AndesNet & SZ4D Scientific Community Workshop

A workshop funded by
the National Science Foundation

June 12-14, 2023
Termas El Corazón, Chile

SZ4D

SZ4D
defining the limits and possibilities
of predicting geohazards

Organizing Committee

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This meeting is funded by the National Science Foundation

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Document prepared by Anaïs Férot, SZ4D Office
Last update June 6, 2023

Remarks from the Organizing Committee

Estimados y estimadas colegas, Dear Colleagues,

On behalf of the Organizing Committee for the 2023 AndesNet & SZ4D Scientific Community Workshop, we look forward to welcoming you to Termas el Corazón next week!

The primary goal of this year's workshop is to develop a consensus recommendation from AndesNet to SZ4D on an instrumental array configuration and priority science activities to meet the scientific objectives outlined by both groups. Through a series of plenary and breakout discussions, you will help to define:

- A prioritized list of three ~500-km-long zones for the location of MultiArray (formed by the overlap of VolcArray, SurfArray, and MegaArray), along with a recommendation for the locations of VolcArray, SurfArray, and MegaArray
- A list of high-priority scientific efforts ("activities", e.g., geologic mapping, sampling, modeling) that do not depend on the location of the Arrays.

In addition, workshop attendees will begin discussions about how the SZ4D-AndesNet collaborative scientific effort should work, focusing on individual and group roles, data policies, and immediate science opportunities and critical funding needs. Workshop attendees will also discuss and identify the challenges that could arise in the deployment of the arrays and begin to discuss mechanisms that resolve these challenges.

Scan to visit the meeting webpage

AndesNet & SZ4D Scientific Community Workshop

An NSF-sponsored workshop on Chilean subduction zone geohazards

June 12-14, 2023 | Termas El Corazón, Chile

Conference Room: Azúl Room
Breakout Rooms: Salones San José, San Francisco, Juncal, Azúl, Library
Meals served in Galería and Mirador Rooms
Poster Session and registration booth in Foyer

SUNDAY June 11

18:00 | Early Career informal dinner (Mirador room)

18:00 | Organizing Committee dinner (Mirador room)

MONDAY June 12

7:30-9:00 | Breakfast (Galería room)

9:00-12:00 | Early Career Symposium (Azúl room) - Conveners: Alejandra Serey y Ignacio Sepúlveda

12:00-14:00 | Welcome lunch and registration (Lunch in Mirador room, registration booth located in the foyer by the meeting room Azúl)

** Meeting starts at 14h**

14:00-15:30 | SESSION 1 - Welcome & introduction

Moderators: Diana Roman and Cristian Farías

14:00-14:15 | Welcome and overview of meeting objectives, code of conduct, and feedback from Termas 1.0 - Diana Roman

14:15-14:45 | Introductory remarks from Chilean and U.S. Agencies (5 min each)
Moderator: Cristian Farías

- Gonzalo Arenas, Head of International Affairs at Ministry of Science, Technology, Knowledge and Innovation
- Shelby Walker, National Science Foundation
- Alejandra Avila, Subdirectora Nacional de Geología, SERNAGEOMIN
- Alvaro Hormazabal, Director Nacional, SENAPRED
- Lt. Matías Sifón, Head of Oceanography Department. Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)

14:45-14:55 | Panel Question & Answer. Moderator: Cristian Farías

14:55-15:25 | SZ4D overview - Emily Brodsky

15:25-15:45 | SZ4D activities and Collective Impact - Kristin Morell

15:30-16:00 | Coffee break

16:00-16:15 | Question & answer on SZ4D

16:15-19:00 | SESSION 2 - Survey results & plenary discussion

Theme: Summary of results from AndesNet survey and SZ4D All-Hands regarding MultiArray location as a starting point for workshop discussions
Moderator: Ignacio Sepulveda

16:15-16:30 | AndesNet survey results - Andrés Tassara

16:30-17:30 | "Thunder talks" - 3 minutes to share personal opinion on MultiArray locations - 1 slide (optional). *Send an email to Anaïs by 12PM to sign up*

17:30-18:00 | SZ4D All-Hands meeting results - Donna Shillington

18:00-19:00 | Plenary discussion & questions

19:00-20:00 | Poster session & cash bar (Foyer)

20:00 | Dinner (Mirador room)
A local artisan market will be available on site in the evening

Tuesday June 13

7:00-8:30 | Breakfast (Galería room)

