SZ4D PLANS FOR NSF MSRI-2: PROGRESS & PATH FORWARD

CRESCENT SIG - November 18, 2024

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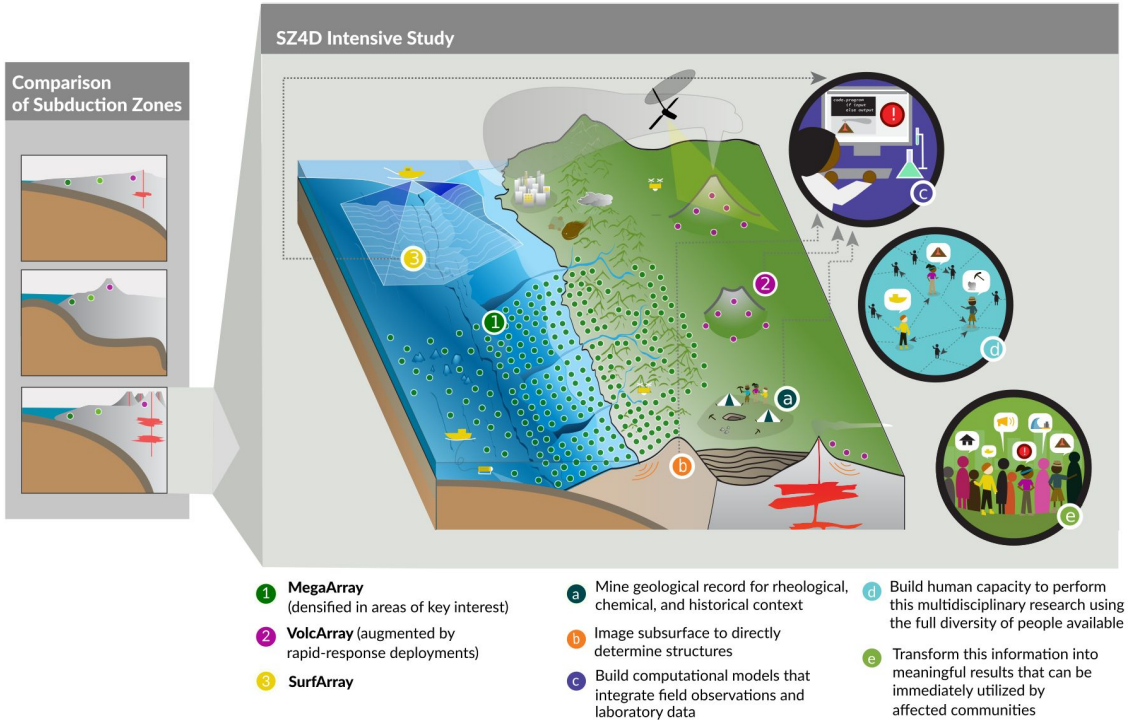
Instrumentation and Activities

Observational arrays

- EarthquakeArray
- VolcArray
- SurfaceArray

Activities

- Analysis of data from arrays
- Other observations:
  - Field geology
  - Geophysical imaging
- Numerical modeling
- Lab experiments
- Training and outreach



SZ4D Implementation Report Fig. ES-1

Locations for study

Recommend:

- Complementary domestic and international sites

Regions of Special Interest:

