



Proposal for a new ILP Coordinating Committee

TopoAsia: 4D Topography Evolution in Asia — From Deep Earth to Surface

Leaders:

Chengshan Wang, Irina Artemieva, Gregory Houseman, Harsh Gupta, Laiming Zhang

1. Introduction

TopoAsia pioneers an integrative 4D framework to unravel the topographic evolution of Asia as a dynamic continuum—from mantle convection to surface-climate interactions. At its core are five key questions: **1)** What controls the timing and patterns of crustal vertical motion? **2)** How do tectonic uplift and surface processes jointly shape landscapes? **3)** When did rifting, uplift pulses and basin subsidence occur across Asia's major tectonic provinces? **4)** How does evolving topography feedback on climate and hydrology? And **5)** how can we enhance earthquake, volcanic and landslide hazard models?

Recent advances now empower us to tackle these questions. **1)** Full-waveform and joint seismic-tomographic inversions have dramatically improved resolution of mantle plumes, slab rollback and lithospheric delamination (Gao et al., 2025; Jin et al., 2022; Kaban et al., 2016; Pan et al., 2021; Schouten et al., 2024; Straume et al., 2025; Wu et al., 2022), **2)** coupled tectonic–climate–surface-process models reveal how uplift, erosion and precipitation interact over geological timescales (Bahadori et al., 2022; Clift and Wilson, 2024; Habousha et al., 2023; He et al., 2021; Seybold et al., 2021; Wolf et al., 2022), **3)** large-scale U–Pb zircon datasets refine the chronologies of rifting, uplift pulses and basin subsidence across Asia (He et al., 2023; Liang et al., 2023; Stanley et al., 2021; Sun et al., 2022; Sundell et al., 2025), **4)** paleoclimate proxies integrated with high-resolution atmospheric simulations clarify topography–climate–environment feedbacks (Chung et al., 2025; Feng et al., 2022; Lu et al., 2024; Lunt et al., 2024; Raavi et al., 2023; Shields et al., 2021; Wang et al., 2022; Yu et al., 2025), and **5)** advanced probabilistic multi-hazard models harness deep learning for earthquake, volcanic and landslide risk assessment (Alqadhi et al., 2024; Bordbar et al., 2022; Meena et al., 2023; Pourghasemi et al., 2023; Selva et al., 2022; Seropian et al., 2021; Torrisi et al., 2024; Zhang et al., 2024).

Building on these breakthroughs and on deep-Earth transects (e.g., seismic velocity structures, lithospheric thermomechanics), the program aims to link deep geodynamic processes (such as subduction rollback and plume upwelling) with surface responses (including erosion, sedimentation, and weathering), modulated by climate forcing. These components are synthesized into a mechanistically coherent terrain-evolution system.

By advancing coupled multi-physics models validated against paleo-topographic and stratigraphic records, TopoAsia will enable predictive reconstructions of Asia's evolving relief—from the uplift history of the Tibetan Plateau to the subsidence of the Sunda Trench. This approach bridges long-term tectonic evolution over hundreds of millions of years with more recent landscape dynamics relevant to environmental resilience on human timescales.

Importantly, TopoAsia will serve as a global platform for research on Asia's geodynamic and topographic evolution, facilitating collaboration among geoscientists across disciplines and national boundaries. The initiative will foster the development of a robust international research network, promote data sharing and methodological integration, and support capacity-building through joint field campaigns, workshops, and

early-career training. By coordinating efforts across the global Earth science community, TopoAsia will significantly enhance our collective understanding of the forces shaping the Asian continent and its environmental systems.

2. Scientific Rationale – Understanding Asia's Dynamic Topography

Asia's continental expanse presents an unparalleled natural laboratory for investigating the interplay between deep-Earth processes and surface dynamics. The region hosts ancient Archean cratons, Paleozoic orogenic belts, the Baikal rift, and the young, high-elevation Meso-Cenozoic Tibetan Plateau and Himalayas, alongside active convergent margins of the Pacific and Indian Ocean subduction zones. Each of these tectonic domains bears the imprint of mantle convection, lithospheric deformation, and plate interactions that have, over tens to hundreds of millions of years, sculpted the present-day relief. Superimposed upon these deep-seated drivers are surface processes—fluvial erosion, sediment redistribution, climate-driven weathering feedback, and the interplay of uplift and denudation—processes that continually remodel topography. These coupled mechanisms underscore the critical role of topography in modulating environmental change at regional and global scales.

Despite significant advances in regional geophysics, geochemistry, and sedimentology, our understanding remains fragmented: models of mantle-driven uplift often neglect the coupling with sedimentary basin evolution, while surface-process studies rarely incorporate realistic geodynamic forcing or climate–tectonic feedback. Moreover, resource exploration efforts—whether for groundwater, hydrocarbons, or mineral deposits—suffer from incomplete integration of tectonic history, landscape evolution, and environmental modulation, limiting predictive power in frontier areas.