8:30-12:00 | SESSION 3 - Breakout session 1

Theme: MultiArray location

Moderator: Doug Wiens

8:30-8:35 | Reminder of charge for the meeting and goals - Doug Wiens

8:35-10:00 | Invited talks (three 30-minute talks on three possible MultiArray zones arising from AndesNet survey)

- 8:35-9:05 | Presentation Seg 14-16 y 20 - Ayleen Gaete
- 9:05-9:35 | Presentation Seg 8-10 - Sergio Ruiz y Juan González
- 9:35-10:05 | Presentation Seg 4-6 - Felipe Aguilera + Ckelar

10:05-10:35 | Coffee break

10:35-10:45 | Breakout instructions and group assignments

10:45-11:45 | BREAKOUT 1: Mixed groups discuss array configuration options and zones of overlap for MultiArray

11:45-12:30 | BREAKOUT 1 : Report-back and plenary discussion and conclusion
**** Participants will identify up to 5 configuration options at this point for discussion in Breakout 2 ****

12:30-14:00 | Group photo & lunch (Mirador room)

14:00-14:30 | “Lightning Talks” related to participant research projects (e.g., advertise posters, recent papers) 1 min each, 1 slide (optional)
Send an email to Anaïs by 12PM to sign up
Moderator: Thorsten Becker

SESSION 4 | Session 4 - Breakout session 2

Theme: Focus on the 5 zones identified in Breakout 1

Moderator: Álvaro Amigo

14:30-14:40 | Breakout instructions and group assignments

14:40-15:40 | BREAKOUT 2: Mixed groups discuss current array configuration options and rationale for SZ4D/AndesNet activities along with priority activities in any segment

15:40-16:10 | Coffee break

16:10-16:40 | BREAKOUT 2: Report-back and plenary discussion

16:40-17:30 | Survey to create consensus on 3 priority zones for MultiArray
Moderators: Andrés Tassara and Alejandra Serey Amador

17:30-19:30 | Poster session & cash bar (Foyer)

19:00 | Social activity: Wine tasting at the hotel (1hr activity, optional, Azúl)

20:00 | Formal Dinner (Galería Room)

A local artisan market will be available on site in the evening

Wednesday June 14

7:00-8:30 | Breakfast (Galería room)

8:30-10:00 | SESSION 5 - Results of final survey and agreement consensus recommendation for geography

Moderator: Esteban Gazel

8:30-9:00 | Presentation of final survey results and proposed consensus recommendation on MultiArray location (3 highest priority zones) and segments of interest to individual arrays
Moderators: Andrés Tassara and Cristian Farías

9:00-9:30 | Discussion on prioritization ranking of 3 priority zones for MultiArray

9:30-10:00 | Final voting on prioritization of 3 zones and concluding recommendation on array configuration (*real-time*)

10:00-10:30 | Coffee break

10:30-12:30 | SESSION 6 - Coordination and collaboration

Theme: Internal coordination strategy
Moderator: Alejandra Serey

10:30-10:50 | Plenary presentation: How can Chile- and Argentina-based scientists get support from the U.S.? (NSF - Shelby Walker, SZ4D - Mark Behn)

10:50-11:10 | Breakout instructions and group assignments

11:00-12:00 | BREAKOUT 3: What are immediate opportunities/mechanisms in Chile to do collaborative subduction zone science? What should AndesNet do to facilitate these and overcome challenges in the next 2-3 years?

12:00-12:20 | Final plenary discussion: How to integrate/support activities and deployments that are not in prioritized MultiArray locations?

12:20-12:30 | Reimbursement and survey instructions - Anaïs Férot
Survey will be collected after lunch

12:30-14:00 | Lunch (Mirador room)

14:00-15:30 | SESSION 7 - Final plenary session

Theme: The road ahead
Moderator: Laura Bono Troncoso

14:00-14:45 | Plenary panel discussion formulating next steps (build 2-3 year plan/roadmap for SZ4D-AndesNet joint scientific and community-building activities)
Panelists: SZ4D (Brodsky, Behn, Morell), AndesNet (Amigo, Barrientos, Bono Troncoso)

