScope's Unique Aspects

- Bold approach to geophysics research facilities: size, scope, data quality
- Diverse offerings: instrumentation, telemetry, auxiliary instruments, etc.
- Biggest open dataset for geophysics... ever
- Community driven
- Coordinated and collaborative
- Substantial education and outreach component
- Continuity: 8 years in the making, 15 year project
- Fundamental shift in the way we do science

EarthScope: coordination and collaboration

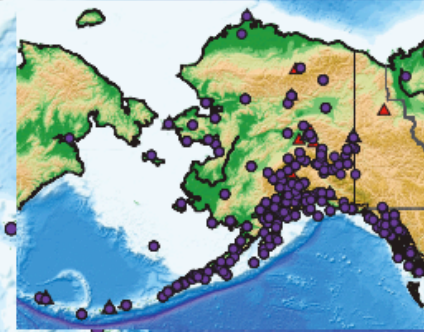


Beyond 2018 ???

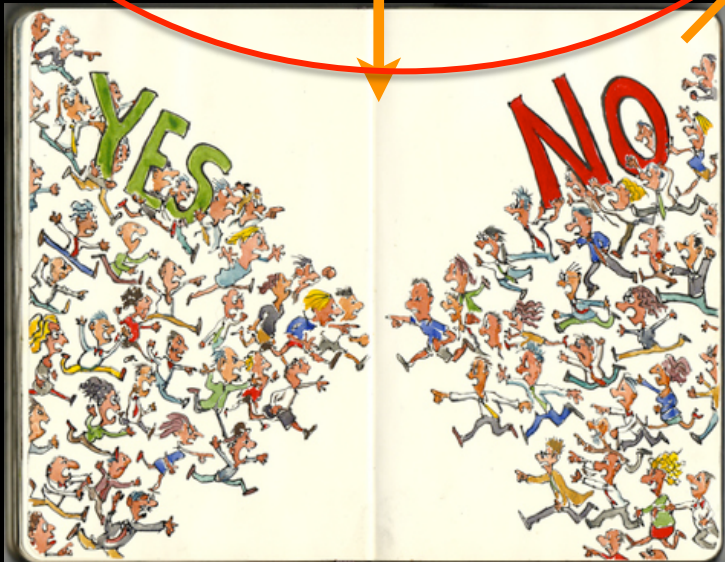
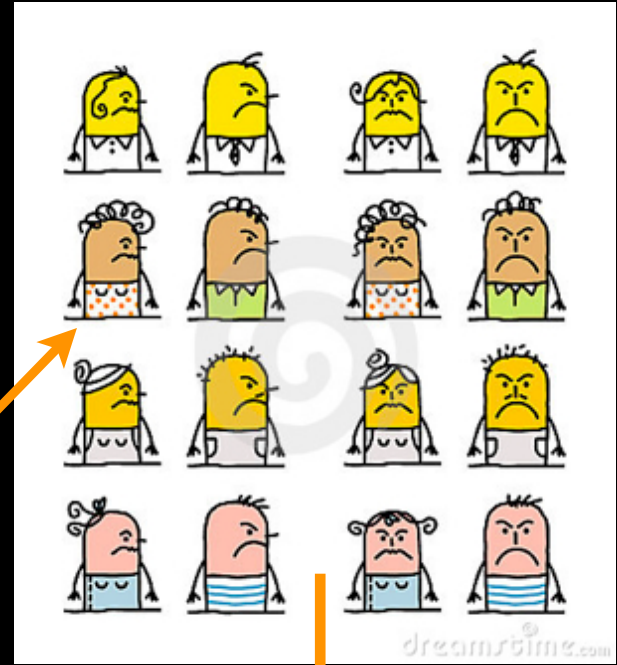
EarthScope changed how we do science, both research and education

- ★ SAFOD
- ◆ Magnetotelluric Backbone Stations
- ◇ Magnetotelluric
- ▲ Permanent Seismometers
- ▲ Adopted Seismometers
- ▲ Operating Seismometers
- ▲ Stations in Construction
- ▲ Removed Station
- ▲ Future Site
- ▲ Flexible Array
- GPS Station