- Chile

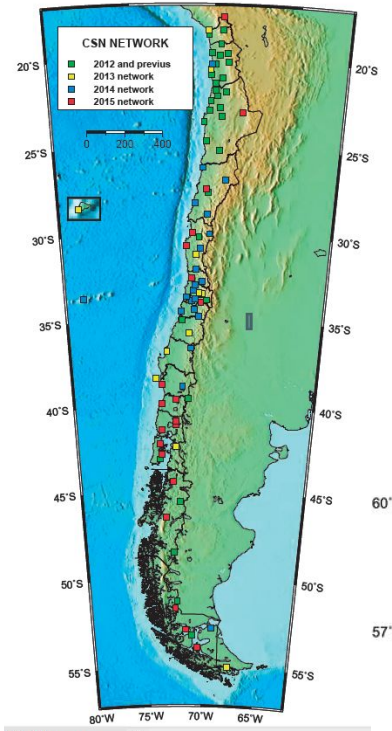
70% Instrumentation; 50% Activities

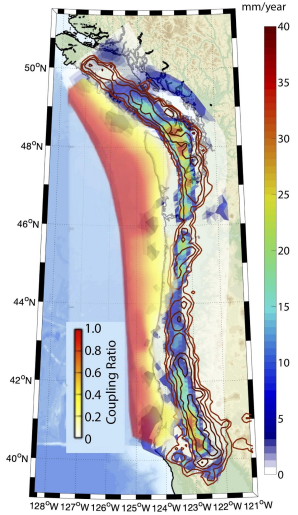
- **Cascadia**

20% Instrumentation; 40% Activities

- Alaska

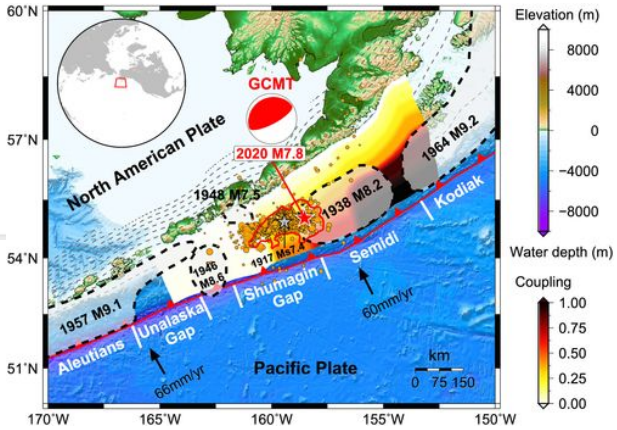
10% Instrumentation; 10% Activities





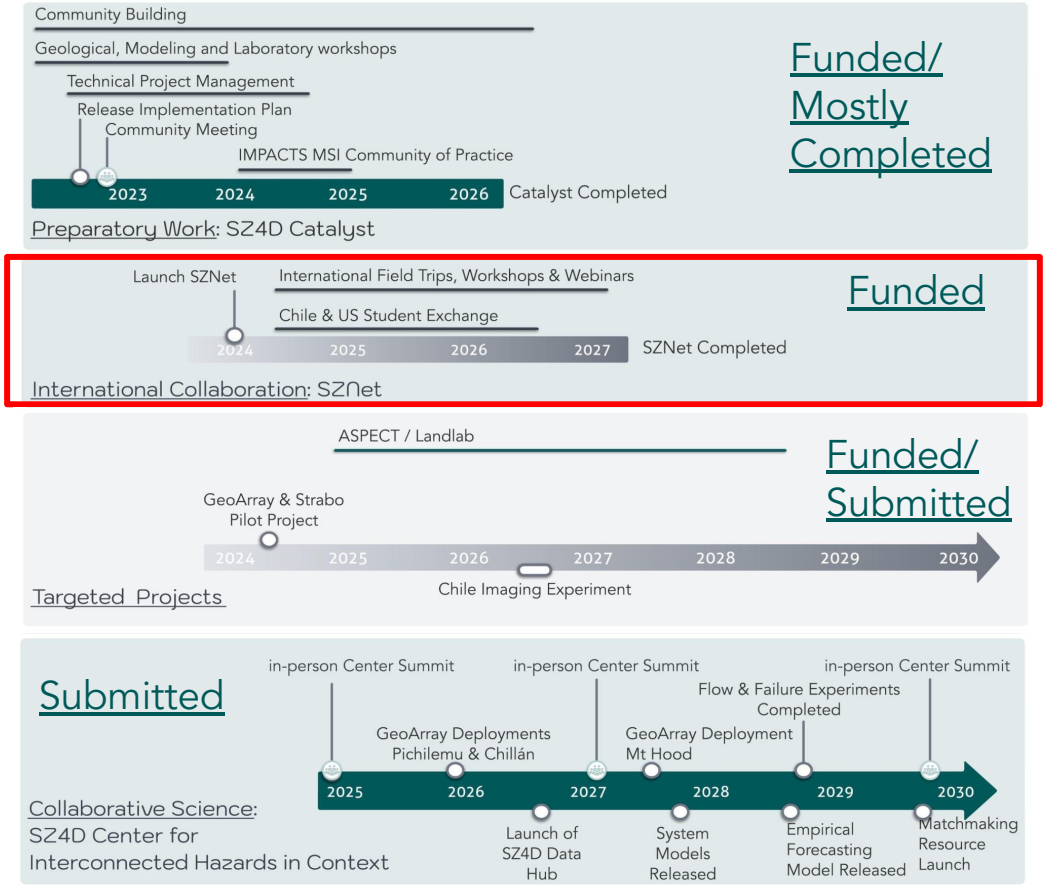
Bartlow (2020)

Liu et al. (2020)



SZ4D Overview

Activities Townhall November 18 (10am PT) - We apologize for double-booking with this meeting! Recording and slides will be available on our website very soon.



