

Abstract volume



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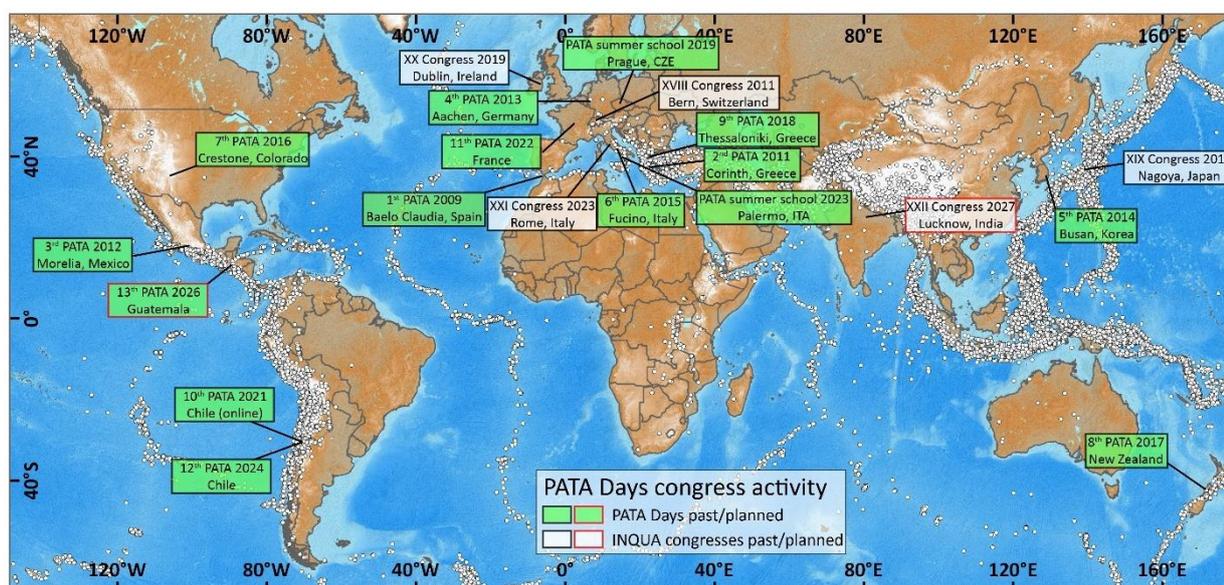
Jonathan Obrist-Farner



Dear participants,

On 4 February 1976, a magnitude 7.5 earthquake ruptured the Motagua Fault, which is part of the North American-Caribbean plate boundary in Guatemala. More than 23,000 people lost their lives and the devastation was huge. On the day 50 years later, we want to commemorate this disaster, and we want to talk about the lessons learned since then.

The International INQUA Meeting on Paleoseismology, Active Tectonics and Archeoseismology (PATA Days) brings together earthquake scientists from all continents to share latest research in earthquake geology and to discuss the developments in our discipline. A central part of the PATA Days are the joint field trips to active faults and to the sites where the actual research takes place. This idea has always been at the core of the PATA Days since their initiation in 2009. All past meeting abstracts and field trip guides can be downloaded at www.pata-days.org.



The PATA Days World Map.

The PATA Days are held under the umbrella of INQUA, the International Union for Quaternary Research and its TERPRO Commission (Terrestrial Processes, www.inqua.org). We are grateful for INQUA's continuous support for Early Career Researchers and Researchers from Developing Countries. But most importantly, we are grateful to our entire team for helping to organize this event.

We wish all participants a successful conference, interesting field trips, unforgettable moments, and fruitful discussions.

Your organizing committee:

- Carla Gordillo
- Omar Flores
- Tina M. Niemi
- Christoph Grützner
- Jonathan Obrist-Farner
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Active tectonics and paleoseismology of Northern Algeria: an overview

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Abstract: Algeria lies within the western Mediterranean domain, where NW–SE convergence between the African and Eurasian plates generates a complex system of active compressive and transpressive structures. This tectonic framework is expressed by moderate to strong seismicity, including damaging earthquakes such as El Asnam 1980 (M_s 7.2) and Boumerdes 2003 (M_w 6.9). Seismic activity is mainly accommodated within three domains: the Algerian margin, where several active offshore structures have been identified; the Tellian Atlas, which folded and faulted by active structures shaping seismogenic basins, extends east–west along the coastline, and the Saharan Atlas to the south, which also records significant activity. Despite the high area’s seismicity, the lack of paleoseismological studies remains a significant gap. This presentation aims to provide an overview of active tectonics in Algeria, summarising the main structural features, seismic activity, and recent advances in identifying seismogenic sources, while emphasising the need to refine seismic hazard assessments.

Geomorphic expression and near-surface structure of a low-displacement intra-Alpine strike slip fault – a case study in Switzerland’s Engadine Line

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Abstract: We studied the surface geomorphology and bedrock structure around the Engadine Line (EL) in southeast Switzerland. We focused on the area south of the Maloja Pass and Lake Sils and Lake Silvaplana. The surveyed structures suggest that the fault zone displays classical Riedel-shear geometry. Overall, the fault zone strikes 058° , and principal displacement occurs across an en echelon array of vertical, 042° -striking brittle faults with synthetic Riedel-shear orientations and sub-horizontal striations indicating pure strike slip. Adjacent units are folded around E-W-trending, sub-horizontal axes, also consistent with a Riedel shear system. This structure is characteristic of a very immature fault system and is consistent with comparatively low displacement. This finding highlights the importance of detailed mapping to characterize the neo-tectonics of the fault zone.



Holocene slip rates on the Santa Cruz Mountains section reveals temporal and spatial consistency for Northern San Andreas Fault, CA

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Abstract: Field observations and high-resolution topography data combined with ^{10}Be exposure dating on offset landforms indicate higher than expected fault slip rates and seismic hazard potential on the Santa Cruz Mountain section of the northern San Andreas Fault in the San Francisco Bay Area. Geomorphic mapping in Sanborn County Park near Saratoga reveals a progression of alluvial fans and debris flows dextrally offset from their upstream sources by 55 ± 10 m, 170 ± 20 m and 320 ± 20 m, respectively. Surface-exposure dating of large sandstone boulders in these deposits, which are derived from the Tertiary Vaqueros Formation, reveals three distinct depositional ages, ranging from 2.8 ± 1.3 ka, 7.7 ± 0.9 ka, and 12.3 ± 1.5 ka (2 σ), respectively. Combining observed offsets with depositional ages indicates an average slip rate of 24.8 ± 3.0 mm/yr on this section of the San Andreas Fault, which is higher than the previously assumed rate of 17 ± 4 mm/yr. This higher slip rate on the fault suggests potentially higher seismic risk for this section of the San Andreas Fault and that slip may remain relatively constant for the northern San Andreas Fault from the North Coast to the Santa Cruz Mountain section.