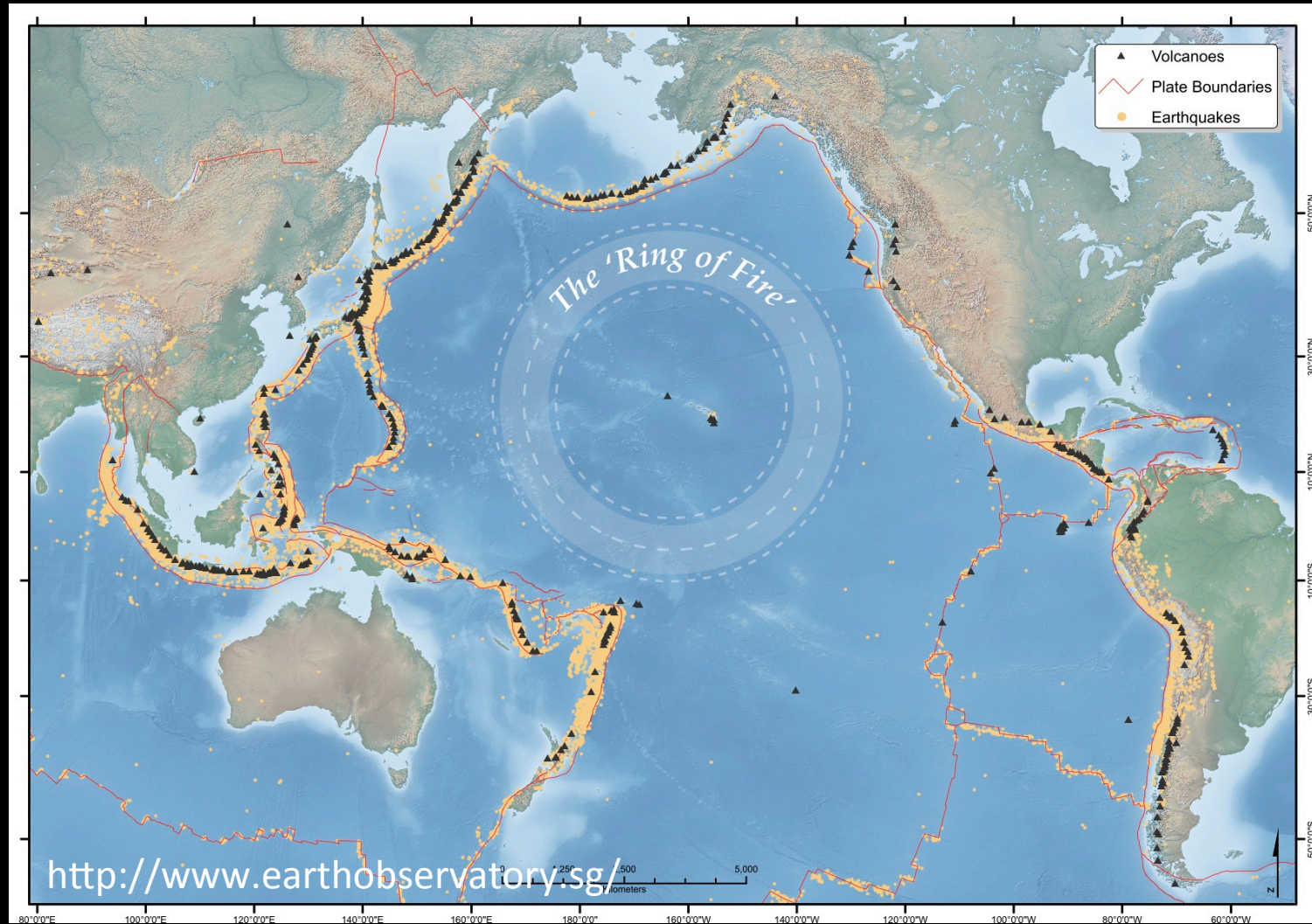
earth scope
www.earthscope.org



EarthScope pre-EarthScope



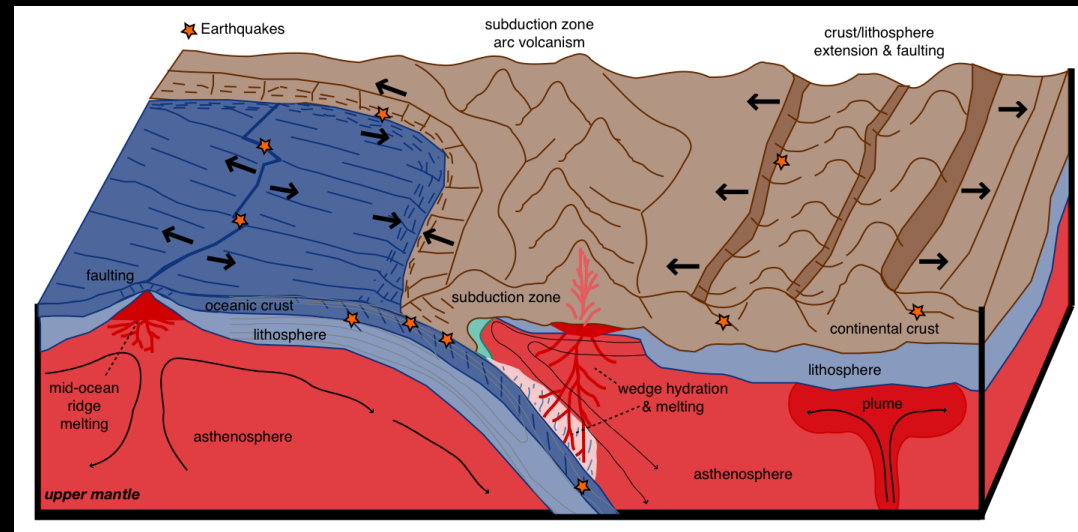
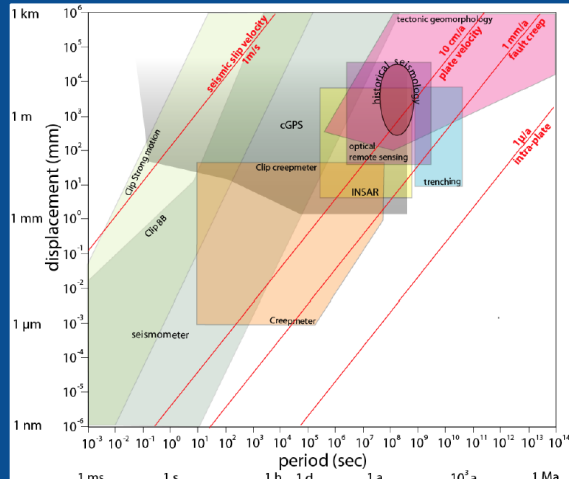
Subduction Zone Observatory



a coherent, structured, multi-disciplinary observatory
along the length of the Pacific subduction zones