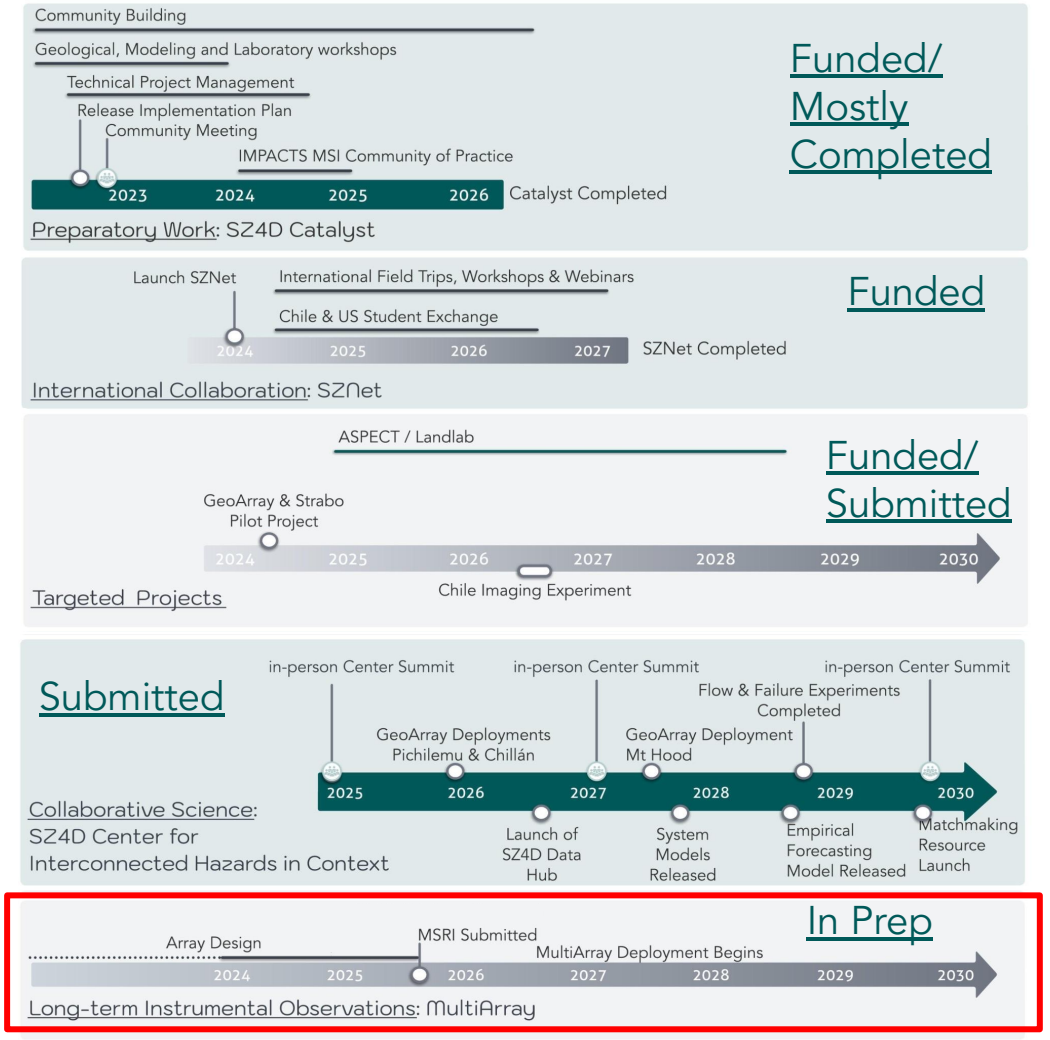
SZNet

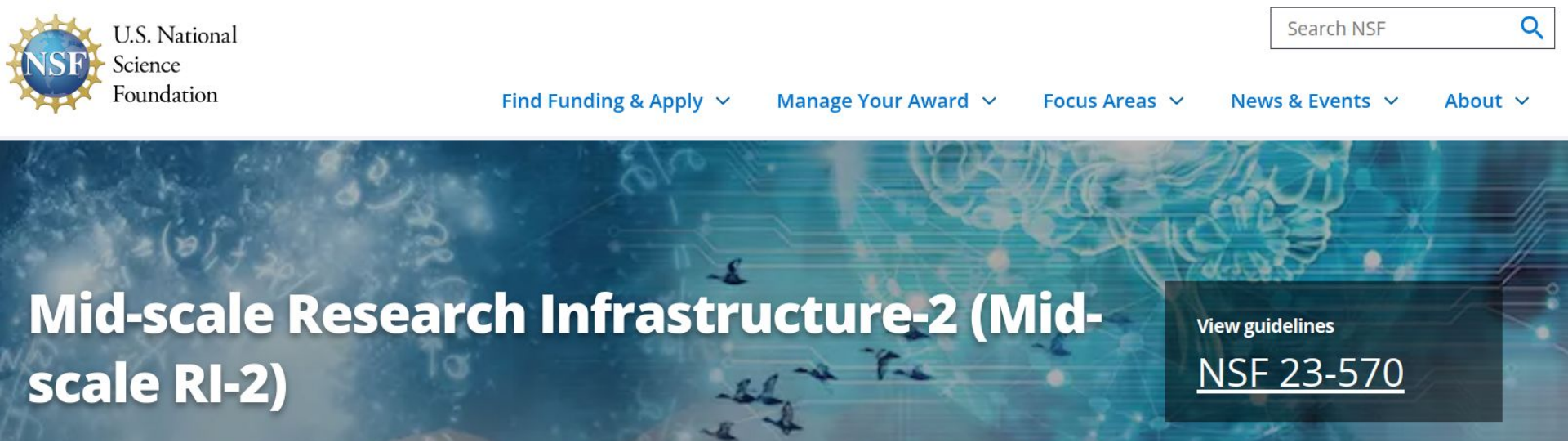
- A Coordinated Global Effort to Understand Subduction Geohazards

OBJECTIVE: Foster international collaboration and communication between active science networks studying subduction zone geohazards