Automated detection and spacing analysis of fracture networks from LiDAR point clouds: implications for distributed surface deformation along the San Ramón Fault, Chile.

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Abstract: Surface rupture associated with active faults commonly involves a combination of localized slip along principal fault strands and distributed brittle deformation affecting surrounding rock volumes. Quantifying the geometry and intensity of this distributed deformation remains challenging due to limited field accessibility and scale dependence of traditional measurements. We present an automated workflow for the remote detection, classification, and spacing analysis of fracture networks derived from high-resolution terrestrial LiDAR point clouds, applied to a bedrock outcrop of the San Ramón Fault (SRF) (central Chile). The method integrates geometric attributes derived from point-cloud surface normals with density-based unsupervised clustering (HDBSCAN) to identify coherent fracture families. Results identify four classes, one of them being consistent with the distributed damage-zone architecture measured in the field, providing first-order geometric constraints on surface deformation at the outcrop scale.

Key words: active fault, LiDAR, clustering, surface deformation.



Investigating continental-scale deformation and fault coupling in northern central America using Sentinel-1 InSAR

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Abstract: Tectonic deformation in northern Central America, driven by the interactions between the Cocos, Caribbean, and North America plates, is accommodated by the Motagua and Polochic left-lateral faults, grabens south of the Motagua Fault, the Middle America subduction zone, and right-lateral faults along the Middle America volcanic arc. Major earthquakes associated with these structures include the 1976 MW 7.5 Motagua and 2012 MW 7.5 Champerico events. To investigate current deformation in this setting, we use Sentinel-1 radar images covering most of Guatemala, El Salvador and western Honduras to obtain the line-of-sight velocity fields, which we subsequently decompose into horizontal and vertical components. While in overall agreement with GNSS data and elastic block models for the region, the high-resolution InSAR data brings new information, highlighting spatial variations across main faults, including a creeping segment along the Motagua fault, slip partitioning within the Caribbean plate wedge and possible coupling variations along the subduction interface.

Strain accumulation along the Motagua Fault: a creeping segment in the context of the 1976 earthquake

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Abstract: The Motagua Fault, a major structure accommodating the relative motion between the North American and Caribbean plates, generated a 230-km-long rupture with an average displacement of ~ 1.08 m during the devastating 1976 earthquake. Slip varied significantly along strike, reaching a maximum of 3.40 m. In the months following the earthquake, afterslip was documented along most of the fault, also showing spatial variations. These observations suggest that the Motagua Fault exhibits not only stick-slip behavior but also aseismic creep. Using Sentinel-1 radar imagery, we derived line-of-sight velocity fields for the region surrounding the fault, which we decomposed into vertical and fault-parallel horizontal components to analyze along-strike slip-rate variations. The unprecedented high-resolution InSAR data reveal a ~ 40 km-long creeping section along the fault. We discuss the along-strike variations in creep in relation to local geology, as well as the coseismic slip and afterslip distribution associated with the 1976 earthquake.



The Saga of Grindavík II: Mapping Concealed Active Graben Faults and Fissures in Iceland Using Electrical Resistivity

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Abstract: On November 11, 2023, an intense seismic swarm was coincident with fault slip along graben faults in and around the Town of Grindavík in Southwest Iceland. An ~5 km wide graben with abundant normal faults slipped in this area with extensive extension that was also manifested by opening of mode I fissures (i.e. pure opening) that caused hundreds of millions of dollars of damage and one fatality. Importantly, many faults were obscured at the surface due to the built environment or due to a till layer. To map these subsurface hazards, electrical resistivity techniques were used. The resistivity technique was excellent as conducts poorly and thus high resistance areas were oftentimes correlated with subsurface faults and fissures that were then validated with trenching. Resistivity surveys worked best in this instance and helped target subsurface faults and fissures that could be addressed for risk mitigation.

Active west-vergent Andean orogeny and potential for large earthquakes along the San Ramon Fault in Santiago, central Chile

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Abstract:

The San Ramón Fault is an active fault system located at the west Andean thrust front in central Chile. The fault is along the Andean piedmont in the eastern border of Santiago, capital city of the country. From seismic network and geodetic monitoring improved during the last decade, we assessed seismic activity and present-day deformation along the fault system. We found two main north-south oriented domains of microseismicity: one located between 10-20 km depth just below the Andes beside Santiago, and another one located ca. 30 km to the east, at depths between 5-15 km, both compatible with major west vergent thrust geological structures. Results from geodetic measurement from continuous and campaign stations reveal a sharp decrease in west-east velocities in the mountain front area, which we interpret as locking of the San Ramón Fault at shallow depths in the crust, suggesting potential for major earthquakes along this fault system.



A long-term slip rate and total offset estimate for the Motagua Fault, Guatemala

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Abstract: The Motagua Fault in Guatemala is part of the plate boundary between the North American and Caribbean plates. The long-term slip rate and the total offset of the fault are poorly constrained so far. We analyzed morphological markers of total offset such as rivers and ridges, using TanDEM-X digital elevation data with 12 m resolution and own airborne LiDAR elevation datasets in some places. Sinistral offsets found in the Motagua Fault Zone range from several hundred meters to over 10 km, with larger displacements being much less frequent. The total offset does not exceed 18–39 km. The data imply that recent activity is mainly concentrated on the strand that ruptured in the 1976 earthquake, while past activity shifted between different strands, creating a wide multi-stranded fault zone. Using OSL dating of offset river terraces at the Rio El Tambor site, we measure a slip rate of ca. 3–5 mm/a for the active strand of the Motagua Fault. This is in line with previous estimates and geodetic rates.

Acknowledgements: This project was conducted as part of the Guatemala GeoHazards IRES program that is funded by an NSF Grant OISE-2153715 to Niemi and a DFG project 529303576 “Active tectonics of the Caribbean-North American plate boundary in Guatemala” to Grützner.

Investigating evidences of Quaternary fault reactivation in Southwest Iberia, Portugal

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Abstract:

Southwest Portugal is close to the European-African plate boundary, and to Mw[~]8 1755 epicenter. It has seismicity and shows Quaternary deformation through NNE-SSW faults and uplifted marine terraces contrasting with neighboring areas. Recent geophysical and geodetic data highlighted a positive gravimetric anomaly consistent with the uplifted area, limited inland by a misunderstood 90 km NW-SE structure, that only matches a known fault for ~50 km. The remaining ~40 km is considered to be an inherent structure, not active, despite a noticeable and prominent scarp in the landscape. We present a preliminary analysis based on 50 cm high-resolution lidar and Plio-Quaternary data, indicating evidence of subtle geomorphic deformation in a wide area, to be investigated combining geology, geophysics and geochronology methods.