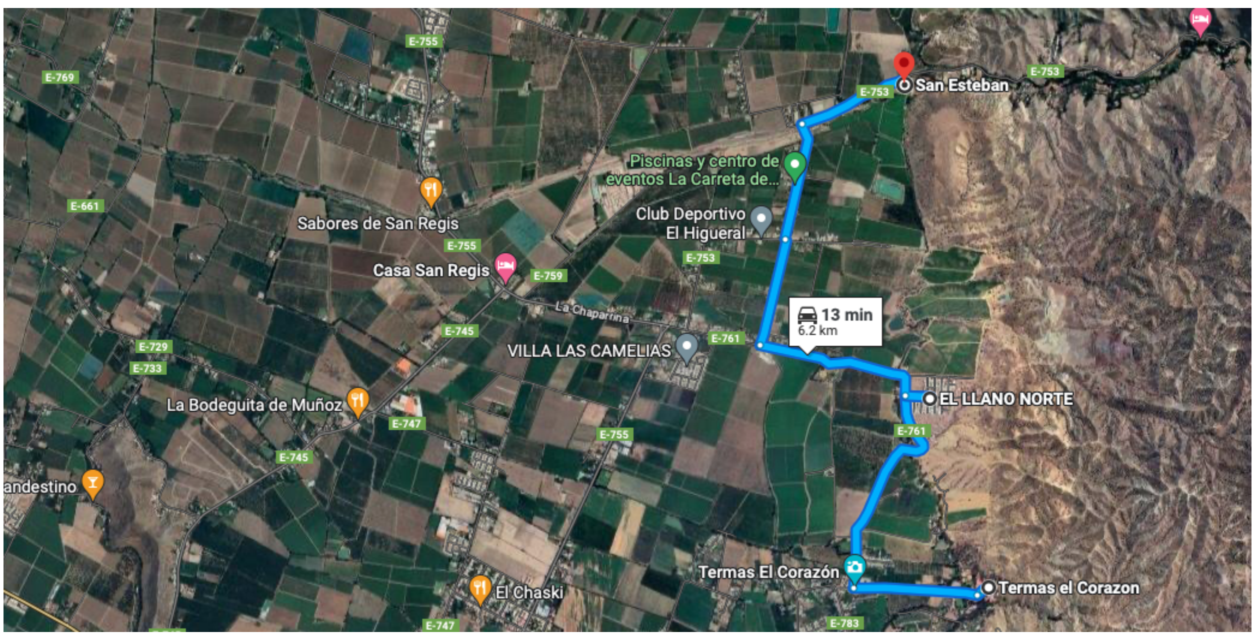
14:45-15:15 | AndesNet needs (summarize panel and next steps (Tassara)

15:15-15:30 | Meeting conclusion (Emily Brodsky and Cristian Farías)

** Meeting adjourned at 15h30**

16:00 | Post-workshop field trip to fault (optional, 14 people max) - Luisa Pinto Lincoñir
Send an email to Anaïs to register - first come first serve

Visit (by mini-bus) to at least three outcrops of the Cariño Botado fault system outcrops. These outcrops include dated alluvial tilted and non-tilted deposits that delimit the age of the last activity of the main fault of the system. In addition, we can see in the distance fluvial and alluvial deposits raised tens of meters above the current rivers/creeks that show an older activity of the faults. To understand the implications of the seismic hazard of these faults, they will be contextualized in a geological map and satellite image, in addition to a field guide.



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- POSTER ABSTRACTS -

The IPOC magnetotelluric array monitoring the subduction zone in northern Chile

Jaime Araya Vargas, Oliver Ritter

The subduction zone in northern Chile (19.7°-23.2°S) is monitored since 2007 by the IPOC array of magnetotelluric sites. Numerical simulations suggest that the magnetotelluric array can detect large-scale electrical resistivity changes in the megathrust region, e.g. as a consequence of post-seismic fluid flow events triggered by large earthquakes. However, anomalies identified to date in magnetotelluric data seem to be caused by resistivity changes related to upper plate faults. The IPOC data and measurements conditions have also challenged aspects of the theory and instrumentation of magnetotellurics. Practical issues involved in maintaining a monitoring array and future perspectives are discussed.