SZ4D Overview

MSRI-2 proposal in prep: The SZ4D MultiHazard Array

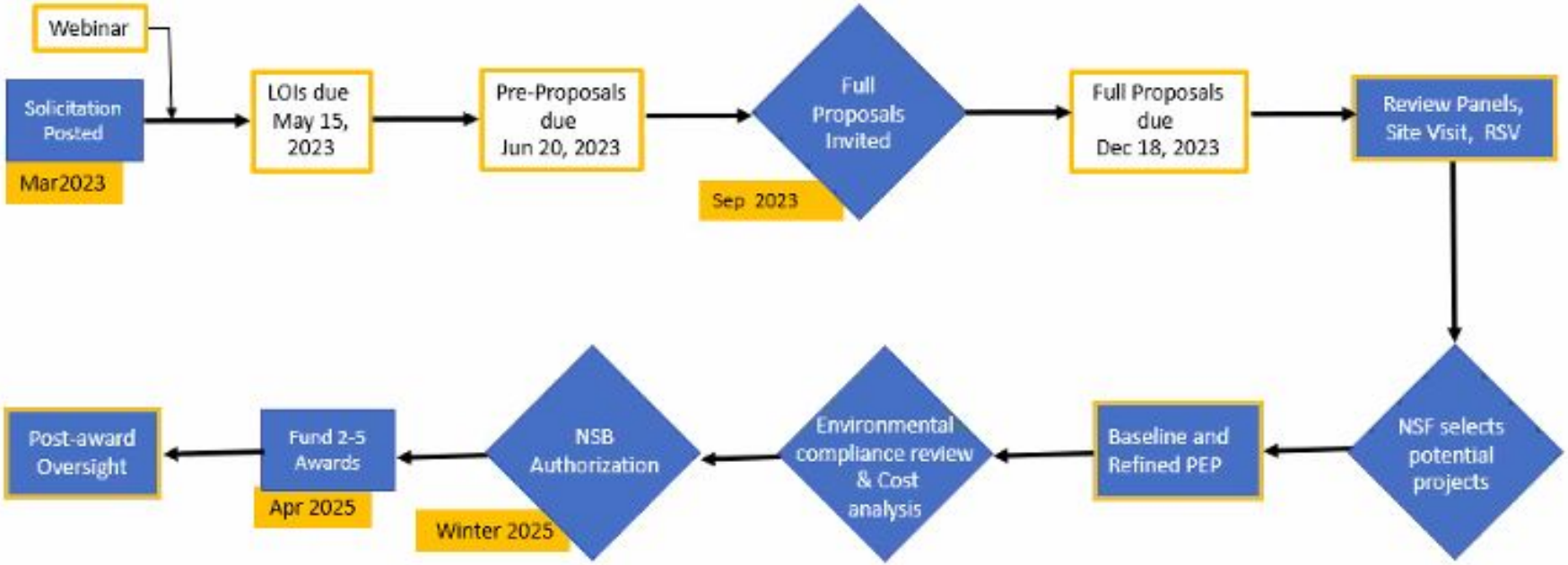




Supports the implementation of research infrastructure - including equipment, cyberinfrastructure, large-scale datasets and personnel - whose total project costs fall between $20 million and $100 million.

- Construction only (5 years):
  - Infrastructure procurement/fabrication, commissioning, and installation
- Operations and Maintenance is separate and also must be affordable to NSF-GEO

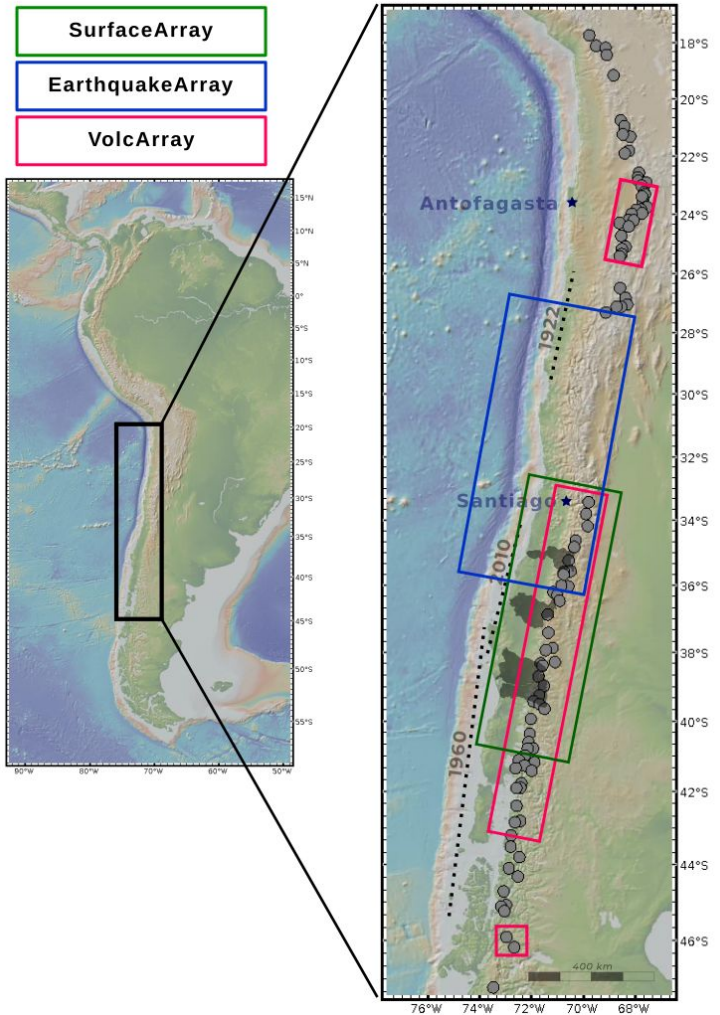
MSRI-2 Pre-Award Process (2023 Cycle)



SZ4D is working towards an MSRI-2 submission in the next cycle (assumed 2025, so all dates +2 years).