To overcome these challenges, we propose to develop a continent-scale, integrated geodynamic framework for Asia that synthesizes seismic tomography, mantle-flow simulations, crustal deformation models, and high-resolution topographic stratigraphic, and paleoclimatic data. This unified approach will (1) quantify the impact of mantle plumes, slab retreat, and lithospheric delamination to uplift and subsidence patterns; (2) couple these deep dynamics with long-term surface erosion, sedimentation processes, and climate–surface feedbacks; and (3) translate resulting topographic and environmental evolution into probabilistic forecasts of resource-rich stratigraphic traps, aquifer architectures, and hazard pathways. By bridging the divide between solid-Earth geodynamics, surface processes, and environmental change, our initiative will not only elucidate Asia's four-dimensional topographic and climatic history but also provide a robust, predictive basis for sustainable exploration and hazard assessment across one of the planet's most tectonically and socioeconomically critical regions.

A list of Natural Laboratories that could serve to focus research efforts was: (1) Tethyan, Pacific and Indonesian active margins; (2) Alpine-Himalayan Orogenic Belt; (3) Central Asia Orogenic Belt; (4) Cratons of India, Siberia, China, Arabia and Borneo.

3. Objectives and Key scientific Questions

The TopoAsia initiative is designed to deliver a transformative understanding of Asia's topographic evolution by explicitly framing relief change as a four-dimensional problem—three spatial dimensions plus geologic time. Building on state-of-the-art methods in geology, geochemistry, geophysics, sedimentology, paleoclimate simulation and numerical geodynamic modeling, TopoAsia will integrate these disciplines into a cohesive research program that links deep-Earth drivers to surface expression and vice versa.

At its core, TopoAsia seeks to:

Quantify Deep-Earth Forcing: Resolve the spatial and temporal patterns of vertical motion induced by mantle plumes, slab rollback and subduction processes, lithospheric delamination, and related convective processes in the mantle, using joint seismic-tomographic inversions and mantle-flow simulations.

Couple Tectonics and Surface Processes: Develop high-resolution erosion–sedimentation models that couple to dynamic-topography outputs, thereby revealing how climatic factors and tectonic uplift together sculpt river networks, sedimentary basins, and mountain front evolution.

Elucidate Rift–Uplift–Basin Chronologies: Establish precise geochronologic constraints on the onset, duration, and progression of rifting, uplift pulses, and basin subsidence across Asia’s major tectonic provinces—ranging from the Baikal Rift to the orogenic systems of Tibet, Iran and Anatolia.

Assess Environmental Feedbacks: Evaluate how evolving landscapes modulate regional and global climate, hydrology, and ecosystem dynamics by synthesizing paleoclimate proxy records with topographically driven atmospheric circulation models.

Develop understanding of geological hazards: Earthquakes, volcanoes, and landslides present a formidable risk to many parts of Asia and call for the development of improved models supported by monitoring of active systems.

Key scientific questions to be addressed by the TopoAsia were summarized under four headings:

1. **The present inherited from the past**

- How did the topography of Asia evolve through time?
- How do cratons develop by being reworked, fragmented and destroyed?
- What is the role of tectonic inheritance and magmatic/metamorphic processes on topography?
- How and where was new continental crust produced in the Phanerozoic?
- How are sedimentary basins archives of tectonics and paleo-drainage, climate, and biospheric evolution?

2. **Relationship between deep and shallow processes on topography**

- Which feed-back relations exist between lithosphere and surface processes, and topography?
- How does mantle convection control the topographic expression of subduction?
- How do tectonics and mantle dynamics control the evolution of sedimentary basins and their mineral and energy resources?

4. **Climate - Solid Earth feedback system**

- How does climate-tectonic interaction affect the topography, climate and biodiversity in Asia?
- How do large river systems regulate sediment and carbon fluxes?
- What is the significance of erosion and weathering on lithospheric processes and the carbon cycle?

5. **Natural Hazards and Natural resources**

- How do natural hazards develop through coupling between dynamic processes, topography and climate?
- How can we develop a natural hazards resilient society?
- How are mineral and energy resources formed, preserved, and destroyed during the evolution of the topography in Asia?

By interweaving these themes, TopoAsia will generate a truly predictive, four-dimensional framework for Asia’s surface and subsurface evolution. This will not only fill critical gaps in fundamental solid-Earth science but also furnish robust tools for natural-hazard assessment, water-resource management, and strategic mineral and geothermal exploration in one of the world’s most tectonically active regions that is also undergoing rapid economic development.

6. **Research Task and Methodology (and Data Management)**

TopoAsia will implement an end-to-end, four-dimensional research pipeline—linking deep-Earth dynamics, surface processes, and data infrastructure—to deliver a unified framework for Asia’s topographic evolution.

Dynamic-Topography Decomposition and Quantification

Flexural–Isostatic Separation: Employ elastic-thin-plate theory (effective elastic thickness, T_e , constrained by seismic and thermal inversions such as Vs tomography and heat-flow modeling) to partition observed relief into isostatic (equilibrium) and residual (dynamic) components.

Mantle–Lithosphere Coupling: Integrate seismic-tomographic models with mantle-flow simulations (ASPECT, CitcomS) to map the spatial and temporal evolution of dynamic uplift and subsidence, and quantitatively attribute residual topography to slab rollback, plume impingement, and lithospheric delamination.

Lithospheric deformation: Use modern geodetic and seismic methods in conjunction with deformation models to constrain the strain-rate field of deforming regions in order to assess the regional and temporal variation of the stress field.