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Pleistocene-Holocene fault activity and offset valleys along the southern Mariánské Lázně Fault, Czechia, central Europe

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Abstract: The Mariánské Lázně Fault (MLF) in western Czechia is probably the most active fault zone within the intraplate Bohemian Massif. While its northern segment is known for Holocene surface ruptures, the timing and nature of movements along the southern MLF remain uncertain. The site near Nová Hospoda, where distinct offset valleys are exceptionally well preserved despite the humid temperate climate and intense periglacial solifluction during the Pleistocene, provides rare evidence of very young deformation. Although a nearby paleoseismological trench (made 2023) revealed late Pleistocene and no clear Holocene displacement, the valley morphology strongly suggests post-Last Glacial Maximum movement. Electrical resistivity tomography and ground-penetrating radar surveys were conducted to identify sedimentary infill suitable for subsequent dating and to characterize the subsurface structure. Determining the precise age and style of recent fault activity at Nová Hospoda is crucial for understanding MLF segmentation, late Quaternary kinematics, and intraplate seismic hazard in the Bohemian Massif.

Evidence of Upper Pleistocene-Holocene tectonic activity along the Longhere-Fadalto-Cadola line (eastern Southern Alps, NE Italy)

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Abstract: We made paleoseismological investigations on the eastern part of the Bassano-Valdobbiadene Thrust Auct., i.e. the left lateral Longhere-Fadalto-Cadola transpressive fault. The study area lies at the Pliocene-Quaternary front of the eastern Southern Alps, a S-SE verging active thrust-and-fold belt characterized by moderate to high seismic hazard and risk, where some historical earthquakes registered $M_w \geq 6$. The Bassano-Valdobbiadene Thrust Auct. extends with NE-SW trending at the base of the Venetian Prealps, where the Jurassic-Cretaceous carbonate succession overthrusts the Palaeozoic Turbidites and Miocene Molasse. In the framework of the National Seismic Microzonation Project, we carried out a paleoseismological study following preliminary morphotectonic and geophysical investigations, to assess the recent activity and capability of Longhere-Fadalto-Cadola transpressive fault. The paleoseismological trenches, dug on upper Pleistocene-Holocene sediments, reveal clear evidences of recent tectonic activity, possibly related to the 1873 Alpago earthquake (I_{max} X MCS, M_w 6.3).



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Fault Throw Evolution Across Multiple Time Scales in the Aremogna–Cinque Miglia Fault System (Italy)

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Abstract: The Aremogna–Cinque Miglia Fault System (ACMFS), in the Central Apennines (Italy), is an exceptionally well-preserved active normal fault system that offers key insights into long-term fault evolution. This study combines geological, geomorphological, and paleoseismological data to quantify displacements over three timescales: long-term (~1-2 Myr), mid-term (post-Last Glacial Maximum, ~18 kyr), and short-term (recent paleoearthquakes). Analyses of topography, geological sections, and fault scarps reveal cumulative throws up to ~1500 m in the Aremogna sector and ~1000 m in the Cinque Miglia sector. Post-LGM offsets reach ~20 m, mainly along Cinque Miglia faults, while trench data show coseismic displacements up to 0.8 m. The similarity between long- and mid-term profiles suggests that the ACMFS has acted as an integrated system through multiple seismic cycles, now approaching complex linkage. Structural inheritance controls segmentation and displacement patterns. These results constrain fault growth and scaling, indicating potential earthquakes up to M6.5, with implications for regional seismic hazard.

Interplay Between Tectonics and Surface Processes in the Landscape Evolution of the Colca Region, Peru

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Abstract: The Colca region represents a unique natural laboratory for studying landscape evolution driven by the interplay of tectonic and volcanic activity, fluvial erosion, mass-wasting processes, lithological variability, karst development, glacial processes, and climatic influences. Here, we adopt a multidisciplinary approach to understand the mutual feedbacks between these interacting processes. Our findings reveal strong coupling among tectonic, volcanic, and surface processes: paleoseismological and archeoseismological evidence indicates potential for large damaging earthquakes; active faults exert a primary control on the hydrothermal system; Coulomb stress-transfer modeling confirms a predominantly tectonic origin for most earthquakes; ¹⁰Be-derived basin-averaged erosion rates vary among sub-basins, from the upper plateau and broad valley to the deeply incised canyon and piedmont basins; incision rates reveal the combined effects of tectonic uplift and mass wasting, including temporary river damming and ephemeral lake formation; and karst development, including travertine deposition and cave formation, is closely linked to the region's volcanic and tectonic activity.



Ground-Based Remote Sensing for Enhanced Paleoseismic Characterization of Trenches and Fault Scarps in Tectonically Complex Areas of Spain and Italy

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Abstract: Ground-based remote sensing provides new perspectives in paleoseismology by enhancing fault characterization and reducing interpretative uncertainty. This study applies portable multi-sensor hyperspectral imaging combined with LiDAR and high-resolution photogrammetry to characterize paleoearthquake events and deformation structures in trenches, outcrops, and exhumed fault scarps across diverse tectonic regions in Spain and Italy, including the Eastern Betics Shear Zone, the Central Pyrenees, and the Central Apennines. The objectives are to improve paleoseismic trench interpretation, identify subtle deformation features commonly overlooked in conventional logging to enhance event-horizon recognition, and analyze mineralogical and spectral variations along exhumed fault rock scarps to detect alteration patterns linked to differential exposure and progressive exhumation. Results show that hyperspectral analysis reveals features difficult to observe with the naked eye, including fault-related surface deformation, centimeter-scale soft-sediment deformation, and spectral mineralogical variations expressed as zones of differential weathering along exposed fault surfaces. This multi-sensor approach demonstrates broad applicability and transferability across contrasting tectonic settings, strengthening event reconstruction and reducing interpretative uncertainty.

Past Site Use Impacts the Pedogenic Age Estimation of Alluvial Fan Deposits in the Simi Valley Area of Southern California: A Cautionary Tale

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Abstract: We conducted fault trenching studies for a property previously used as a fruit orchard and chicken farm inferred to be bisected by the Holocene Simi fault. The 172-m-long, 3.35- to 5.5-m-deep trench extended nearly the entire site length. A ~0.75-m-thick calcic (Btk) soil horizon 1.25 m below the ground surface in the northern, medial alluvial fan surface was traced the entire trench length as a marker bed, confirming a lack of near-surface faults through the site. In the distant portion of the fan, at the trench's south end, the horizon was less well-developed and buried by 5.1 m of alluvium and younger soils. Given its degree of development, the Btk horizon was initially interpreted as a Pleistocene relict soil. However, radiocarbon dating returned ages of about 3.4 ka, requiring reconsideration of the soil's pedogenic history and deeper fault analyses. Past land uses likely contributed to the unexpected rapid soil development.