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The river structure of fault-bounded mountains can be used to inform seismic hazard assessments

Felipe Aron, Samuel A. Johnstone, Andreas Mavrommatis, Robert Sare, Frantz Maerten, John P. Loveless, Curtis W. Baden, George E. Hilley

The 1989, Mw = 6.9 Loma Prieta earthquake resulted in tens of lives lost and cost California almost 3% of its gross domestic product. Despite widespread damage, the earthquake did not clearly rupture the surface, challenging the identification and characterization of these hidden hazards. Here, we show that they can be illuminated by inverting fluvial topography for slip-and moment accrual-rates—fundamental components in earthquake hazard assessments—along relief-generating geologic faults. We applied this technique to thrust faults bounding the mountains along the western side of Silicon Valley in the San Francisco Bay Area, and discovered that these structures may be capable of generating a Mw = 6.9 earthquake every 250–300 years based on moment accrual rates. This method may be deployed broadly to evaluate seismic hazard in developing regions with limited geological and geophysical information.

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Understanding the coastal cliff evolution in rock coasts: insights from an exploratory numerical model

Camila Arróspide, Germán Aguilar, Joseph Martinod, María Pía Rodríguez, Vincent Regard

Cliff activity in shoreline systems is modulated by processes such as landmass uplift, marine erosion, and previous topographical conditions. We present an exploratory numerical model to study the influence of these processes on coastal cliff activity. This model purposely considers values of uplift, marine erosion, and initial topography according to the Atacama Desert coast in northern Chile. We show that the morphology of the coastal zone does not simply reflect the rate of tectonic uplift. It depends on a number of parameters that must be taken into account to decipher the tectonic signal highlighted by the presence of inactive cliffs.

Continuous activity of nonvolcanic tremor activity in the vicinity of the Chile triple junction over time

Kellen Azua, S. Ruiz, H. Sugioka, H. Shiobara, A. Ito, M. Shinohara, M. Miller, J. Ojeda, C. Tassara, M. Kinoshita, T. Iidaka, H. Iwamori

The subduction of active spreading centers is an unusual phenomenon along subduction zones. In southern Chile, the Chile ridge subducts beneath the South American plate forming the Chile triple junction (CTJ). The difference in convergence rate between the northern (6.6 cm/yr) and southern (1.8 cm/yr) regions of the CTJ, as well as the presence of a slab window south of the CTJ, make this area of particular interest for studying seismogenic behavior. Recent studies in the zone have given new evidence of a possible brittle and brittle-ductile behavior in the superficial part, capable of generating earthquakes, LFEs, and nonvolcanic-tremors (NTVs). To study in detail the long-term seismic behavior of CTJ, an OBS network was deployed between 2019 and 2021. Two years of continuous data have been analyzed using the envelope technique and cross-correlation of the vertical and horizontal components. Preliminary results in this study show a constant activity over the years of shallow NVTs in the vicinity of the CTJ.

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Variations in b-value as a precursor tool in silicic volcanic systems: the case of the Laguna del Maule Volcanic Complex

Daniel Basualto, Cristian Farías, Jonathan Lazo, Pablo Gonzales, Fabian Valdés, Ivo Fustos

Monitoring active volcanoes involves the use of a series of physical parameters to understand the processes occurring in metastable volcanic systems. However, the existence of other tools that require more advanced post-processing, such as b-value, has contributed successfully to the discussion and prediction of eruptions. However, this tool is still controversial, as the b-value is highly dependent on the completeness magnitude (Mc). For this reason, we propose working with a new method called "b-Positive [β+]" (van-der-Elst 2021), as β+ is calculated from the distribution of positive differences between successive magnitudes of earthquakes. Preliminary results obtained through temporal analysis for Laguna del Maule [LDM] show significant variations in β+ since May 2021. Special attention is warranted for decreases in β+ followed by abrupt increases, as significant oscillations suggest magma intrusions ($\downarrow\beta$+), followed by significant stress transfers to local faults ($\uparrow\beta$+).

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Mechanical layering and layer inclination controls on magma chamber induced stress

John Browning, Matias Clunes, Carlos Marquardt, Jose Cembrano, Janine Kavanagh, Agust Gudmundsson

Stress surrounding a magma chamber presents a first order control on the position of magma chamber rupture and the resulting direction of any magma fracture that is formed. The vast majority of models used to estimate the crustal stress field during periods of magma inflation

either assume that the crust is homogeneous or heterogeneous but simplified to a series of horizontal layers with often contrasting mechanical properties. Using finite element method (FEM) analysis we expand on those assumptions so as to consider a magma chamber hosting crustal segment composed of heterogeneous layers of contrasting mechanical properties and with variable dip angles.
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Collective Impact provides a framework for accomplishing large-Scale community geoscience with sustainable equity and capacity building