SZ4D MultiHazard Array: Chile Node

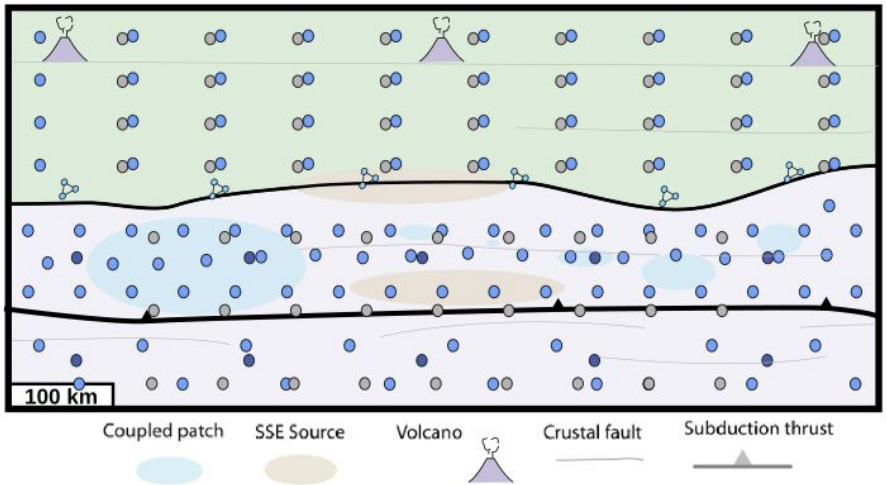
- Main target region: 28°S-43°S
- Developed based on input from AndesNet (SZ4D's Chilean partner consortium)
- Incorporates a nested set of instrumental arrays
  - SurfaceArray
  - EarthquakeArray
  - VolcArray



SZ4D MultiHazard Array: EarthquakeArray

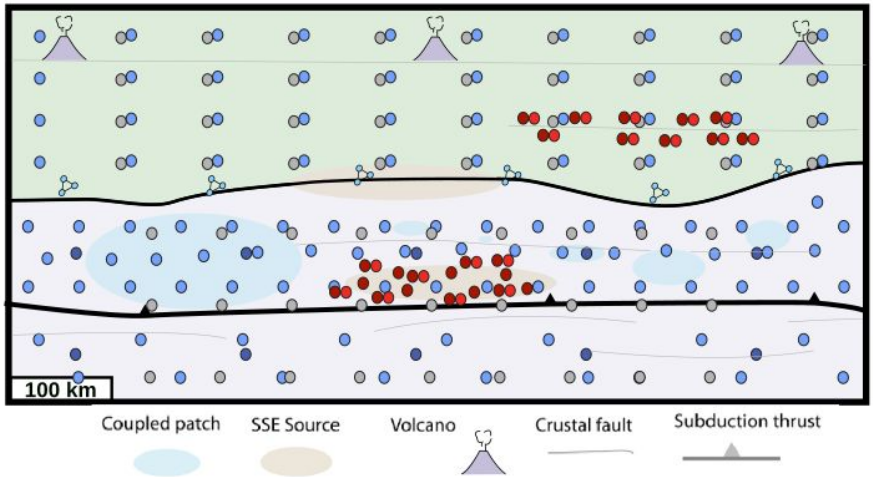
Phase 1:
Offshore (850 x 200 km)
- 70 OBS + APG (denser landward of trench, sparser seaward of trench)
- 50 GNSS-A (70 km spacing)
- 10 Offshore MT (multiphased suvey - multiple two-month drops)

Onshore (850 x 200 km)
- 40 Seismometers (+ other sensors?)
- 36 GNSS (+ other sensors?)
- 6 Microseismicity arrays [1 BB+8 SP]



Phase 2 (6 years):
Offshore (targeted deployment)
- 15 OBS
- 8 GNSS-A

Onshore (targeted deployment)
- 10 Seismometers
- 10 GNSS

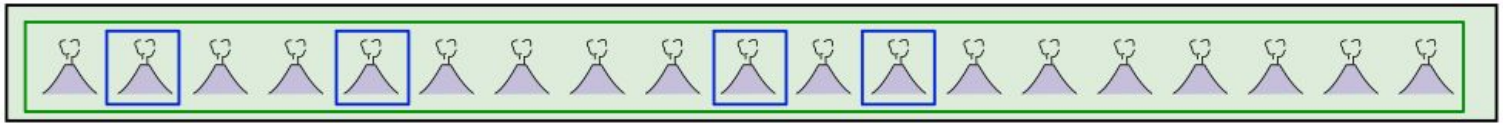


SZ4D MultiHazard Array: VolcArray

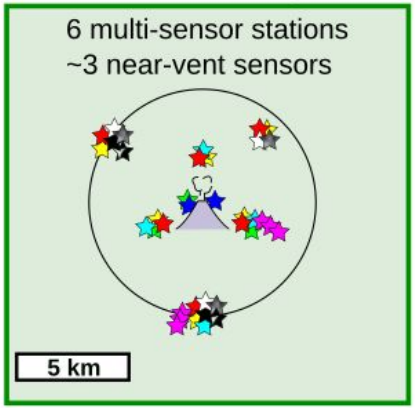
Chile Footprint (1200 x 100 km + additional targets in N. and S. Chile)