subduction zones contain a rich diversity of tectonic processes, from plate- scale over millions of years to grain-scale over micro-seconds

Observe the complete deformation spectrum



- Hazards

- Faulting & Deformation

- Volcanism

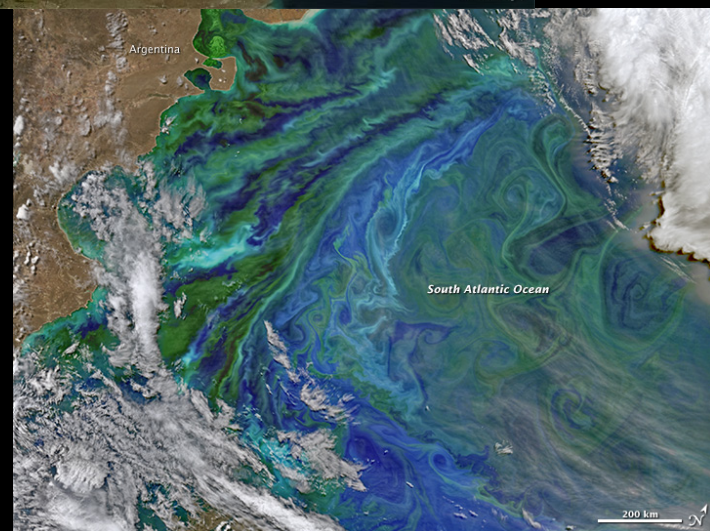
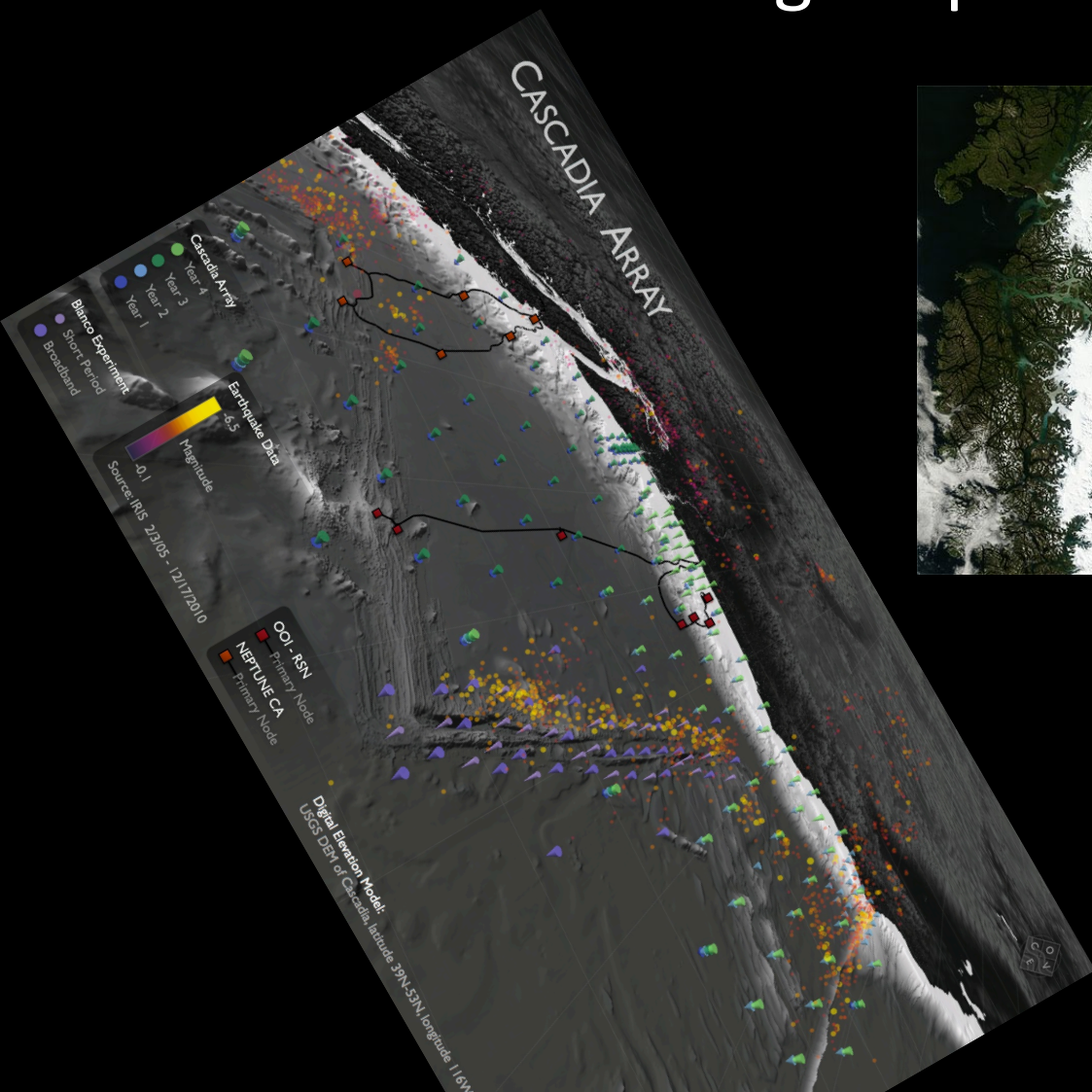
- The plate boundary shear zone