Mike Brudzinski and the SZ4D Collective Impact Committee

The impact of subduction zone hazards can be fundamentally changed by better understanding the physical processes involved. Transformation of the solid-earth geoscience community to embrace transdisciplinary system science as a solution requires a novel approach to building equity and capacity based on strategies vetted by social science research. Collective impact is a recommended framework for accomplishing this. It is a structured form of collaboration based around establishing a common agenda shared by the entire group of participants, reinforced by mutually beneficial activities, shared measures for assessing success, pervasive communication among participants, and a backbone organization to ensure sustainability.
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A Struggled rupture initiation of the Mw 6.1 2009 L'Aquila earthquake

Leoncio Cabrera, Piero Poli

How earthquakes start is a key question in Earth science. In this work we show how we can study the rupture initiation of an earthquake. For this aim, we analyze the Mw 6.1 2009 L'Aquila (Italy) earthquake. We identify an ~0.6-s signal preceding the large dynamic rupture. From the geometrical characterization and rupture parameters of this initial phase, we infer that the rupture struggled to initiate exhibiting a slow rupture velocity (V_r=0.9±0.2 km/s) and low seismic efficiency (η=0.24) due to a complex environment in the region where the rupture starts.
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Dike induced ground deformation influenced by mechanical layering and rock layer inclination

Matías Clunes, John Browning, Carlos Marquardt, Jorge Cortez, Kyriaki Drymoni, Janine Kavanagh

The vast majority of ground deformation inversions made for volcano monitoring assume that dikes are emplaced in an elastic half-space or in a crust made of mechanically heterogeneous horizontal layers. We conducted a set of 2D FEM numerical simulations that consider dike-induced ground into a crust formed by inclined and heterogeneous rock layers. Our results show that layer inclination and heterogeneity can influence the magnitude and the location of ground deformation peaks. These results highlight the necessity of quantifying both the mechanical properties and attitude of the geology underlying active volcanoes.

Active hidden faults and high energy deposits: signals from coastal areas of central Chile

Ximena Contardo, Cristian Rodrigo

Along the coast of central Chile, paleotsunami deposits (Miocene to Paleocene) provide stratigraphic evidence of past seismic activity. Geophysical methods, such as seismic tomography, have identified strike-slip faults under dune deposits covering marine terraces. In addition, the mapping of active normal faults affecting the retreat of the coastal cliffs, emphasizing the area's susceptibility. Recently, the Quaternary deposits identified in these coastal areas show sequences of high-energy events, such as tsunamis and mass wasting processes. Therefore, signals of active potentially seismogenic faults must be looked at both in geological mapping, through geophysical methods, and by looking at high-energy coastal deposits.

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Anatomy and Structural Evolution of the Western Andean Slope in Central Chile (36°S)

Mauricio Espinoza, Joaquín Cortés-Aranda, Juan-Pablo Contreras, Andrei Maksymowicz, Eduardo Vargas, Julie Fosdick, Megan Mueller and Andrés Tassara

The Andean orogen is traditionally seen as a crustal-scale retro-wedge, but the discovery of an active west-vergent thrust system (WTS) on its western slope has sparked debates about the role and significance of these structures. Furthermore, the transition between the WTS and the well-developed east-vergent fold-thrust belt remains unclear. To investigate this, we analyze the structure of the western Andean slope at 36°S using various sources (structural data, geo-thermochronology and gravimetry). We identify two major west-vergent inverse faults (Mesamávida and Ancoa faults) as part of the WTS. We propose that these structures represent large-scale backthrusts related to the east-vergent fold-thrust belt, with the Ancoa fault possibly being an ancient structure associated with the inversion of the Abanico basin master faults.

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Exploring the suitability of stochastic tsunamigenic scenarios: the case of the Mw 8.8 Maule, Chile, earthquake

Juan González, Catalina Díaz, Matías Carvajal

Currently, the use of stochastic seismic scenarios has become widespread in tsunami hazard estimation studies. However, there is no significant evidence of the ability of stochastic scenarios to reproduce real seismic events. The present investigation reports a comparison of a set of stochastic seismic scenarios used as a source for tsunami simulations versus inundation data acquired after the Maule, Chile, Mw 8.8 earthquake. Statistical analysis based on the Aida number is used to estimate the accuracy levels of the modeled stochastic scenarios.