22 Volcano Sensor Arrays (10+ years)

4 Volcano Imaging Arrays (2 year data collection)

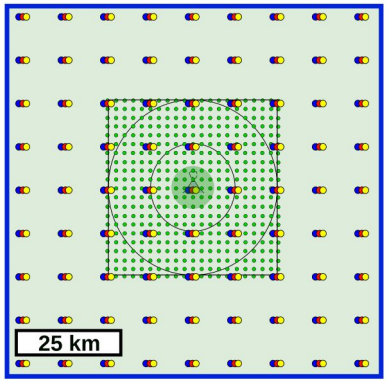


Volcano Sensor Arrays



- 4 Ash Collectors
- 6 Seismometers
- 2*3 Infrasound Sensors
- 3 Tiltmeters
- 6 GNSS
- 2 Webcams
- 3 FLIR
- 3 ScanDOAS
- 2 UV cameras
- 2 MultiGas+met station

Volcano Imaging Arrays



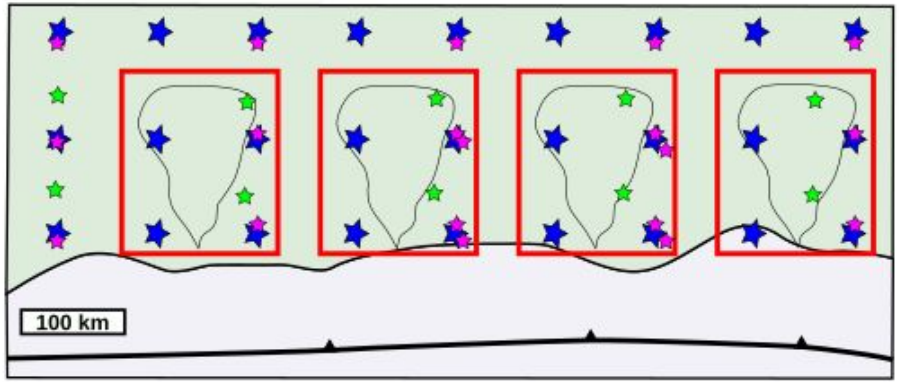
- 80 BB seismic
  (~10 km spacing, 40 km radius)
- 450 Nodal seismic
  (~1.5 km spacing, 20 km radius)
- MT Survey Points
  (~10 km spacing)
- Bouguer gravity/Diffuse CO_2 survey point

VSA footprint

SZ4D MultiHazard Array: SurfaceArray

Backbone Array (over 850 x 300 km region):

- 27 Met Stations (100 km spacing)
- 15 Seismometers (35 km spacing)
- 10 GNSS



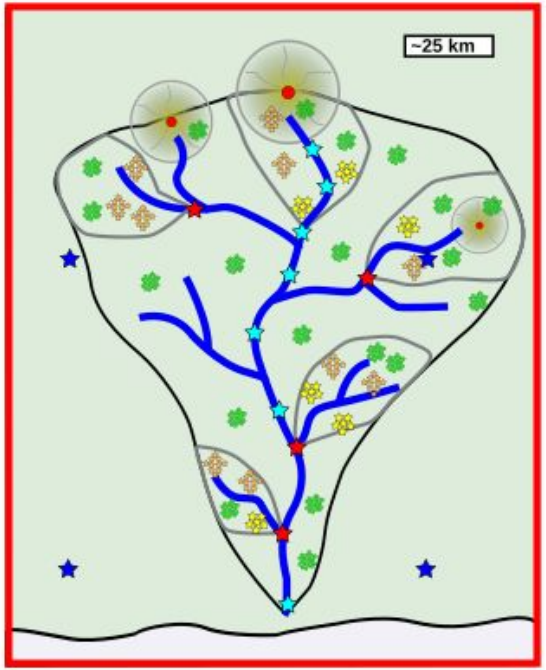
4 Watershed-Scale Arrays (~150 x 175 km each)

Hillslope Arrays:

- 6 Fancy Packs* per watershed - 18 Fancy Packs total
- 10 Midgrade Packs** per watershed - 30 Midgrade Packs total
- 19 Simple Packs per watershed - 57 Simple Packs total

Stream Gauge Arrays:

- 7 radar bounce gauges (stem) per watershed - 21 radar bounce gauges total
- 4 simple level gauges (tributary) per watershed - 12 simple level gauges total



*Fancy Pack (river site):
- Precipitation
- Stream discharge
- Suspended sediment
- Microseismicity

* Fancy Pack (nonriver site):
- Precipitation
- Soil moisture
- Soil temperature
- Microseismicity

**Midgrade Pack (river site):
- Precipitation
- Stream discharge
- Turbidity
- Microseismicity

**Midgrade Pack (nonriver site):
- Precipitation
- Soil moisture
- Microseismicity

***Simple Pack (nonriver site):
- Precipitation
- Soil moisture

SZ4D MultiHazard Array: Alaska and Cascadia Nodes

SurfaceArray:

- **Opportunistic studies and event response to mass movement events (**Alaska and **Cascadia)**

EarthquakeArray:

- 9 OBS/GNSS-A (Alaska)
- 10 onshore seismic/GNSS (Alaska)
- **9 GNSS-A+APG (Cascadia) + 2 wavegliders**

VolcArray:

- **3 Volcano Sensor Arrays (Cascadia)**
- **2 Volcano Imaging Arrays (Cascadia)**
- 5 Volcano Sensor Arrays (Alaska)

Opportunities to address FEC science in Cascadia

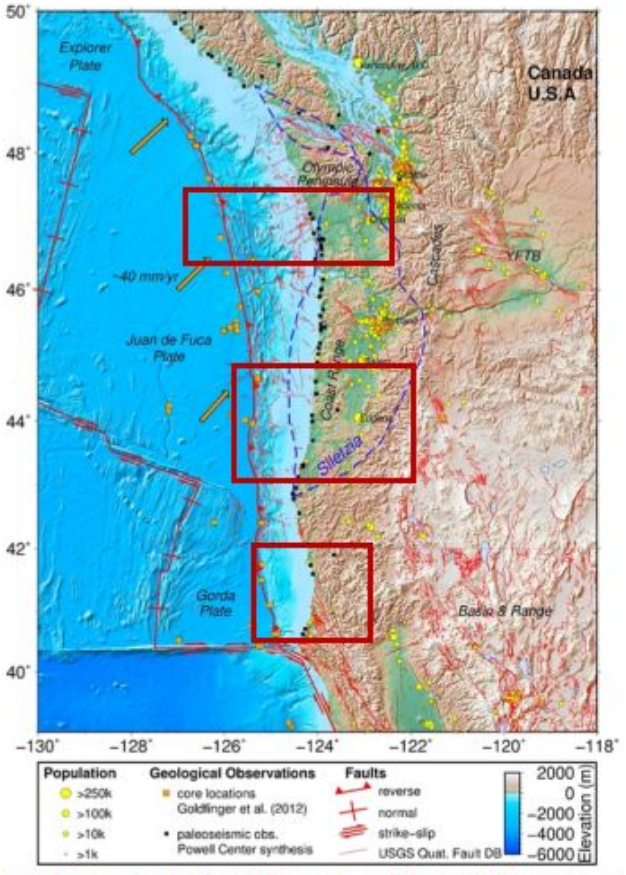
- FEC Q1:
  - Well known faults and terranes in overriding plate - what is their role in strain budget and influence on megathrust behavior?
- FEC Q2 and Q4
  - Along-strike and downdip variations in coupling. *Is megathrust locked to the trench, and does this vary along-strike?* Is coupling linked to subduction input, upper plate structure, or both?

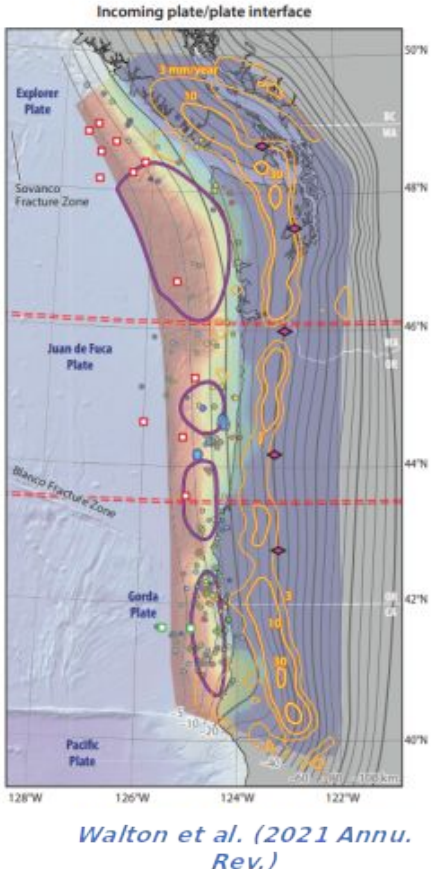
Possible Cascadia Corridors (input welcome!)

(~3-4 GNSS-A + APG per transect)

1. Northern Cascadia: Widest locked zone, which may continue to trench; overriding plate faults
2. Central Cascadia: Variation in locking and upper plate terranes
3. Southern Cascadia: Relationship of upper plate faulting and megathrust

Refine based on other planned deployments (community geodesy experiment, OOI cable deployment plan) and logistics (e.g., bathymetry, CASIE seismic lines)





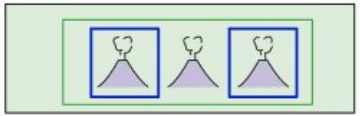
Walton et al. (2021 Annu. Rev.)