Stable-Isotope Paleo-Elevation Reconstruction

Multi-Isotope Suite: Collect samples along elevation transects at 500–5,000 m intervals and analyze: $\delta^{18}\text{O}$ ($^{18}\text{O}/^{16}\text{O}$ ratio), $\delta^{17}\text{O}$ ($^{17}\text{O}/^{16}\text{O}$ ratio), δD ($^2\text{H}/^1\text{H}$ ratio, also reported as $\delta^2\text{H}$), $\delta^{13}\text{C}$ ($^{13}\text{C}/^{12}\text{C}$ ratio), Clumped-isotope parameter Δ_{47} (reflecting ^{13}C – ^{18}O bonding in carbonate).

4D Topography Inversion: Couple isotope–climate models (e.g., IsoGSM outputs) with Monte Carlo uncertainty propagation to produce spatiotemporal paleo-elevation surfaces, suitable for direct comparison with dynamic-topography predictions.

Chronostratigraphic Framework & Source-Sink Analysis

High-Resolution Chronostratigraphy: Integrate biostratigraphy (planktonic foraminiferal zonation), magnetostratigraphy (polarity reversal tie-points), Sr-isotope stratigraphy ($^{87}\text{Sr}/^{86}\text{Sr}$ ratio curves), and U–Pb zircon geochronology (ID-TIMS/LA-ICP-MS data) into a unified chronostratigraphic framework with ± 0.5 Ma precision.

Surface Process Modeling: Employ four-dimensional landscape evolution models (Badlands, Landlab, goSPL) under prescribed uplift histories and variable base-level scenarios (e.g., sea- and lake-level curves) to simulate sediment routing, construct sediment-flux budgets, and link discrete uplift pulses to basin-fill architecture and stratigraphic stacking patterns.

Coupled Geomorphology–Uplift–Erosion–Thermochronology Modeling

Integrated Workflow: Develop an iterative coupling between landscape evolution (Badlands), flexural uplift (BEM/FEM solvers), erosion algorithms, and low-temperature thermochronometer predictions (Pecube).

Convergence Criteria: Iterate uplift–erosion–thermochronology cycles until predicted cooling ages, elevation change, and erosion rates converge within a 2% threshold.

Multi-Proxy Paleoclimate & Paleoenvironment Reconstruction

Proxy Integration: Combine major- and trace-element geochemistry (XRF, ICP-MS), Isotope geochemistry, fossils, organic biomarkers ($\delta^{13}\text{C}_{\text{org}}$, saturated hydrocarbons), and TEX_{86} sea-surface proxies to reconstruct paleotemperature, precipitation, wind regimes, and redox conditions.

Model Validation: Cross-validate proxy reconstructions against GCM outputs (CESM, HadCM3, EC-Earth) and evaluate feedbacks between inferred climate shifts and landscape evolution.

Unified Data Infrastructure & Visualization

Centralized Data Repository: Implement a FAIR-compliant database with standardized metadata (NetCDF, GeoTIFF, CSV) and DOI registration.

Interactive Visualization Portal: Develop a web-based GIS platform enabling 4D playback of topography, tomography, and proxy data, equipped with API access for custom analyses by consortium members.

By weaving together seismic-tomographic imaging, geodynamic and tectonic models, isotope geochemistry, stratigraphic synthesis, paleoclimate simulation and advanced surface-process modeling within a robust data management framework, TopoAsia will set a new standard for integrated, predictive studies of continental topography.

7. Societal Relevance

By tracing the continuum from deep-mantle convection and lithospheric deformation to surface erosion and sedimentation, TopoAsia delivers insights that transcend academic inquiry and directly inform societal resilience. Improved geodynamic–geomorphic models will sharpen seismic-hazard forecasts and landslide susceptibility maps across densely populated mountain belts such as the Himalaya and Tien Shan, guiding urban planning and infrastructure design. Simultaneously, our 4D reconstructions of paleo-environment and drainage reorganization will elucidate long-term shifts in water availability, soil formation, and ecosystem stability—critical for managing trans-boundary river basins under a changing climate. Beyond hazard mitigation and water security, coupling dynamic-topography with basin-evolution analyses will refine predictive tools for mineral and geothermal resource exploration, supporting sustainable energy and raw-material supply chains. Ultimately, by embedding deep-time perspectives into Earth-system models, TopoAsia fosters integrated strategies for disaster risk reduction, environmental stewardship, and climate adaptation in one of the world’s most tectonically active and socioeconomically vital regions.

8. Dissemination and Outreach

TopoAsia will implement a rigorous, academically driven dissemination program to ensure that its scientific advances are rapidly integrated into the global geoscience community. Key components include:

Periodic Thematic Symposia

Convene one to three peer-reviewed workshops annually, each with pre-circulated white papers and thematic poster sessions, to critically evaluate progress in seismology, geomorphology, paleoclimatology, and geodynamics.

Establish cross-cutting working groups that co-author consensus reports summarizing methodological innovations and priority research gaps.

Dedicated Conference Sessions and Special Issues

Sponsor “TopoAsia: Four-Dimensional Topography Evolution” sessions at AGU, EGU, and AOGS, featuring invited state-of-the-art talks and solicited full-length papers.