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Size and time of giant Chilean earthquakes controlled by rock composition and forearc structure

Joaquín Julve, Sylvain Barbot, Marcos Moreno, Andrés Tassara, Rodolfo Araya, Nicole Catalán, Jorge Crempien, Valeria Becerra

Subduction zones exhibit a wide range of rupture styles from slow-slip events to supercycles of great and giant earthquakes. Despite a growing understanding of the friction properties of rocks, how the overall architecture of subduction zones controls their seismic cycle is still poorly known. The Chilean megathrust stands out among global subduction zones for its remarkable potential to generate large earthquakes, such as the 1960 Mw9.5 Valdivia mega-earthquake. Along with these giant ruptures, more frequent but smaller events (< 8Mw) occur in the down-dip limit of the seismogenic zone, suggesting a rheological control on large earthquake features. Here, we build a thermo-mechanical model of the Southern Chilean subduction zone, bringing together insights from rock laboratory experiments, petrology, seismic and geodetic data, to explain the cycle of these giant events. Within a representative cross-section, we build a rheological model of the subduction zone, and divide multiple segments of the megathrust based on morphology, rock composition, and frictional properties. We simulate seismic cycles in a viscoelastic lithosphere assuming a rate-and-state dependent friction at the megathrust and dislocation creep of olivine in the oceanic lithosphere and mantle wedge. The model consistently explains the recurrence times of giant earthquakes, compatible with paleoseismic data. Individual simulated events also explain the geodetic data collected after the 1960 Mw9.5 and the 2016 Mw7.6 Melinka earthquakes and their slip distributions. In our model, the arc-localized uplift that followed the Valdivia earthquake is explained by viscoelastic postseismic relaxation. The coseismic segmentation of earthquake size down-dip the megathrust is controlled by the composition of subducted sediments and rocks, with the seismogenic zone associated with quartz-rich rocks of the inner wedge and paleo-prism, and the creeping section corresponding to serpentinized material. Our synoptic model of the seismic cycle provides a valuable framework to understand the role that rheological structure has on the recurrence and size of mega-earthquakes in Southern Chile.

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Effects of structural control on hydrothermal fluid flow in the Nevados de Chillán Volcanic Complex (South Volcanic Zone)

Valentina Mura, Gloria Arancibia, John Browning, Javier Espinosa, David Healy, Camila López-Contreras

The volcano-hosted geothermal system of Nevados de Chillán Volcanic Complex has a high geothermal potential, shows evidence of cortical fluid flow related to tectonics, evidenced by hotsprings and fumaroles, spatially associated with potentially seismogenic faults which has not been well studied to date. Understanding the influence of fractures on hydrothermal circulation remains unclear, and the configuration of fracture network exerts a main control on fluids circulation. This work represents the opportunity to understand the fluid flow on fractured systems by directly quantifying fracture connectivity at different scales and these findings contribute to the current understanding of the fractured geothermal reservoir.

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GNSS-acoustic siting challenges Offshore Chile

Andrew Newman

GNSS-Acoustic methods provide an opportunity to constrain long-term deformation behavior offshore that can give insights into plate coupling, and earthquake and tsunami potential. However, to date there have been limited application in deep water environments, and concerns remain about the use of such methods in steep terrains. The Chile Trench has both. This poster will present an overview of some of the challenges, as well as maps showing regions with higher confidence for deployment given currently used methods.

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Cariño Botado Fault System: Active thrust tectonics along the western slope of the Central Andes (~33°S, Chile)

Luisa Pinto, José Estay, Gabriel Easton, Gregory de Pascale, Miguel Troncoso, Sebastien Carretier, Steve Forman

The main Cariño Botado fault system (~33°S) is expressed with Late-Cenozoic hanging wall fault rocks over thrusting Quaternary coarse-grained alluvial fan deposits. This reverse fault is exposed along a surface trace up to ~15 km long, with an average dip of 40°E and an associated vertical throw (up to the east) of the hanging wall from ~3.2 m up to ~30 m. OSL ages support Holocene fault activity and ~5 m of fault slip in the last ~8.7 ka. Besides, detrital zircons ages indicate that CBF activity could have started as early as ~1 Ma producing an accumulated hanging wall uplift of ~130 m. Because of the clear relationship between the river incision, distribution of fluvial terraces, variation in sinuosity and stream power, and the location of the faults, we suggest that the tectonic uplift controls the hanging wall fluvial incision from ~1 Ma to the present.