Linking Surface Uplift and Upper-Plate Extension in the Forearc of Northern Chile: Insights from Quaternary active deformation in the Mejillones Peninsula

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Abstract:

The relationship between surface uplift and upper-plate faulting provides fundamental insights into how convergent margins partition strain. In northern Chile, the hyperarid Mejillones Peninsula preserves Pleistocene marine terraces and eolian deposits displaced by normal faults, enabling direct quantification of coeval uplift and extension. We investigate whether uplift and slip rates are dynamically linked, reflecting forearc flexure driven by megathrust segmentation. Geomorphic mapping, structural analysis, and new OSL ages from K-feldspar in marine and eolian sediments, combined with $^{40}\text{Ar}/^{39}\text{Ar}$ single-crystal fusion ages from volcanic ash layers, constrain Quaternary deformation. Dated shoreline markers show a marked acceleration in uplift after MIS 19 and later after MIS 11. Uplift rates increase northward, coinciding with a 24 m north-to-south decrease in the highest wave-cut notch over 24 km, indicating southward tilting of $\sim 0.1^\circ$ and spatial segmentation of Quaternary uplift. The uplift pattern is mirrored by a similar gradient in fault slip rates along the Mejillones Fault, demonstrating mechanical coupling between upper-plate extension and surface uplift. We propose that the spatiotemporal evolution of deformation reflects a local deep structural control of the plate margin. These results highlight that deep subduction-zone architecture exerts first-order control on forearc deformation and megathrust segmentation along the northern Chile margin.

Microseismicity and Quaternary deformation along the Puerto Aldea Fault, north-central Chile

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Abstract: *The Puerto Aldea Fault (PAF) constitutes the main Quaternary geological structure in coastal north-central Chile. This normal fault exhibits a 60–70 km-long trace, encompassing both subaerial and submarine expressions. Vertical displacements of 2–5 m in Pliocene–Pleistocene units, suggest that crustal earthquakes of $M_w \sim 7.0$ may have ruptured the area during the recent geological past. Following the 2015 M_w 8.3 Illapel earthquake, a significant increase in upper-crustal seismicity was observed in the PAF area. In 2022, a field campaign installed 10 temporary broadband seismological stations that recorded microseismic activity over a 7-month period. From the 9,605 detected events, 3,724 occurred in the upper crust (<25 km depth), of which 2,295 were located inland. These results indicate that the recorded microseismicity could be associated with the PAF and likely reflects ongoing upper crustal deformation, offering valuable insights into how the fault operates on both geological and present-day timescales.*



Remote Sensing-based Geohazard Assessment in Kambarata, Kyrgyzstan

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Abstract: The ongoing India-Eurasia continental collision causes significant and widespread seismic activity in central Asia, with approximately 20 mm per year of north-south shortening accommodated by a diffuse network of active faults spanning the Tien Shan and Pamir mountain ranges. The Kambarata 1 hydroelectric power plant in western Kyrgyzstan is currently in pre-construction stage, so there is motivation to accurately determine and mitigate the surrounding hazard associated with active faults and landslides before construction is completed. Here, we use a combination of analyses of field surveys and high-resolution satellite imagery to improve existing fault maps and recognise previously unidentified gravitational and fault-related surface features in the vicinity of the Kambarata 1 site. We explore the uses and limits of different remote sensing analysis techniques, considering both modern and historical imagery as mapping resources, and the use of repeat radar and optical satellite data as the basis of quantitative monitoring techniques.

The anatomy of a strike-slip plate boundary fault in a pull-apart basin

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Abstract: The Motagua Fault in Guatemala is part of the plate boundary between the North American and Caribbean plates. At the Estanzuela site, the fault-parallel, elongated topographic depression “Laguneta Los Yajes” is about 2 m lower than its surroundings and interpreted as a pull-apart basin. Since it was seasonally filled with water, the surface rupture of the 1976 M7.5 Earthquake could not be mapped precisely here. We trenched the northern topographic scarp to investigate the boundary fault but did not encounter a distinct major shear zone. Instead, we found distributed deformation. Two additional trenches showed the main fault zone in the center of the depression, and additional structures that accommodate distributed shear. We interpret the fault geometry to be a fault bend rather than a stepover, and we document the evidence for off-fault deformation over 80 m around the main strand at this site.

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Spatial and Temporal Clustering of Earthquakes in a Subduction Setting in Central Aotearoa-New Zealand

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Abstract: *Spatial and temporal clustering of fault ruptures, occurring as either multi-fault earthquakes or earthquake sequences, pose hazards that are challenging to forecast. In the central Aotearoa-New Zealand plate boundary, comparisons of paleoearthquake and historic earthquake timings for upper-plate and subduction-interface faults reveal that temporal clustering is common. Temporal clustering is most prominent where upper-plate faults are underlain by, and inferred to be connect with, the subduction interface. Clustering is interpreted to be driven by stress transfer promoted by physical fault linkage along strike and with the plate interface at depth. Quantifying earthquake clustering could have important implications for estimates of time-dependent hazards and estimating plausible rupture lengths and requires further investigation.*

Developing a fault segmentation model for seismic hazard assessment in intraplate regions: insight from the Yangsan Fault system, SE Korea

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Abstract: *Fault models are fundamental input data for Seismic Hazard Analysis (SHA). In tectonically active regions, these models are readily constructed from surface ruptures of historical earthquakes. However, in slow-deforming intraplate regions like the Korean Peninsula, constructing fault models is challenging due to the scarcity of surface-rupturing records and the modification of fault traces by erosion. Here, we propose a methodology for identifying the segmentation geometry of strike-slip fault systems in such regions. Our approach utilizes geometric and structural discontinuities as primary criteria, supplemented by along-fault variations in lithology and geomorphology. We apply this method to the Yangsan Fault (YF), a major structure in South Korea. The ~200 km-long YF is divided into 12 to 15 segments, primarily controlled by fault bends. This segmentation correlates well with available paleoseismological data, suggesting that inherited structural geometries control rupture behavior even in slow-deforming settings.*



Displacement and Slip Distribution along Fossil and Active Faults: A Framework for Interpretation and Hazard Assessment

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Abstract: Displacement and coseismic slip variations along faults are essential for understanding fault evolution, rupture dynamics, and seismic hazard, yet structural and geomorphic complexities often obscure such measurements. To address these challenges, this study proposes a concise, multi-proxy framework that integrates geomorphic, stratigraphic, and paleoseismic evidence, supported by insights from the analysis of fossil- and active-fault systems. The framework emphasizes the fundamental controls on displacement and slip distribution; fault type, geometry, linkage, and maturity, incorporating quantitative analyses with high-resolution geomorphic markers. Illustrative examples demonstrate how normalized slip patterns on active ruptures distinguish true rupture barriers from compensating linkage zones, and how displacement–distance ($d-x$) data reveal cumulative slip increments and strain partitioning between faulting and folding. Contrasting post-depositional and syn-depositional $d-x$ signatures further aid in reconstructing faulting chronology and sedimentation interactions. By reducing interpretive uncertainty in data-limited environments, the framework improves estimates of slip per event, recurrence intervals, and maximum earthquake magnitudes. Ultimately, this approach enhances the reliability of seismic hazard assessment and strengthens our understanding of long-term fault behaviour.