Organize special-issue volumes in high-impact journals (e.g., *Earth and Planetary Science Letters*, *Geophysical Research Letters*, *Global and Planetary Change*) with rigorous peer-review and editorial oversight by TopoAsia leadership.

Scholarly Editorials and Review Articles

Commission comprehensive review articles in *EOS* and *Nature Geoscience* to synthesize TopoAsia’s cumulative findings, articulate future research trajectories, and propose standardized protocols for four-dimensional topographic analyses.

Publish methodological primers and data-descriptor papers in *Nature Protocols* and *Scientific Data* to ensure transparent, reproducible workflows.

Open Data Infrastructure and Analytical Challenges

Release datasets via a FAIR-compliant repository with DOIs and metadata structured for interoperability (NetCDF for DEMs, SEG-Y for tomography, CSV for geochemical proxies).

Host annual “Topo-Asia Data Analytics” competitions, judged by an international panel, to incentivize novel statistical and machine-learning applications on consortium data.

Strategic Partnerships and Joint Funding Calls

Issue formal letters of collaboration to major geoscience institutes and national funding bodies; collaborate with ILP and IUGS to co-sponsor bilateral and multilateral grant programs.

Launch targeted calls for proposals under joint TopoAsia–agency funding schemes, emphasizing interdisciplinary team composition and international co-PI participation.

Transparent Membership and Mentoring Framework

Maintain an up-to-date TopoAsia portal detailing working-group charters, data-access procedures, and publication pipelines.

Provide structured mentorship pairings through an “Early-Career Scholar” initiative, matching emerging researchers with senior investigators to co-lead subprojects and co-author publications. By embedding TopoAsia outputs within peer-reviewed forums, high-impact journals, and structured data-sharing platforms, this program will ensure maximal scholarly visibility, rigorous evaluation, and enduring integration of its findings into the broader Solid-Earth science paradigm.

9. Collaboration within ILP

Our project investigates deep Earth-surface couplings across Asia—a scope that intersects thematically with already active ILP Task Forces. Collaboration will create synergistic convergence: their insights into subsystem processes (e.g., mantle dynamics, crustal deformation) and our integrated topography-climate models will co-advance predictive frameworks for continental evolution.

2019TF1 (Lithosphere structure and mineral resources) examines lithosphere-scale structure and how plate-tectonic and mantle-dynamic processes shape lithospheric composition and architecture, providing essential deep-Earth constraints for TopoAsia. By integrating these datasets, we refine our simulations of mantle–crust interactions and directly improve the accuracy of 4D topographic reconstructions across Asia’s tectonic provinces.

2021TF2 (Deformation and magmatic processes from the lithosphere to the surface: integrated multidisciplinary approaches) investigates the primary drivers of volcanism—detailing how magma forms, evolves, and migrates through the lithosphere. High-resolution insights into melt-generation depths, ascent pathways, and crustal storage architectures offer critical validation for TopoAsia’s lithosphere-to-surface interaction models.

2021TF6 (Sedimentary Basins) develops physics-based frameworks for basin dynamics that establish the fundamental principles governing surface responses to lithospheric forcing, thereby underpinning TopoAsia’s surface-evolution simulations.

2021TF8 (Lithospheric Heat Flow-Global Data Assessment) curates and validates a global heat-flow database, supplying TopoAsia with first-order constraints on lithospheric thermal-rheological states that are critical for its quantitative models.

2024TF1 (Lithospheric evolution and tectonic carbon cycle) examines how the tectonic carbon cycle drives climate change by coupling deep-Earth carbon processes with surface and climatic dynamics. Its mechanistic frameworks—especially subduction-zone decarbonization and orogenic CO₂ outgassing—supply TopoAsia with essential forcing functions that link lithospheric dynamics to climate-mediated surface evolution.

We look forward to Collaborating with these ILP Task Forces —whether completed or currently active—to foster mutual advancement and achieve a truly win-win collaboration.

In addition, TopoAsia is inspired by the success of EUROPROBE and TOPO-EUROPE in the European Earth science community, and it takes their excellent examples of interdisciplinary research and international collaboration as a guide for TopoAsia. TopoAsia will maintain close cooperation with TOPO-EUROPE to collaborate on long-term scientific programs and initiatives.

10. Task force activities

1. Annual Deep-Surface Integration Workshops (60-100 participants)

- (1) Catalyze interdisciplinary convergence across geodynamics, climatology, and surface process modeling.
- (2) Train early-career researchers in 4D terrain reconstruction methodologies.
- (3) Establish joint field-data-modeling protocols for Asia’s tectonic hotspots.

2. Thematic Working Groups (5-15 participants)

Focusing on a specific issue to carry out more detailed research in a more flexible and efficient manner.

3. Field investigations targeting typical or hotspot geological problems.

Collaborative field investigations aimed at addressing representative or emerging geological challenges in key tectonic regions.