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Geodetic observation of crustal deformation in Patagonia

Andreas Richter, Luciano Mendoza, Eric Marderwald, Mirko Scheinert

Our group has installed and repeatedly observed regional GNSS networks in Tierra del Fuego (Magallanes-Fagnano Fault System, MFFS) and southern Patagonia (Patagonian Slab Window). These observations have been used to constrain models of geodynamic processes such as tectonic and post-seismic deformations along the MFFS, glacial isostatic adjustment at the Southern Patagonian Icefield, effects of ocean-tidal and hydrological loading as well as seismic surface waves. At present, we process available GNSS data of 400 permanent stations throughout South and Central America which allows us to analyze station motions with daily resolution and millimetre-level accuracy.

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Landscape evolution of the Chiloe Island in the north Patagonian margin using morphometric and thermochronological data

Lucia Sagripanti, María Pía Rodríguez (corresponding author), Stephanie Brichau, Claudio Saavedra Diaz, Sébastien Carretier, Andrés Echaurren, Alfonso Encinas, Andrés Folguera

The Chiloé Island (42°S) represents a natural laboratory for evaluating how Miocene to

Pleistocene glaciations may have interplayed with subduction processes. We combine thermochronology with large-scale topographic and morphometric analysis to constrain their evolution on a Myr and Kyr scale. Our results suggest that, uplift and exhumation in the Chiloé Island have been mostly controlled by tectonic accretion induced by a higher input of sediments reaching the trench. After LGM, the island has responded to deglaciation by the generation of a wide wavelength positive relief, similar to terrains that have undergone glacial isostatic rebound.

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Landslides in Central Chile: The role of the mega drought and megathrust earthquakes in hazard assessment and disaster prevention

Alejandra Serey Amador, Sergio Sepúlveda, Tania Villaseñor, Dave Petley, Bill Murphy

Landslides are an important landscape forming process, providing the main mechanism for sediment release from slope to permit transportation through the fluvial system. Chile is one of the most seismically active countries on the Earth and strong earthquakes are often associated with a chain of cascading hazards. Landslides are an important natural hazard driven by strong earthquakes and heavy rainfall, both triggers present in our country. The present study seeks to improve the understanding of mechanics, temporal-spatial distribution, and geological controlling factors, obtaining quantifiable inputs applicable to urban/territorial planning and disaster prevention strategies.

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Upper and lower plate controls on megathrust properties and behavior in the Alaska subduction zone

Donna Shillington, Anne Bécel, Josh Burstein, Jacob Clarke, Jiyao Li, Mladen Nedimovic, Demian Saffer

The subduction zone offshore of the Alaska Peninsula exhibits variations in coupling, seismicity and earthquake history, making it an excellent place to evaluate controls on megathrust properties and behavior. Here we use constraints from active-source seismic imaging and bathymetry data to evaluate the contribution of the incoming and overriding plates to this variability. Variations in bending faulting and sediment thickness on the incoming plate appear to influence along-strike variations in megathrust heterogeneity, locking, and seismicity while terranes in the overriding plate may influence downdip variations in earthquake rupture and locking.

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GNSS - derived ionospheric total electron content utilization for Earthquake, Tsunami and Volcanic eruption study

Mahesh Shrivastava, Gabriel Gonzalez, Felipe Aguilera, Pablo Salazar, Ajeet K Maurya, Marcos Moreno and Juan Gonzalez

The quantity and accuracy of satellite-geodetic measurements have increased over time, revolutionizing the monitoring of tectonic processes. Global Navigation Satellite System (GNSS) and satellite radar signals provide observations beyond ground deformation, including how