- Deformation of the subducting plate

- Affect of/on the overriding plate

- Asthenosphere/mantle wedge rheology

subduction zones span continental to oceanic environments, and interact with climatological and biological processes



subduction zones host many of Earth's most extreme natural events, coupled with increasing human populations, leads to an urgent need to understand how they work



Tohoku earthquake

Image: Reuters



Sumatra earthquake

Getty Images



Calbuco Volcano, Chile

Alex Vidal Brecas—EPA



Quito Ecuador

Subduction Zone Observatory

Needs to have:

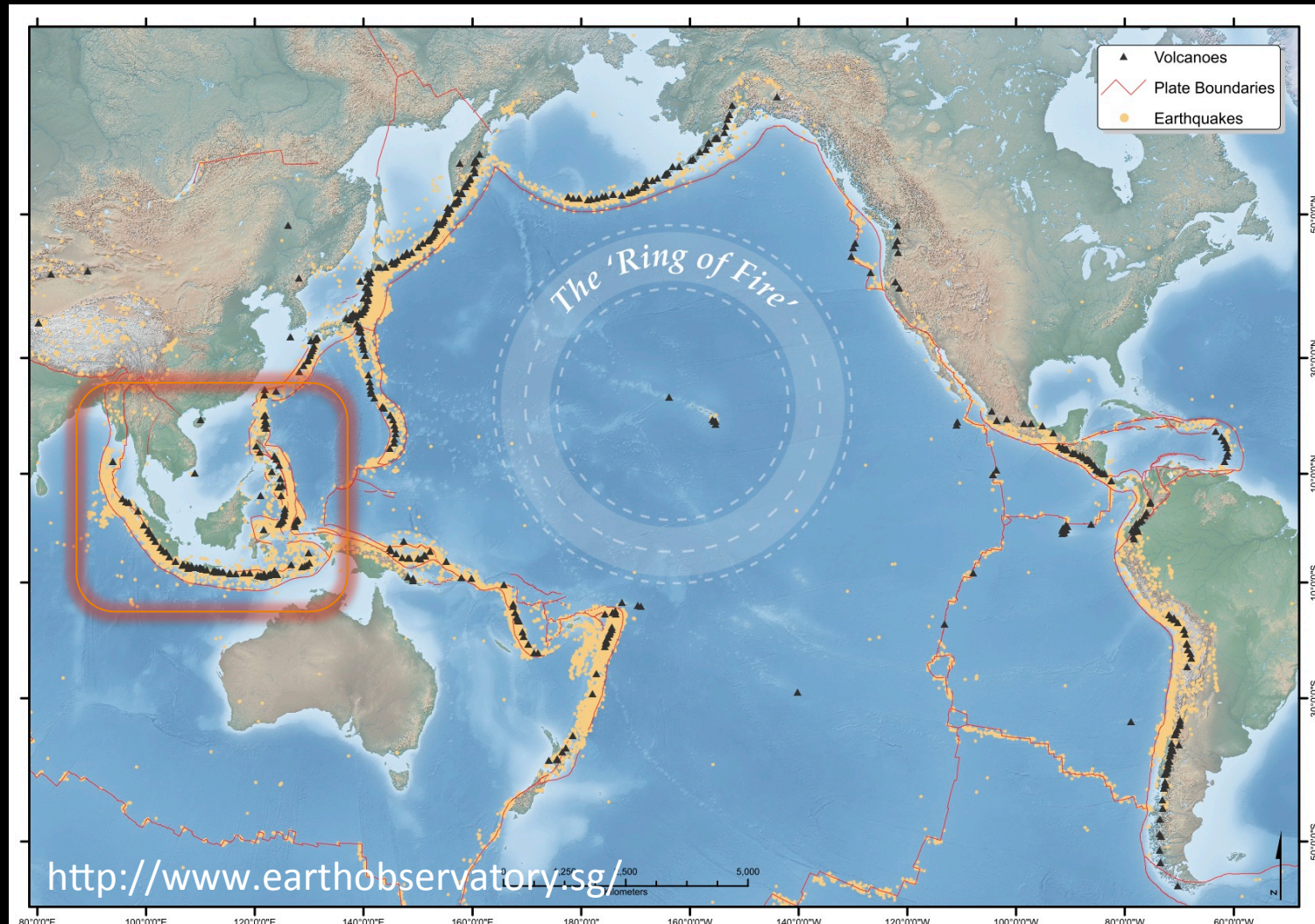
- Transformational & high impact science
- **Societal relevance - strong focus on hazards**
- International collaboration
- Multi-disciplinary components
- On-shore/off-shore
- New technologies
- New high quality data
- Strong integration with modeling

Subduction Zone Observatory