4. Specific small workshops with potential industry or society partners.

11. Potential key collaborators

Name	Country/ Region	Affiliation	Email	Expertise
Peter Cawood	Australia	Monash University	peter.cawood@monash.edu	Geology, orogenies
Sun-Lin Chung	Taiwan, China	Institute of Earth Sciences, Academia Sinica	sunlin@earth.sinica.edu.tw	Igneous petrogenesis, chemical Geodynamics, east Asian magmatism and orogeny
Chengshan Wang	China	China University of Geoscience (Beijing)	chshwang@cugb.edu.cn	Sedimentology, tectonics
Zengqiang Hou	China	CAGS, Beijing	Houzengqian@126.com	Ore deposits
Mingguo Zhai	China	IGG, CAS, Beijing	mgzhai@mail.iggcas.ac.cn	Geology
Shuwen Dong	China	CAGS, Beijing	swdong@nju.edu.cn	Tectonics
Peng Cui	China	CAS, Beijing	pengcui@imde.ac.cn	Debris flow, wenchuan earthquake, landslide, debris flows, climate change
Qingtian Lv	China	CAGS, Beijing	lqt@cags.ac.cn	Crustal structure, deep seismic reflection, magnetotelluric, 3D inversion, magnetotelluric sounding
Yanghua Wang	UK	China University of Geosciences (Beijing), Imperial College London	yanghua.wang@imperial.ac. uk	Geophysics and engineering, reservoir geophysics, geophysical inversion, sub-surface imaging, exploration seismology, geodynamics and tectonophysics
Peizhen Zhang	China	Peking University, Sun Yat-sen University, China	peizhen@ies.ac.cn; zhangpeizhen@mail.sysu.ed u.cn	Seismic dynamics, structural geology, and geodynamics
Jing Liu	China	Tianjin University	liu_zeng@tju.edu.cn	Tectonic geomorphology
Qin Wang	China	Nanjing University	w_wang123@126.com, qwang@nju.edu.cn	High P-T metamorphism
Dicheng Zhu	China	China University of Geosciences (Beijing)	dczhu@cugb.edu.cn	Geochemistry, geodynamics, petrology, plate tectonics
Xiumian Hu	China	Nanjing University	huxm@nju.edu.cn	Sedimentary geology, sedimentary tectonics
Jingen Dai	China	China University of Geosciences (Beijing)	djgtibet@163.com	Low temperature thermochronology, structural geomorphology, petrology and geotectonics, geological evolution of Qinghai-Tibet Plateau
Yuan Gao	China	China University of Geosciences (Beijing)	yuangao@cugb.edu.cn	Sedimentary geology, paleoclimate, terrestrial environment, stable isotopes
Laiming Zhang	China	China University of Geosciences (Beijing)	lzhang@cugb.edu.cn	Sedimentary geochemistry, paleoclimatology, paleogeomorphology, paleobiology
Irina Artemieva	Denmark	University Copenhagen	iartemieva@gmail.com	Geophysics, geodynamics, global lithosphere research, lithosphere

				thermal structure, lithosphere buoyancy
Hans Thybo	Denmark	University of Copenhagen	h.thybo@gmail.com	Geophysics, tectonics, seismology
Sierd Cloetingh	Dutch	Utrecht University	s.a.p.l.cloetingh@uu.nl	Tectonics, basin analysis
Albert Galy	France	University of Lorraine, CRPG	albert.galy@univ-lorraine.fr	Geochemistry, erosion, Tibet
Bilal Haq	France/USA	Sorbonne University, Paris	bilhaq@gmail.com	Stratigraphy, eustasy, tectonics
Stuart Gilder	Germany	Ludwig-Maximilians-Universität (LMU) München	Gilder@lmu.de, stuart.gilder@geophysik.uni-muenchen.de	Paleomagnetism
Hans-Peter Bunge	Germany	Ludwig-Maximilians-Universität (LMU) München	bunge@lmu.de	Mantle and lithosphere dynamics, parallel and high-performance computing (HPC), fluid dynamic inverse techniques for global geodynamic Earth models
Steffen Kutterolf	Germany	GEOMAR Helmholtz Centre for Ocean Research Kiel	skutterolf@geomar.de	Tephrostratigraphy, rare earth elements, marine pore waters, ash alteration, tephrochronology
Harsh Gupta	India	ISC, AERB, Geological Society of India, IUGG	harshg123@gmail.com	Induced seismicity, seismology
Vasanthi Anthwar	India	CSIR-National Geophysical Research Institute	vasanthi99ngri@gmail.com, vasanthi@ngri.res.in	Geophysics, tectonics
Sajeev Krishnan	India	CES, Indian Institute of Science	sajeev@iisc.ac.in	Metamorphic geology, petrology, geochemistry, thermodynamics, in situ micro-chronology, tectonics
Danny Hilman Natawidjaja	Indonesia	National Research and Innovation Agency of Indonesia	bagus@itb.ac.id, danny.hilman@gmail.com	Active tectonics, seismic hazard, paleoseismology
Hossein Azizi	Iran	University of Kurdistan	h.azizi@uok.ac.ir, azizi1345@gmail.com	Petrology, geochemistry
Claudio Faccenna	Italy	Università degli studi Roma Tre	faccenna@uniroma3.it	Orogeny, subduction, mantle convection, crustal deformation, tectonics
Weiren Lin	Japan	Kyoto University	lin@kumst.kyoto-u.ac.jp, hayashi.tameto.6s@kyoto-u.ac.jp	Natural sciences/solid earth science
Yuzuru Yamamoto	Japan	Kobe University	yuzuru-y@harbor.kobe-u.ac.jp	Tectonics and sedimentology
Takehiko Satoh	Japan	Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA)	satoh@stp.isas.jaxa.jp	Solid planets, cosmic plasma, planetary atmospheres
Askar Syzdykov	Kazakhstan	Satbayev University	syzdykovaskar1954@gmail.com, a.syzdykov@satbayev.university	Technic and technology of exploration of mineral deposits
Rustam Orozbaev	Kyrgyz Republic	Institute of Geology, National Academy of	r.t.orozbaev@gmail.com	Geology, metamorphic petrology, geochronology, geochemistry