earthquake and tsunami processes affect variations in the ionosphere. We have unraveled the relationship between earthquake and tsunami propagation using ionospheric total electron content (TEC) changes, we analyzed two Chilean tsunamigenic subduction earthquakes: the 2014 Pisagua M w 8.1 and the 2015 Illapel M w 8.3. During the Pisagua earthquake, the TEC changes were detected at the GPS sites located to the north and south of the earthquake epicenter, whereas during the Illapel earthquake, we registered the changes only in the northward direction. Tide-gauge sites mimicked the propagation direction of tsunami waves similar to the TEC change pattern during both earthquakes. Also, we have studied the Hunga Tonga Hunga Ha'apai (HTHH) volcanic eruption 2022 and its associated tsunami propagation combining the analysis GNSS derived TEC, Synthetic Aperture Radar Interferometry (InSAR) Sentinel-1 interferometric data with tsunami observations. We considered data from GNSS sites within a ~5000 km radius from the volcanic eruption obtaining estimates of ionospheric TEC. We detected gravity wave signatures from TEC perturbation concentrated in the southwest of Tonga, which directly correlates with the direction of propagation of the tsunami triggered by the eruption. However, the acoustic wave signature in the TEC is dominant in the north direction, and weak in the other directions. Sentinel-1B InSAR data shows that after 5 hours of the volcanic eruption the central part of the HTHH island landscape disappeared with the biggest explosion. We postulate that the HTHH volcanic blast might have generated acoustic and gravity waves in the water column along with ash columns, which enhanced the waves velocity observed in the ionospheric TEC perturbation. The unprecedented detail resolved by integrating satellite data yields previously unknown details of the deformation of the 2022 HTHH volcano eruption.
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Thermodynamics of foundering at a subduction zone

Mitchell McMillan, Shi Sim, Cian Wilson

Thickening of the lithosphere in convergent settings can produce high pressure, eclogite-facies rocks (here referred to as "eclogitization" regardless of mineralogy), which are often more dense than underlying mantle. Such negatively buoyant eclogite is prone to vertical removal by foundering (delamination or viscous dripping). Lithospheric foundering, in turn, drives crustal deformation, heating, and volcanism. Eclogitization may therefore control the thermomechanical structure of the lithosphere in major orogens.
Exhumed granulite--eclogite terranes suggest that eclogitization is highly dependent on the presence of fluids. Fluids released from subducting slab likely aid eclogitization of the overlying crustal rocks. We investigate the kinetics and thermodynamics of eclogitization using thermodynamic modeling for a range of bulk compositions and fluid content. Because we are concerned with crustal thickening and orogenesis, we choose bulk compositions representative of the continental crust (ranging from felsic to mafic) and mantle lithosphere based on existing studies of exhumed lower crustal terranes, xenoliths, and seismic analyses. We then use thermodynamic pseudosections to infer the main chemical reactions responsible for production of negatively buoyant mineral assemblages. We synthesize these results with existing experimental data and microtextural studies to suggest how best to parameterize these reactions for use in coupled thermodynamic-geodynamic models. The insights gained by this study will be useful for parameterizing geodynamic models of eclogitization and lithospheric foundering.
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Sediment generation and transfer in fluvial systems of central Chile (33-36°S)

Tania Villaseñor, Vicente Mendez-Freire, Ismael Contreras, Marion San Juan, Valentina Flores-Aqueveque, Marco Pfeiffer, Raul Valenzuela, Alida Perez-Fodich

We will present an overview of current studies in two fluvial basins in central Chile (Maipo and Itata basins) on processes of sediment generation and transfer based on i) provenance analyses of suspended sediment sampled since 2019 and ii) instrumental records of water and sediment discharge for the period 1986-2017. The results provide insights into the influence of the current megadrought that affects central Chile since 2010 and extreme rainfall events on the sedimentary dynamics of these basins as well as geomorphological and anthropogenic constraints on sediment transfer from source to sink.

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Structure and seismicity of Southern Patagonia from the GUANACO project

Douglas Wiens, Hannah Mark, Walid Ben-Mansour, Jean Baptiste Ammirati, Sergio Ruiz, Sergio Barrientos, Pedro Guzman, Federica Lanza, Andreas Richter, Beatrice Magnani

The GUANACO project deployed 27 broadband seismographs across southern Patagonia during 2018-2021, allowing characterization of the structure and seismicity of this poorly understood region. Joint inversion of Rayleigh waves and receiver functions revealed very slow upper mantle seismic velocities in the slab window region, extending for 200-300 km south of the triple junction (Mark et al, 2022). The mantle lithosphere is absent in this region, leading to extremely rapid glacial isostatic adjustment. Shear wave splitting measurements show strong east-west fast directions in the window, consistent with toroidal mantle flow around the Nazca slab edge (Ben Mansour et al, 2022). Little seismicity is detected from the shallow thrust zone or the downgoing slab. Instead, seismicity occurs in the overriding plate resulting from stresses related to rapid uplift due to deglaciation (Ammirati and Ruiz, Guzman and Lanza, manuscripts in prep).