Interdisciplinary approach to solving major scientific challenges

- Observe the entire deformation spectrum from sec to Myrs
- Capture the pre-seismic, co-seismic and post-seismic deformational response to a megathrust earthquake(s)
- Mega thrust interface - earthquakes, slow slip events, episodic tremor, transient deformation
- Tsunami generation
- Volcano processes & hazards
- Imaging the factors controlling geochemical variability in arcs
- Lithospheric dynamics and orogeny – lithospheric modification
- Subduction of water and the Earth's water budget
- Subduction into the lower mantle and the fate of slabs

Subduction Zone Observatory



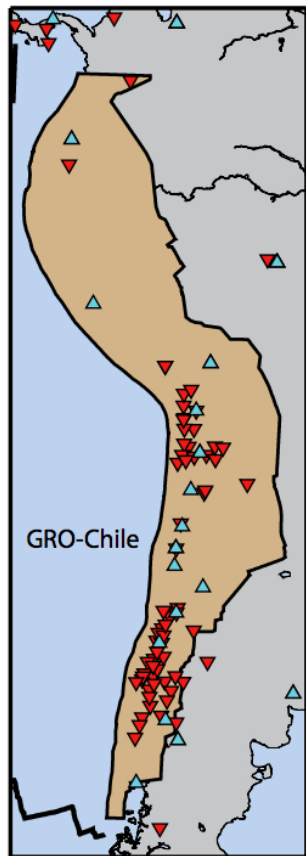
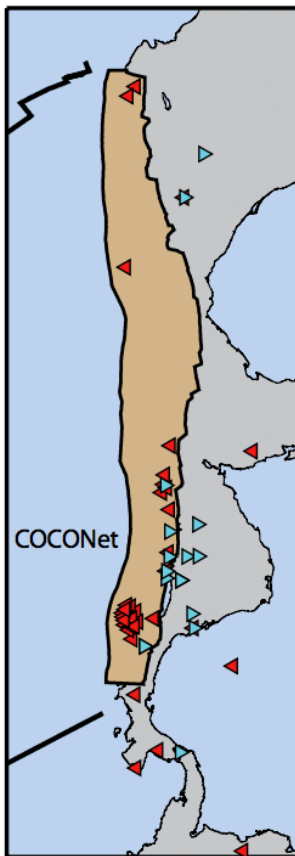
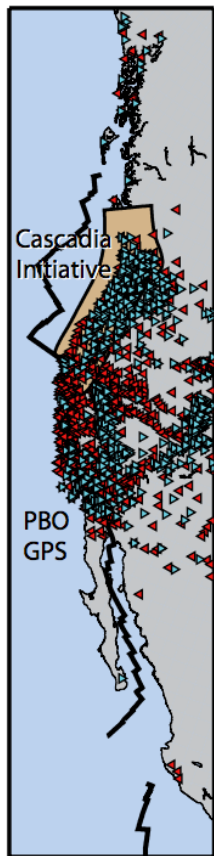
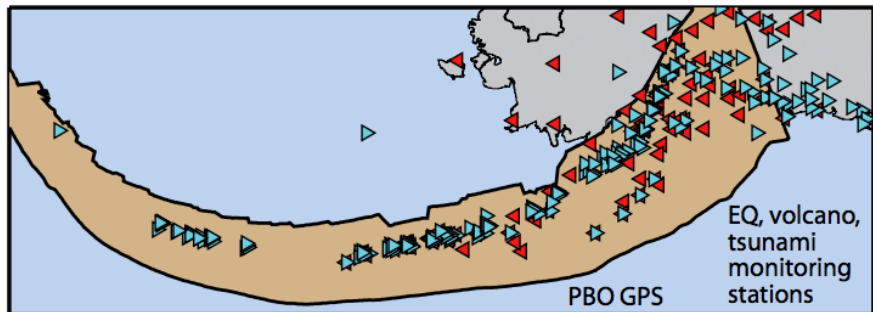
a comprehensive suite of multidisciplinary onshore and offshore observations to understand the entire subduction zone system