SZ4D MultiHazard Array: VolcArray

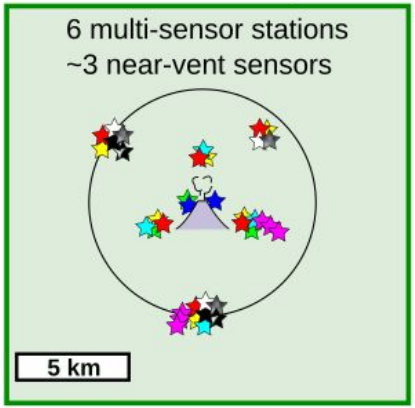
Cascadia Footprint

3 Volcano Sensor Arrays (10+ years)

2 Volcano Imaging Arrays (2 year data collection)



Volcano Sensor Arrays



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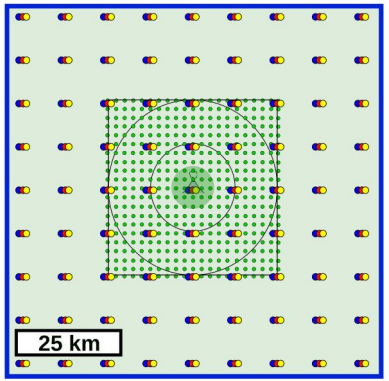

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SZ4D MultiHazard Array Budget: Status

- Initial budget modeling based on ‘wishlist’ infrastructure cartoons is now complete.

- <u>The initial budget model is too big</u> (with lots of uncertainties) -

We need to plan for budget and scope reduction.

Table 2.9.1 – Summary of Oversight Requirements for Major Facility versus Mid-Scale RI

NSF Oversight Requirements for Major Facility versus Mid-scale		
	Major Facilities	**Mid-scale RI**
Budget Contingency	YES For Construction Stage, Monte Carlo (MC) simulation methods to demonstrate 70-90% confidence.	NO **(Highly Recommended)** Simplified algorithmic method to full Monte Carlo (MC) simulation, if proposed.
Schedule Contingency	YES	NO
Scope Contingency	YES At least 10% of baseline cost	NO (Recommended based on project complexity and risk profile)

SZ4D MultiHazard Array Budget Refinement Plan

- PI/OPC-I will continue to refine budget with input from WGs
  - Goal: Turning the budget model into a proposal that complies with the MSRI-2 solicitation and budget cap, focused on the highest priority science elements.
  - WGs will provide main guidance on priority elements.
  - Transparent process for making these decisions (change control)

- SZ4D WGs will continue to refine the experiment plan
  - Continued footprint refinement (target volcanoes, watersheds, fault segments)
  - Design proposal (in review) to assess critical instrument density/topology (if funded, basis for prioritization by WGs)

NSF PROPOSAL SUBMITTED TO NSF MGG MAY 2024 (PENDING)

“Data- and model-driven optimization of the SZ4D MultiArray”

(Lead PI - Roman) (“Design Proposal”)

Table 1. Synopsis of the proposed Work Packages

Work Package	Summary of work	Personnel
MegaArray-1	Assessment of seismicity detection capabilities in Chile	Barcheck, Potin, Ruiz
MegaArray-2	Synthetic seismic resolution modeling of MegaArray configurations	Fan
MegaArray-3	Modeling to assess GNSS resolution	Newman, Baez
MegaArray-4	Optimizing APG distribution to detect offshore transient distribution in the face of realistic ocean noise	Wei, Fredrickson, Wallace, Moreno
MegaArray-5	Assessment of oceanographic/bathymetric conditions and implications for OBS deployment logistics	Collins, Barclay, Ferrini, Caceres
SurfaceArray-1	GIS database assembly for candidate watersheds in Chile	Finnegan
SurfaceArray-2	Coupled hydrologic-sediment transport modeling to optimize SurfaceArray	Yanites
VolcArray-1	Synthetic seismic resolution modeling of VolcArray (VIA) configurations	Byrnes
VolcArray-2	Conceptual VolcArray (VSA) design - to be based on USGS/NVEWS - no NSF funding required	*N/A*
MultiArray-1	Synthesis and Integration	SZ4D OPC-I EarthScope Consortium

SZ4D MultiHazard Array Scope Refinement Plan

- Optimize the plan based on quantitative analysis of current capabilities, and resolution simulations (design proposal, if funded)
  - Some infrastructure in Chile already exists (e.g., seismic, geodetic networks)
  - Some instruments can contribute to multiple arrays
  - Tradeoffs between spatial coverage and spatial density will be analyzed
  - WGs will provide main guidance on priority targets.
  - Transparent process for making these decisions (change control)

Transition to Operations and Decommissioning

- All instruments will operate for a minimum of 10 years
  - Domestic data will be made openly available immediately
  - Raw data + metadata and limited data products (input welcome!)

- Decommissioning plan - long-term adoption(?)
  - Depends on commitments/funding
  - Alternatively, return to instrument pools
  - Input welcome!

SZ4D MSRI Planning - How to Stay Informed and Engaged

- AGU 2024 townhall - Wednesday, December 11, 6-7pm
  - Updates and a breakout discussion on the MSRI proposal

- Stakeholders meeting (invite-only) prior to USGS SZS workshop in January (CRESCENT reps will attend)

- Where to provide input, get updates, and ask questions in the interim:
  - New ‘Infrastructure Planning’ webpage @ www.sz4d.org
  - Email the SZ4D OPC-I or Infrastructure PI**
  - Email the SZ4D Working Groups**

 www.sz4d.org*  contact@sz4d.org**