		Sciences of the Kyrgyz Republic		
Edic Sathiamurthy	Malaysia	University of Malaysia	edlic@umt.edu.my	Sedimentology
Turbold Sukhbaatar	Mongolia	Institute of Petrology and Structural Geology, Mongolian Academy of Sciences	turboldtmn@gmail.com	Paleomagnetism, tectonics of CAO B
Soe Moe Lwin	Myanmar	Myeik University	moalwinmyk@gmail.com	Geology and paleoceanography
Qasim Jan	Pakistan	University of Peshawar	mjqan@yahoo.com	Geodynamic and crust-building processes
Fernando Siringan	Philippines	University of the Philippines	fpsiringan@msi.upd.edu.ph	Marine and coastal geology, sedimentology, seismic stratigraphy
Andrey Khudoley	Russia	St. Petersburg State University	akhudoley@gmail.com	Tectonics of E. Siberia, structural geology, thermochronology
Sang-Mook Lee	South Korea	Seoul National University	smlee@snu.ac.kr	Marine geophysics
Taras Gerya	Switzerland	ETH-Zurich	taras.gerya@eaps.thz.ch	Geodynamics, numerical modeling, geochemistry
Sean D. Willett	Switzerland	ETH Zürich	swillett@eaps.ethz.ch	Geomorphology, tectonics, sedimentology
Panjai Sompongchaiyakul	Thailand	Chulalongkorn University	spenjai@hotmail.com	Marine science
Yener EYUBOGLU	Turkey	Karadeniz Technical University	yenereyuboglu@gmail.com	Geology, tectonics, igneous petrology, ore geology
Celal Sengor	Turkey	Istanbul Technical University	sengor@itu.edu.tr	Geology, tectonics
Peter D. Clift	UK	University College London	pclift@lsu.edu	Climate tectonics, marine geology, geology, basin analysis
Greg Houseman	UK	University of Leeds	G.A.Houseman@leeds.ac.uk	Geodynamics, crustal deformation, seismology
Matthew Fox	UK	University College London	m.fox@ucl.ac.uk	Geomorphology, thermochronometry
Tim Wright	UK	University of Leeds	T.J.Wright@leeds.ac.uk	InSAR geodesy
Yani Najman	UK	Lancaster University	y.najman@lancaster.ac.uk	Paleogeography, tectonics
Jeremy K. Caves-Rugenstein	USA	Colorado State University	Jeremy.Rugenstein@colostate.edu	Geochemistry, paleoclimate, weathering, Central Asia
Daniel E Ibarra	USA	Brown University	daniel_ibarra@brown.edu	Isotope geochemistry, paleoclimate, Lithium enrichment
Mark Harrison	USA	UCLA	tmh@epss.ucla.edu	Tectonics
Bakhtiar Nurtaev	Uzbekistan	Institute of geology and geophysics	nurtaevb@gmail.com	Geology, geophysics, geodynamics, Tien Shan
Nguyen Van Vuong	Vietnam	University of Science, Vietnam National University	vuongnv@vnu.edu.vn	Geology, tectonics, natural resource
Dmitry Gladkochub	Russia	Institute of the Earth's Crust, Siberian Branch, RAS	dima@crust.irk.ru	Geology, geochemistry

Inna Safonova	Russia	Novosibirsk State University	inna03-64@mail.ru	Geology, lithosphere
Victor Kovach	Russia	Institute of Precambrian, Geology and Geochronology, Russian Academy of Sciences	v.kovach@mail.ru	Geology, geochronology
Thorsten Becker	USA	Jackson School of Geosciences, University of Texas at Austin	twb@ig.utexas.edu	Geodynamics, seismology
Donald DePaolo	USA	University of California, Berkeley, and Lawrence Berkeley National Laboratory	djdepaulo@berkeley.edu	Lithosphere, mantle
Katharine W. Huntington	USA	University of Washington	kate1@uw.edu	Geology, tectonics, surface processes, thermochronology