Subduction Zone Observatory



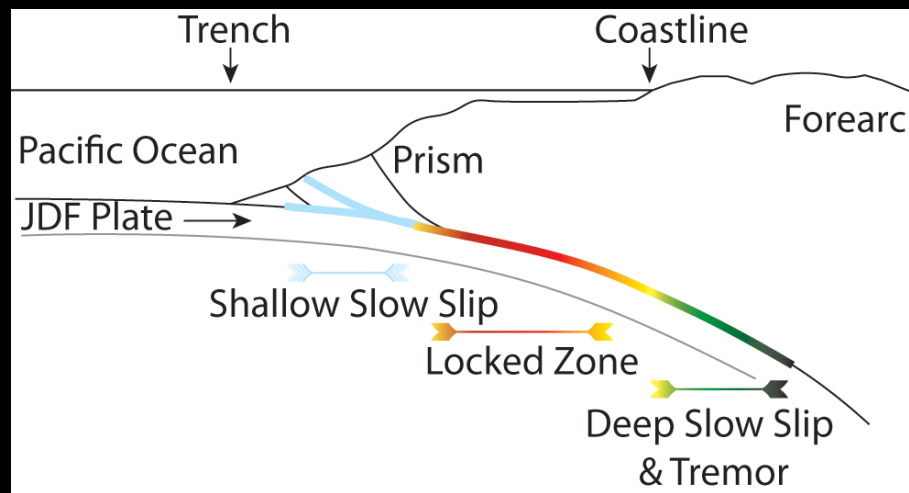
the Americas

Current Availability of Observations Varies Widely



Observations are concentrated in some regions, sparse in others
(GPS: red, seismic stations: blue)