Revisiting the Mw6.6 1968 Meckering, Australia, slip distribution using optical correlation

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Abstract: The 1968 Mw6.6 Meckering earthquake, Australia, is a typical intracontinental earthquake affecting a slow deformation region. The general deformation pattern indicates dominant thrusting with some component of dextral lateral offset. A post-earthquake field survey allowed to get the rupture trace and some sense of the slip distribution along strike, mostly based on survey of human-made features (roads, fences...) Here, taking advantage of recent advances in optical image correlations, especially in the ability to constrain common tie points between old diachronic air photographs, we compute differential topography between images acquired in 1962 and 1972 to recover detail of the vertical slip distribution. Massive changes did occur during the decade between the two periods of image acquisition, due to farming and reallocation of land use. This makes optical correlation for horizontal displacement more complicated and we could only recover measurements along long-term permanent features such as paved road.



Paleoseismicity of the Rieti Basin (Central Apennines, Italy): insights on faults interaction and multisegment ruptures

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Abstract: The Rieti Basin is a typical example of a rhombohedral tectonic basin within the basin-and-range system of Central Apennines (Italy). Although largely overlooked in paleoseismological research, this area is crucial for understanding how the present-day extensional regime generates high-angle, intersecting basin-bounding normal faults. We excavated 17 paleoseismological trenches along the normal faults bordering the Rieti Basin and identified evidence of 6–15 paleoearthquakes that ruptured these faults during the last ~20 kyr. We found that during sequences of rupture events, which can reach a maximum magnitude M_w 6.5, a consistent spatial and temporal pattern is followed. These results suggest that, for the Rieti Basin, stress transfer among surrounding faults may have played a key role in controlling the spatio-temporal sequence of earthquakes.

Paleoseismic Evidence for Recurrent Large Earthquakes along the Motagua Fault, Guatemala: Implications for North American-Caribbean Plate Boundary Seismicity

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Abstract: The 1976 Motagua Earthquake ruptured over 240 km of the North American–Caribbean plate boundary in Guatemala. Despite its significance and potential for severe societal impacts, the long-term seismic behavior of the Motagua Fault remains poorly limited. We present paleoseismic evidence for up to eight surface-rupturing earthquakes identified in three trenches at Gualán over the past 7,000 years. Radiocarbon dating and stratigraphic analysis indicate a maximum recurrence interval of 885 ± 61 years (95% confidence), with temporal clustering and variable interevent times of 400–1,200 years—patterns consistent with other major transform boundaries. Historical and instrumental data suggest seismic activity resumed in the late 1700s, culminating in the 1976 rupture, potentially indicating renewed seismicity after a prolonged period of quiescence. These results demonstrate that contemporary strain is primarily accommodated by slip along the Motagua Fault, with creep dominating the eastern segment and large earthquakes releasing stress along the western segment.



Transient Aseismic Vertical Deformation Across the Steeply-Dipping Pisia-Skinos Normal Fault (Gulf of Corinth, Greece)

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Abstract: *Geodetically-derived deformation rates are sometimes used to infer seismic hazard, implicitly assuming that short-term (annual-decadal) deformation is representative of longer-term deformation. This is despite geological observations indicating that deformation/slip rates are variable over a range of timescales. Using geodetic data from 2016 to 2021, we observe an up to 7-fold increase in vertical deformation rate in mid-2019 across the Pisia-Skinos normal fault in Greece. We hypothesize that this deformation is aseismic as there is no temporally correlated increase in the earthquake activity ($M > 1$). We explore four possible physical mechanisms, and our preferred hypothesis is that the transient deformation is caused by centimeter-scale slip in the upper 5 km of the Pisia fault zone. This is the first observation of shallow tectonic (i.e., not related to human activities) aseismic deformation on a normal fault globally. Our results suggest that continental normal faults can exhibit more variable slip/deformation over shorter timescales than previously observed, and thus care should be taken when utilizing geodetic rates to quantify seismic hazard.*

Monitoring slow aseismic slip along faults from InSAR time series: the case example of the Haiyuan fault in China

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Abstract: *Advances in geodetic monitoring have revealed complex interactions between aseismic and seismic slip throughout the seismic cycle. The Haiyuan Fault (northeast China) provides an exceptional setting to study fault slip behavior due to the coexistence of locked and creeping sections. We analyze a 35 km creeping segment located between the 1920 Mw 7.9 rupture and the Tianzhu seismic gap using Sentinel-1 InSAR time series (2014–2020). The average horizontal creep rate reaches up to 5 mm/yr, with along-strike variations. Local subsidence, up to 8 mm/yr, occurs within an extensional relay zone whose morphology and slip behavior are further characterized using Independent Component Analysis. Comparison with ERS and Envisat data reveals persistent creep over 27 years. The enhanced signal-to-noise ratio of Sentinel-1 data highlights intermittent creep behavior with recurrent transient accelerations, providing new insights into the processes controlling fault slip along the Haiyuan Fault.*



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Revisiting Aotearoa New Zealand's Alpine Fault earthquake history: Evidence for three events in the last 500 Years

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Abstract: Alpine Fault earthquakes are a major contributor to seismic hazard in Aotearoa New Zealand. Earthquake forecast models use 1717 CE as the most recent rupture on the Alpine Fault. Our compilation of dendrochronology and radiocarbon dating of landscape disturbances challenges this conclusion. A systematic review of evidence suggests three significant events in the last 500 years around 1610-1640, 1710-1730 (previously 1717 CE), and 1800-1840. While the 1700s event caused widespread disturbance, evidence for, and dating of, the early 1600s and 1800s events are less common, especially in lake records. These less well-documented 'earthquakes' could comprise multiple moderate-to-large ruptures (M6.5–7.9) rather than a single long rupture. The timing of these three earthquakes and the possibility of Alpine Fault earthquake sequences may modify hazard forecasts and warrant further investigation.