12. Reference

- Alqadhi, S., Mallick, J., Alkahtani, M., 2024. Integrated deep learning with explainable artificial intelligence for enhanced landslide management. *Nat. Hazards* 120, 1343–1365. <https://doi.org/10.1007/s11069-023-06260-y>
- Bahadori, A., Holt, W.E., Feng, R., Austermann, J., Loughney, K.M., Salles, T., Moresi, L., Beucher, R., Lu, N., Flesch, L.M., Calvelage, C.M., Rasbury, E.T., Davis, D.M., Potochnik, A.R., Ward, W.B., Hatton, K., Haq, S.S.B., Smiley, T.M., Wootton, K.M., Badgley, C., 2022. Coupled influence of tectonics, climate, and surface processes on landscape evolution in southwestern North America. *Nat. Commun.* 13, 4437. <https://doi.org/10.1038/s41467-022-31903-2>
- Bordbar, M., Aghamohammadi, H., Pourghasemi, H.R., Azizi, Z., 2022. Multi-hazard spatial modeling via ensembles of machine learning and meta-heuristic techniques. *Sci. Rep.* 12, 1451. <https://doi.org/10.1038/s41598-022-05364-y>
- Chung, E.-S., Kim, S.-J., Rodgers, K.B., Jun, S.-Y., Kim, J.-H., Lee, S.-S., Yun, K.-S., 2025. Paleoclimate proxy records suggest reduced tropical Pacific zonal asymmetry under sustained global warming. *Commun. Earth Environ.* 6, 93. <https://doi.org/10.1038/s43247-025-02039-0>
- Clift, P.D., Wilson, L.J., 2024. Syn- and post-rift lower crustal flow under the Sunda Shelf, southern Vietnam: A role for climatically modulated erosion. *Basin Res.* 36, e12809. <https://doi.org/10.1111/bre.12809>
- Feng, R., Bhattacharya, T., Otto-Bliesner, B.L., Brady, E.C., Haywood, A.M., Tindall, J.C., Hunter, S.J., Abe-Ouchi, A., Chan, W.-L., Kageyama, M., Contoux, C., Guo, C., Li, X., Lohmann, G., Stepanek, C., Tan, N., Zhang, Q., Zhang, Z., Han, Z., Williams, C.J.R., Lunt, D.J., Dowsett, H.J., Chandan, D., Peltier, W.R., 2022. Past terrestrial hydroclimate sensitivity controlled by Earth system feedbacks. *Nat. Commun.* 13, 1306. <https://doi.org/10.1038/s41467-022-28814-7>
- Gao, Y., Tilmann, F., Yuan, X., Rietbrock, A., Kufner, S., Li, W., Schurr, B., Fichtner, A., 2025. Unraveling the Mantle Dynamics in Central Asia With Joint Full Waveform Inversion. *J. Geophys. Res. Solid Earth* 130, e2024JB030061. <https://doi.org/10.1029/2024JB030061>
- Habousha, K., Goren, L., Nativ, R., Gruber, C., 2023. Plan-Form Evolution of Drainage Basins in Response to Tectonic Changes: Insights From Experimental and Numerical Landscapes. *J. Geophys. Res. Earth Surf.* 128, e2022JF006876. <https://doi.org/10.1029/2022JF006876>
- He, C., Yang, C.-J., Turowski, J.M., Rao, G., Roda-Boluda, D.C., Yuan, X.-P., 2021. Constraining tectonic uplift and advection from the main drainage divide of a mountain belt. *Nat. Commun.* 12, 544. <https://doi.org/10.1038/s41467-020-20748-2>