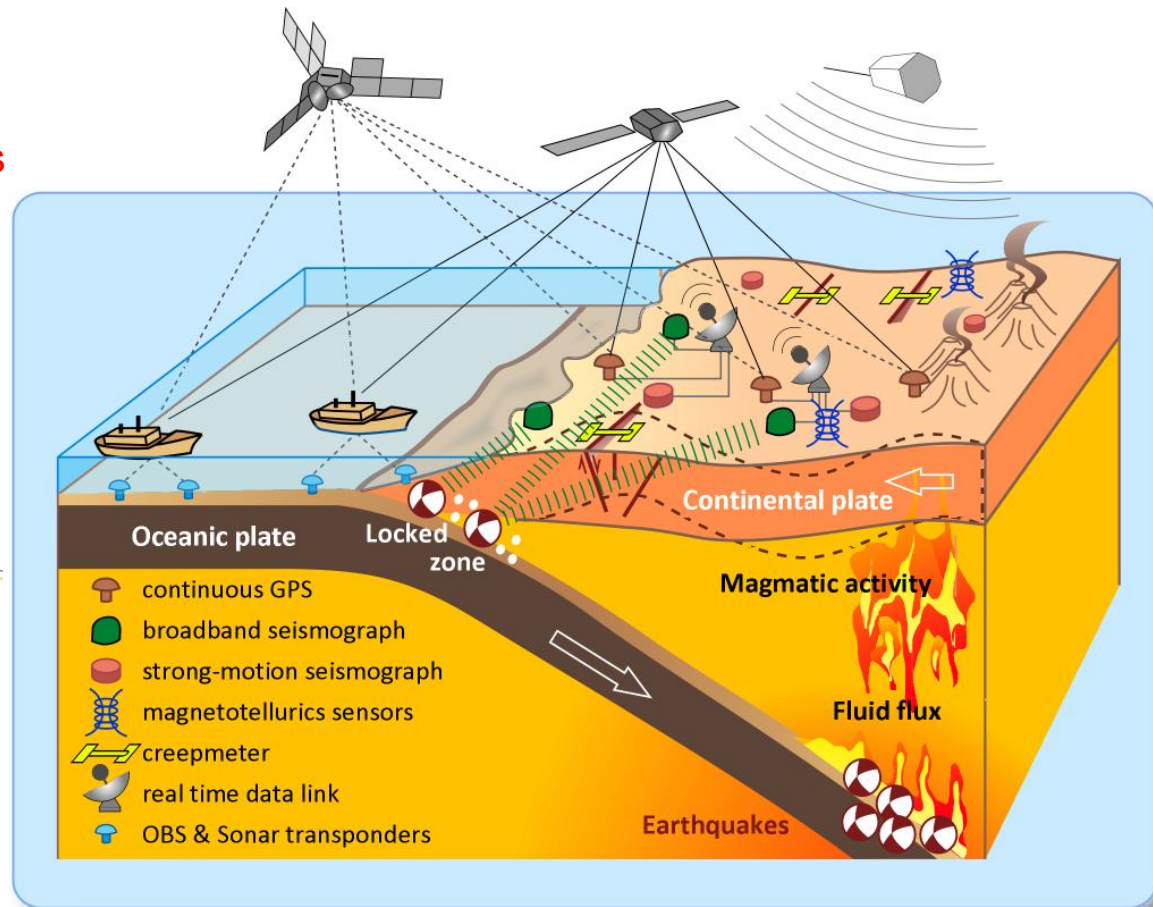
Tremendous lateral variability in the seismogenic portions of the subducting slab (brown)





Integrated Plate boundary
Observatory Chile

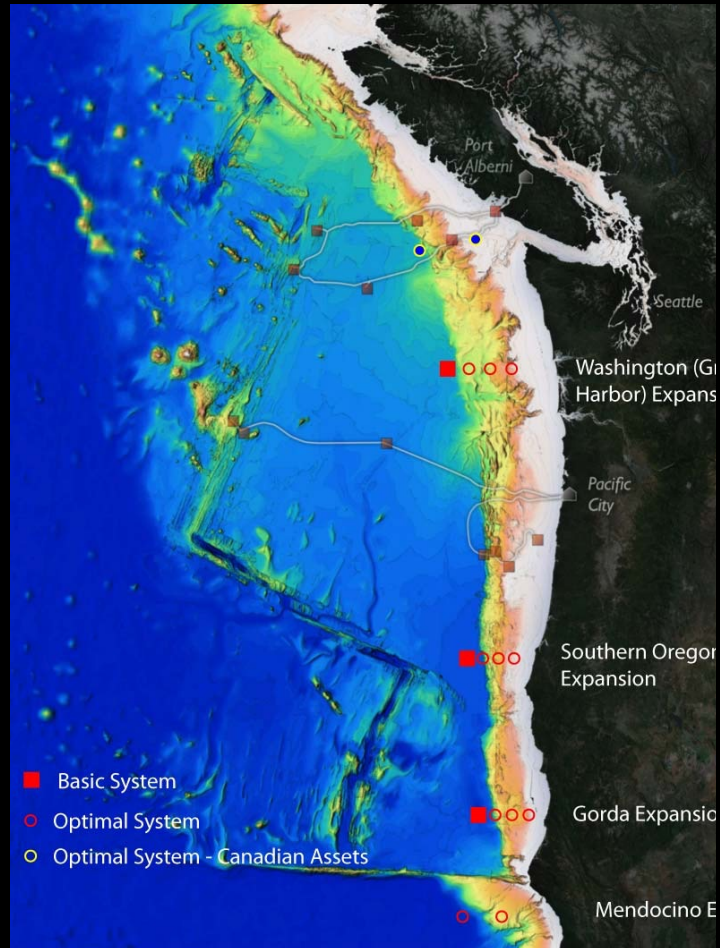
Understand processes
to develop a new
generation of hazard
prediction tools