Postojna Cave: speleoseismic evidence of Late Quaternary earthquakes

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Abstract: This study establishes a paleoseismic record within the Postojna Cave (SW Slovenia) using uranium-thorium geochronology of deformed speleothems located in fault zones. The cave system lies within the dextral strike-slip regime of the NW Dinarides, influenced by the seismogenic Idrija and Predjama Faults. Nine deformed speleothems were sampled and dated from the TM extensometer site in Postojna Cave, revealing three temporal clusters of deformation: 1.4–4.3 ka, 6–8 ka, and 20–23 ka BP. These clusters correspond to previously identified regional paleoseismic events, notably the Holocene seismic phases on the Idrija and Selce Faults. The integration of speleoseismology and fault micro-displacement monitoring demonstrates that cave speleothems preserve reliable records of tectonic activity, confirming episodic seismicity in the NW Dinarides. This represents the first application in Slovenia combining in-cave extensometric monitoring with U-Th-dated speleothem deformation, contributing new insight into fault kinematics and long-term earthquake recurrence in karst environments.



Deciphering Late Holocene Coastal Deformation and Tsunami Evidence from the Tongoy Wetlands.

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Abstract: The Tongoy wetlands on the semiarid coast of north-central Chile (~30°S) preserve a valuable record of coastal evolution during the Late Holocene. This study presents the first geomorphological, stratigraphic, and sedimentological results aimed at reconstructing their geological history and evaluating evidence of past seismic and tsunami events. Preliminary observations reveal sedimentary sequences containing high-energy marine deposits interbedded with estuarine and alluvial facies, which may correspond to tsunami-derived inundations deposits. In addition, the spatial distribution of fluvial terraces levels within the wetlands suggests deformation patterns influenced by both the megathrust earthquake cycle and active crustal faults. These findings provide insight into the interaction between tectonic activity, coastal processes, and sedimentary dynamics along the semiarid Chilean margin, contributing to the regional paleoseismic framework and advancing our understanding of Late Holocene coastal evolution in a tectonically active setting.

Displacement patterns and segment interaction in the Ulsan Fault Zone, SE Korea: Insights into fault growth and activity

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Abstract: Fault systems grow through the propagation and linkage of individual segments, producing displacement profiles that are important for understanding tectonics and seismic hazard. We examine how offsets at the scale of segments relate to the dynamics of the broader fault network by analyzing the approximately 50 km long, NNW-SSE oriented Ulsan Fault in SE Korea, which remains relatively active despite the generally low seismicity of the region. The fault is subdivided into six segments composed of subparallel reverse strands. We extracted geomorphic vertical separations from swath profiles across valleys oriented perpendicular to the fault and compared them with reported Quaternary offsets to confirm a tectonic signal. Vertical displacement reaches its maximum in two central segments and decreases toward both ends, consistent with widely recognized models of fault growth. Landscape based separations of roughly one to three meters likely underestimate the total cumulative vertical displacement because of ongoing incision and erosion within the valleys. Segments with greater displacement coincide with zones of elevated small magnitude seismicity, linking present-day deformation to long term displacement recorded in the topography. We infer that an active central segment influences the activity of neighboring faults, while the reduced activity in the northern part of the system reflects the diversion of stress, thereby improving the regional assessment of seismic hazard.



Holocene faulting along the Budoia-Aviano Thrust (eastern Southern Alps, NE-Italy): insights from a multidisciplinary and multiscale approach

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Abstract: We present a multidisciplinary and multiscale investigation of the Budoia-Aviano Thrust System (BA), located along the Pliocene-Quaternary external front of the eastern Southern Alps (NE Italy). As part of the active SSE-verging Southalpine fold-and-thrust belt, BA accommodates ongoing N-S crustal shortening. The area has experienced at least three $M > 5.5$ historical earthquakes, indicating significant seismogenic potential. Within the NASA4SHA PRIN project, we combined morphotectonic analyses, high-resolution geophysical imaging (deep and shallow ERT, GPR), and palaeoseismological trenching to constrain the geometry and Quaternary evolution of the fault system. The excavated trenches exposed Upper Pleistocene-Holocene deposits displaced by reverse faults, showing evidence of repeated Holocene deformation with a cumulative offset of at least 4.5 m. Here we present one of the two parallel trenches excavated. This integrated approach refines the seismotectonic framework of the eastern Southern Alps and provides essential constraints for assessing the seismic potential of the area.

Intraplate rupture pattern revealed by lacustrine deposits in northwestern Mongolia

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Abstract: Large intraplate earthquakes can occur in unexpected places and can reach devastating magnitudes. However, how these earthquakes accommodate deformation over long-term periods remains unknown, given their rare occurrence. Here, we apply lacustrine paleoseismology to reconstruct the history of large earthquakes along the Bulnay Fault System (BFS) in Mongolia. Sedimentary archives from Mongol Lakes revealed micrometer-scale event deposits triggered by large-to-major earthquakes. We identify four seismic events from sedimentological and geochemical signatures over the last 9kyr. The most recent corresponds to the great $Mw8$ 1905 earthquake sequence, while the penultimate event appears to be previously undocumented. The tempo of these ruptures suggests that: 1) the Bulnay fault releases strain by episodic independent ruptures along the Bulnay fault and synchronized major events involving the Bulnay and nearby Tsetserleg faults, and 2) the 1905 earthquake-doublet may have marked the onset of a multimillennial period of seismic quiescence along the BFS.



Paleoseismological constraints on fault linkage and segmentation in the Cinque Miglia–Aremogna fault system, central Italy.

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Abstract: We analysed the geological and structural setting, and paleoseismological record of the Aremogna–Cinque Miglia Fault System (ACMFS), located in the southernmost portion of the active extensional belt of the central Apennines (Italy). A key objective of the study was to test whether the ACMFS may have ruptured synchronously with the Mt. Morrone Fault to the north, for which previous work suggested rupture lengths exceeding 21 km to account for the displacements observed in paleoseismic trenches. We also examined the possible southeastward continuation of the system along the Ortona–Roccamonfina transverse lineament (ORL), which marks the boundary between the central and southern Apennine arcs, to assess whether inherited contractional structures may act as segmentation barriers. Geological and structural mapping, integrated with three paleoseismological trenches across the ACMFS, revealed evidence of at least four Holocene surface-rupturing earthquakes (younger than 3365 BCE). At least one of these events displays an age consistent with a surface-rupturing event recognized along the Mt. Morrone Fault. This temporal overlap suggests a possible “multi-fault system earthquake” involving both structures. On the other hand, the new surface and subsurface geological constraints appear to exclude the “physical continuation” of the ACMFS southeast of the ORL, suggesting that strain is instead accommodated by distinct fault architectures and deformation styles. This supports the view of the ORL as a major structural segmentation boundary.

Searching for Hidden Local Faults Using a Dense Seismic Array

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Abstract: To contribute to the identification and 3-D mapping of active faults in and around Cartago in central Costa Rica, scientists from OVSICORI-UNA and the USGS installed and operated an urban, dense, seismic array from July 2024 to April 2025. The network consisted of 70 autonomous, short-period, three-component ‘nodal’ seismometers on a grid at an average spacing of about two km. Local faults produced moderate magnitude earthquakes that destroyed the city of Cartago and killed hundreds of people in the 19th and 20th centuries and are likely to do so again. We present preliminary results from both manually and AI-located earthquakes. This easily deployed seismic system is well-suited for preparing for, or responding to multiple types of impactful geologic events and may be shared with regional partners as needed.