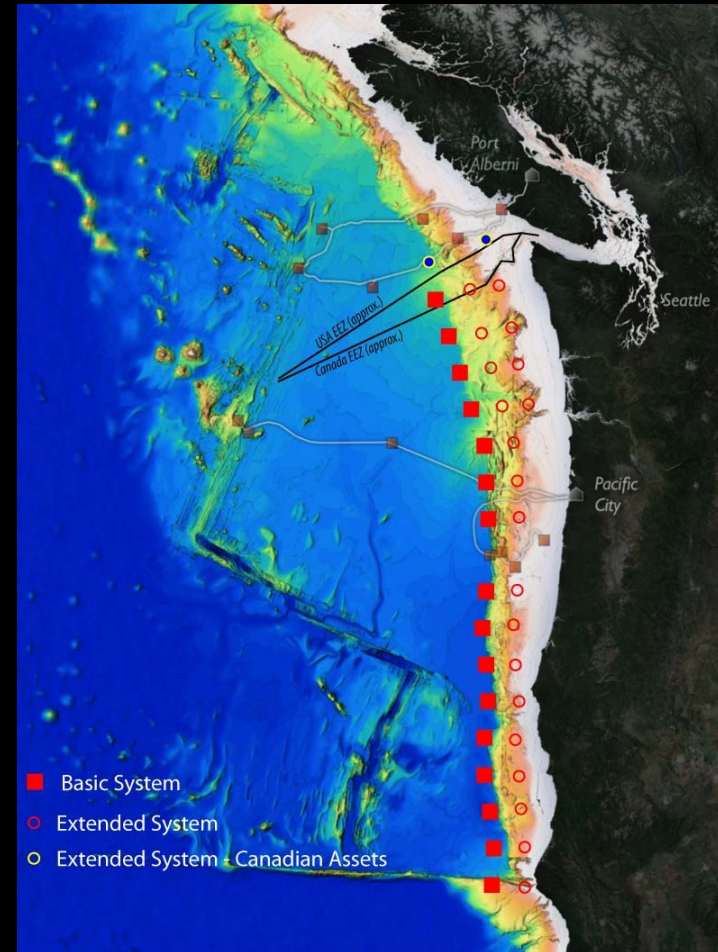
For more information and data portal: ipoc-network.org

Distribution of seafloor instrumentation??

Profiles



Distributed





balance between permanent and temporary?
balance between monitoring and opportunistic?

Onshore...

USArray TA style deployment??

Flexible Array style deployment??

integrated GPS/seismic/infrasound/met pack?

hydrology?

geochemistry?

and...???

SZO's Unique Aspects

- Bold approach to geoscience research: size, scope, data quality
- Integration across a broad spectrum of geoscience disciplines
- **Open data** for: research; hazard assessment, mitigation, and early warning; education and outreach
- Community driven
- Coordinated and collaborative
- **International collaboration on an unprecedented scale**
- Partnerships between academics and multiple agencies
- Substantial outreach component

Subduction Zone Observatory

Related on-going initiatives and activities

- Cascadia Initiative – US, Canada, and Japan
- Neptune/Canada and OOI cabled observatories
- Alaska EarthScope - US
- GeoPrisms – US and international
- International Ocean Drilling Program
- IPOC – GFZ, IGP Paris, Chile, Caltech
- COCONet – Geodesy in Caribbean/central America - UNAVCO & international
- JAMSTEC & ERI - Japan
- Extensive regional networks in Central and South America
- Many more...

Discussions/Community Forums

- UNAVCO GAGE and IRIS SAGE proposals
- IRIS Workshop 2012 and 2014 Workshops
(Boise, ID and Sunriver, OR)
- Breakout session: EarthScope National meeting, May 2013
- Special Interest Group: Fall AGU, Dec. 2013
- IASPEI – LACSC Meeting (Bogota, Columbia), July 2014
- Amphibious Array workshop (Snowbird, UT), Oct 2014

Upcoming Discussion Opportunities

- Today, tomorrow, Friday...
- June 2015: EarthScope National Meeting
- Dec 2015: Proposed AGU special session - Scientific Advances from Subduction Zone Observatories
- March 2016 (tentative): International Workshop with partners

Collaboration and information exchange

- Website:

<http://www.iris.edu/hq/szo>

- Mailing list:

[http://www.iris.washington.edu/
mailman/listinfo/szo](http://www.iris.washington.edu/mailman/listinfo/szo)

Possible items for discussion in panel and breakout groups

- What are the science gains from a Subduction Zone Observatory?
- What subduction zone observations does your science require that you don't have now?
- How can a Subduction Zone Observatory improve hazard assessment, mitigation, and early warning?
- What infrastructure developments are required to implement a Subduction Zone Observatory?
- What are the various models for collaboration?
- What sources/mechanisms exist for funding?