A strategy for refining post-LGM slip rates of fault systems in the Central Apennines, Italy

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Abstract: In the Central Apennines, a significant discrepancy exists between geodetic extension rates and geological slip rates, likely due to short observational windows and inaccuracies in slip-rate estimates. To address this, we present a high-resolution approach to refine post-Last Glacial Maximum (LGM) displacement variability. Using systematic airborne LiDAR, we generated high-resolution DTMs to image subtle geomorphic offsets, even in vegetated areas. We developed SCARPS (Scarp Analysis and Reconstruction Profile System), a Python-based tool for semi-automatic morphometric analysis. SCARPS extracts along-strike throw distributions by modeling the geometric intersection between the fault plane and the reconstructed LGM footwall surface. Furthermore, we introduce a theoretical framework to evaluate the "zero-age" assumption of LGM markers, defining the boundary between scarp preservation and demolition based on the interplay between fault kinematics and erosion rates. This integrated method provides a robust baseline for improving strain-release models and seismic hazard assessments in complex active fault systems.

Trees that Witnessed Earthquakes in the Tien Shan mountains

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Abstract: Paleoseismic research is crucial for improving earthquake hazard mitigation in the Tien Shan, a region marked by active faults, frequent strong earthquakes, and landslides. The Zailisky-Kungey Range was shaken by the 1889 Chilik and 1911 Chon-Kemin earthquakes, which triggered widespread slope failures. Yet, their surface ruptures remain poorly constrained due to scarce historical mapping and large dating uncertainties. This study combines drone mapping with dendrochronology on *Picea schrenkiana*—both dead trunks submerged in dam-lakes and living trees on landslide debris or fault scarps. Along the 1911 fault scarp, tree rings record a decade-long growth decline, confirming severe ground disturbance. Submerged trees show that a lake formed co-seismically in 1911. Conversely, dendrochronological evidence from Kaindy Lake (UNESCO Biosphere Reserve) links its origin to the 1889 earthquake, not 1911, overturning previous interpretations and local belief. Our findings highlight dendrochronology's remarkable potential as a precise paleoseismic tool in complex mountain environments.



Using earthquake cycle models to explore seismic hazard in normal fault systems

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Abstract: Physics-based earthquake cycle simulators such as QDYN (a Quasi-Dynamic earthquake simulator) can be used to simulate numerous earthquakes on multiple faults to explore how faults interact and generate earthquakes over longer timescales than available from observations. We have used QDYN to model multiple normal faults, and we drive our simulations with field data from the central and southern Italian Apennines. We explore how the geometry of a normal fault network affects the earthquake behaviour, finding that CV (coefficient of variation of recurrence time) is sensitive to the spacing of across-strike faults, but CV is insensitive to the spacing of along-strike faults. We explore how using slip rates from field data can affect the rupture patterns and recurrence of earthquakes and generate synthetic earthquake catalogues for multiple faults over thousands of years. Ultimately, these catalogues can be used to create new seismic hazard assessment models.

Surface Failure at Lake Amatitlán Attributed to Liquefaction of Deltaic Sediments During the 1976 Guatemalan Earthquake

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Abstract: On February 4, 1976 seismic waves 50 kilometers from their source triggered liquefaction in recent, non-cohesive deltaic sediments at Lake Amatitlán in the Guatemalan volcanic highlands. Lateral spreading, fractures, sand boils and subsidence occurred mostly within 1.2 square kilometers on the youngest part of the delta of the Río Villalobos extending inland from the shoreline for about 600 meters. Destruction of brick and concrete houses, and a fatality were caused by the surface failure. The regional geography and geologic setting are discussed, and the mechanism and scenario for the failure are presented. Descriptive data and photographs are included to document the event for the community of geotechnical scientists, engineers and developmental planners concerned with seismic hazards. Further work is recommended to accurately determine the subsurface stratigraphy and the control it exerted on ground response.



Stratigraphy of an Inverted Quaternary Pull-apart Basin along Motagua fault in Guatemala

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Abstract: The Motagua fault, North-American-Caribbean sinistral strike-slip plate boundary in Guatemala, has limited information about its Quaternary history. This study investigates a deformed Quaternary sediment outcrop near west of La Laguna, Sanarate. Stratigraphic section, petrographic analyses, x-ray diffraction, and SEM-EDS mapping were conducted and revealed that the base contains poorly sorted limestone fault-brecciated cobbles in a fine calcilutite matrix, overlain by 17 m interbedded cobble conglomerates, bioturbated terrigenous clays, and marls. XRD analysis indicates clay layers derived from schist bedrock, composed of smectites, quartz, plagioclase, and vermiculite (altered micas). Marl petrography and SEM reveal an abundance of algal laminae, pisoids, peloids, acicular calcite, and possible coralline red algae. The data suggest alternating high-energy fluvial sequence or debris flow events and low-energy lacustrine phases. The basin likely formed in a pull-apart structure along an older strand of the Motagua fault, now uplifted by compression. Further tectonic and geochronological dating studies are recommended.

Are surface ruptures more complex than they should be? Examples that suggest triggered slip is to blame

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Abstract: Mapped surface rupture traces often exhibit a complex wide zone of cracking along the surface rupture with multiple subparallel minor traces. As modern field methods increasingly incorporate remote sensing the resulting surface rupture maps show greater details and complexity. The rupture patterns are often difficult to reconcile with the rupture patch on the causative fault. In fact, the seismicity may only roughly indicate the rupture trace region.

I'll discuss ruptures to show how we can incorporate various information such as displacements, kinematics, and seismicity to interpret the origin of the surface cracking which may allow an improved focus on the tectonic surface ruptures versus others. Detailed examples from the Napa M6.0, 2014; Ridgecrest M6.4, 7.1, 2019; and the Monte Cristo M6.5, 2020, will be included.

I suggest that making a greater effort to interpret the origin of individual rupture features may lead to an improved correspondence of rupture maps to earthquakes.



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Clustered Multi-Segment Earthquakes and Long-Term Slip History of the Bet Kerem Fault System, Northern Israel

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Abstract: We investigated the spatiotemporal evolution and seismic behavior of the Bet Kerem Fault System forming the Zurim Escarpment in northern Israel. Using ^{36}Cl exposure dating and U–Pb dating of calcite precipitates, we reconstructed late Quaternary and long-term fault activity. Sixty new ^{36}Cl ages and re-modeled data reveal simultaneous faulting on three segments during 12–11 ka, 8.5–7 ka, and 5–4 ka, each period producing 1.5–6.6 m of slip. U–Pb dating indicates deformation began before ~2.5 Ma, yielding a long-term slip rate of ~0.15 mm/yr. The results suggest that individual segments ruptured together in Mw ~6.5 multi-segment earthquakes, with activity clusters recurring every 3.5–5 ka and separated by ~13 ka of quiescence. These findings reveal supercycle behavior and provide new quantitative constraints on the evolution of intraplate normal-fault systems and on seismic hazard in northern Israel.

Earthquakes and Their Perception in the Bible and Through History

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Abstract: During tectonic cycle, new crust is formed at divergent plate boundaries, subduction and mountain building during continental collisions, and is accompanied by earthquakes and volcanism. While these processes can be studied by geoscientists as natural phenomena to better understand Earth's internal structure and dynamics, while others confront their destructive impact on human life and property. The way earthquakes were perceived in antiquity can be learned from the Bible. Based on a compilation of references to earthquakes and related geological phenomena in the Bible, several groups can be distinguished based on their interpretations and perceptions. It appears that these geological events mostly precede or accompany pivotal events, the revelation of God, and apocalyptic visions, and always highlight God's glory, power and magnificence. Over time, the interpretation of natural disasters has shifted— from attributing responsibility to God, to nature, and finally to humankind in relation to social injustice, where the poorest are the most vulnerable to disasters.



New paleoseismological Investigations in the framework of Level III Seismic Microzonation Studies in the L'Aquila Municipality (Central Italy)

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Abstract: As part of Seismic Microzonation studies of the Municipality of L'Aquila, severely affected by the 2009 earthquake ($M_w = 6.3$; $I_0 = IX-X$ MCS), we present a study aimed at improving the understanding of local seismic sources and their potential surface effects. To this end, a comprehensive set of investigations has been carried out, including a review of existing literature and geognostic data, morphotectonic analyses, geological and structural field surveys along the identified fault traces. Furthermore, four paleoseismological trenches were excavated. Although chronological analyses are still in progress, preliminary trench observations have yielded promising results regarding recent surface faulting involving shallow historical deposits, containing pottery shards. These findings provide new insights into the most recent activity of the L'Aquila fault system, contributing to the characterization of active and capable faults. The results of this study will be a key element in defining fault displacement hazard scenarios and fault zoning.

Complex Spatial-Temporal Rupture Patterns of Reverse Faults: The Dunstan Fault, Otago, New Zealand

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Abstract: The Dunstan Fault is an active reverse fault in Otago, Aotearoa-New Zealand, which is expressed at the surface by multiple parallel fault traces across a zone up to 2.5km wide. We present paleoseismic results from trenches excavated across three of the four major traces preserved on the Devonshire fan section of the Dunstan Fault. These are D3-2025, M2-2025 and D1-2025. There is evidence for one, two and three events respectively in these trenches. Combined with the four-to-six events found in T04/2 trench on the D2 trace (Van Dissen et al., 2007), there has been a maximum of twelve and a minimum of four ground rupturing earthquakes since the deposition of the Devonshire Fan c. 30ka – 70ka (Van Dissen et al., 2007). OSL samples taken from the three trenches will be used to constrain event timings in each trench. These samples are currently being analysed at the Desert Research Institute, Reno. Future work will involve comparing event timings across the different traces, in order to understand whether traces ruptured independently or together in paleoearthquakes. These results will have implications for fault zonation and fault displacement hazard analysis of reverse faults in Aotearoa-New Zealand and beyond.



The subaerially exposed Iceberg Lake sediments: an exceptional record of historical subaqueous earthquake disturbance at the eastern edge of the Alaskan-Aleutian subduction zone

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Abstract: Paleoseismic records are limited in the Yakutat terrane (eastern edge of the Alaskan-Aleutian subduction zone) due to extensive ice cover that hinders traditional methods such as trenching of the faults, but lacustrine sediments offer an alternative archive. We investigated lakebed sediments exposed after recent outburst floods (1999 CE) at Iceberg Lake, a glacier-dammed basin whose stratigraphy was revealed after the lake drained and partially eroded. We logged six outcrops across the basin and sampled their sediments. Between annually laminated background deposits, we identified sediment gravity flow beds and in-situ soft-sediment deformation structures (convolutions, sand blows, and fractures) interpreted to be earthquake-induced. Our age model links some of the uppermost depositional and deformational events to the 1958, 1964 and 1979 CE earthquakes. These results demonstrate that Iceberg Lake was a sensitive recorder of seismic shaking and its sediments hold strong potential for producing a paleoseismic record for the northern Yakutat terrane.

The September 19, 1985 Mexico earthquake and its earthquake environmental effects: reassessment of intensity using the ESI-07 scale

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Abstract: The September 19, 1985, Michoacán earthquake (Mw 8.1), represents a key event in Mexico's seismic history, with devastating consequences and more than 10,000 victims. We apply the ESI-07 Scale to reassess the impact of the event through the analysis of coseismic Earthquake Environmental Effects (EEE), which as of yet have been overlooked. We also analyzed the EEE in Mexico City, where the site amplification focused the intensity assessment mainly on structural damages; however, we concentrate here on the coseismic environmental impact in the epicentral area. The systematic review of scientific literature, technical reports, and institutional archives produced during and after the emergency enabled until now the identification of coastal uplift/subsidence (19), tsunami (20), liquefaction (14), ground cracking (13), landslides/rockfalls (5), and hydrogeological anomalies (7). Integrating the results obtained with available MM scale intensity estimates offers a more complete picture of the impact of this earthquake across the national territory. This analysis contributes to strengthening the methodological approaches for seismic hazard assessment and risk reduction in Mexico.



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Stress modeling of the March 2022 seismic swarm in the Colca region, southern Peru: implications for dike intrusion and fault activity

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Abstract: *The Colca Region in the Central Andes, southern Peru, is affected by shallow (<20 km) small- to moderate-magnitude earthquakes associated with active normal and strike-slip crustal faults, as well as geothermal and volcanic processes linked to the presently active Sabancaya volcano. In March 2022, a seismic swarm occurred, including two main events (Mw 4.9, Mw 5.5). The hypocenter distribution delineates a distinct SSW-NNE linear structure, atypical for active faults in the region (W-E to NW-SE), but aligned with an older fault zone and spatially close to the magma chamber. This spatial relationship suggests a possible dike intrusion, where magma exploited a pre-existing zone of weakness. Coulomb stress modeling tested scenarios of stress changes from both fault reactivation and dike propagation, with the dike intrusion model best reproducing the observed seismic pattern. Furthermore, the results indicate that stress induced by the topographic load may locally modify the regional stress field, influencing the dike orientation and fault activation in the region.*