- He, J., Garzanti, E., Jiang, T., Barbarano, M., Liu, E., Chen, S., Liao, Y., Li, X., Wang, H., 2023. Evolution of eastern Asia river systems reconstructed by the mineralogy and detrital-zircon geochronology of modern Red River and coastal Vietnam river sand. *Earth-Sci. Rev.* 245, 104572. <https://doi.org/10.1016/j.earscirev.2023.104572>
- Jin, S., Sheng, Y., Comeau, M.J., Becken, Michael., Wei, W., Ye, G., Dong, H., Zhang, L., 2022. Relationship of the Crustal Structure, Rheology, and Tectonic Dynamics Beneath the Lhasa-Gangdese Terrane (Southern Tibet) Based on a 3-D Electrical Model. *J. Geophys. Res. Solid Earth* 127, e2022JB024318. <https://doi.org/10.1029/2022JB024318>
- Kaban, M.K., Stolk, W., Tesauro, M., El Khrepy, S., Al-Arifi, N., Beekman, F., Cloetingh, S.A.P.L., 2016. 3D density model of the upper mantle of Asia based on inversion of gravity and seismic tomography data. *Geochem. Geophys. Geosystems* 17, 4457–4477. <https://doi.org/10.1002/2016GC006458>
- Liang, H., Zhang, K., Fu, J., Wang, W., Zhang, P., Grapes, R., Ma, Z., Zhang, Y., Li, Zhigang, Yan, Y., Hui, G., Sun, C., Xu, B., Li, Zhongyun, Zheng, W., Tian, Q., 2023. Stepwise northward compression in the northeastern Tibetan Plateau: Insights from the chronology of the Baima Basin. *Glob. Planet. Change* 220, 104015. <https://doi.org/10.1016/j.gloplacha.2022.104015>
- Lu, H., Zhao, Y., Yang, X., Wu, H., Zhao, C., Wang, J., Wang, Xiaoyong, Kuang, X., Zhang, X., Ma, C., Lu, F., Xiao, X., Zhang, W., Wang, H., Xu, Z., Cheng, J., Zheng, Z., Shi, F., Zhang, E., Liang, Chen, Huang, Z., Liang, Chenghong, Yi, S., Wu, J., Shao, K., Gu, Y., Zhang, H., Li, X., Han, Z., Wang, Xianyan, Wang, S., Guo, Z., 2024. A preliminary integrated analysis of regional paleoclimate variations in China over the past ~ 21 ka. *Glob. Planet. Change* 240, 104510. <https://doi.org/10.1016/j.gloplacha.2024.104510>
- Lunt, D.J., Otto-Bliesner, B.L., Brierley, C., Haywood, A., Inglis, G.N., Izumi, K., Kageyama, M., Kaufman, D., Mauritsen, T., McClymont, E.L., Salzmann, U., Steinig, S., Tierney, J.E., Zhao, A., Zhu, J., 2024. Paleoclimate data provide constraints on climate models' large-scale response to past CO₂ changes. *Commun. Earth Environ.* 5, 419. <https://doi.org/10.1038/s43247-024-01531-3>
- Meena, S.R., Nava, L., Bhuyan, K., Puliero, S., Soares, L.P., Dias, H.C., Floris, M., Catani, F., 2023. HR-GLDD: a globally distributed dataset using generalized deep learning (DL) for rapid landslide mapping on high-resolution (HR) satellite imagery. *Earth Syst. Sci. Data* 15, 3283 – 3298. <https://doi.org/10.5194/essd-15-3283-2023>
- Pan, Y., Hammond, W.C., Ding, H., Mallick, R., Jiang, W., Xu, X., Shum, C.K., Shen, W., 2021. GPS Imaging of Vertical Bedrock Displacements: Quantification of Two-Dimensional Vertical Crustal Deformation in China. *J. Geophys. Res. Solid Earth* 126, e2020JB020951. <https://doi.org/10.1029/2020JB020951>
- Pourghasemi, H.R., Pouyan, S., Bordbar, M., Golkar, F., Clague, J.J., 2023. Flood, landslides, forest fire, and earthquake susceptibility maps using machine learning techniques and their combination. *Nat. Hazards* 116, 3797–3816. <https://doi.org/10.1007/s11069-023-05836-y>
- Raavi, P.H., Chu, J.-E., Timmermann, A., Lee, S.-S., Walsh, K.J.E., 2023. Moisture control of tropical cyclones in high-resolution simulations of paleoclimate and future climate. *Nat. Commun.* 14, 6426. <https://doi.org/10.1038/s41467-023-42033-8>
- Schouten, T.L.A., Gebraad, L., Noe, S., Gülcher, A.J.P., Thrastarson, S., Van Herwaarden, D.-P., Fichtner, A., 2024. Full-waveform inversion reveals diverse origins of lower mantle positive wave speed anomalies. *Sci. Rep.* 14, 26708. <https://doi.org/10.1038/s41598-024-77399-2>
- Selva, J., Sandri, L., Taroni, M., Sulpizio, R., Tierz, P., Costa, A., 2022. A simple two-state model interprets temporal modulations in eruptive activity and enhances multivolcano hazard quantification. *Sci. Adv.* 8, eabq4415. <https://doi.org/10.1126/sciadv.abq4415>
- Seropian, G., Kennedy, B.M., Walter, T.R., Ichihara, M., Jolly, A.D., 2021. A review framework of how earthquakes trigger volcanic eruptions. *Nat. Commun.* 12, 1004. <https://doi.org/10.1038/s41467-021-21166-8>
- Seybold, H., Berghuijs, W.R., Prancevic, J.P., Kirchner, J.W., 2021. Global dominance of tectonics over climate in shaping river longitudinal profiles. *Nat. Geosci.* 14, 503–507. <https://doi.org/10.1038/s41561->

- Shields, C.A., Kiehl, J.T., Rush, W., Rothstein, M., Snyder, M.A., 2021. Atmospheric rivers in high-resolution simulations of the Paleocene Eocene Thermal Maximum (PETM). *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 567, 110293. <https://doi.org/10.1016/j.palaeo.2021.110293>
- Stanley, J.R., Braun, J., Baby, G., Guillocheau, F., Robin, C., Flowers, R.M., Brown, R., Wildman, M., Beucher, R., 2021. Constraining Plateau Uplift in Southern Africa by Combining Thermochronology, Sediment Flux, Topography, and Landscape Evolution Modeling. *J. Geophys. Res. Solid Earth* 126, e2020JB021243. <https://doi.org/10.1029/2020JB021243>
- Straume, E.O., Faccenna, C., Becker, T.W., Steinberger, B., Licht, A., Sembroni, A., Gvirtzman, Z., Ballato, P., 2025. Collision, mantle convection and Tethyan closure in the Eastern Mediterranean. *Nat. Rev. Earth Environ.* 6, 299–317. <https://doi.org/10.1038/s43017-025-00653-2>
- Sun, J., Sheykh, M., Windley, B.F., Talebian, M., Cao, M., Ahmadi, N., Sha, J., 2022. Magnetostratigraphic Age Control of the Timing of Tectonic Deformation and the Shifting Depositional Environments in the Dezful Embayment, Iran. *Tectonics* 41, e2021TC006881. <https://doi.org/10.1029/2021TC006881>
- Sundell, K.E., Eden, R., Styron, R.H., Villarreal, D.P., Usnayo, P., Saylor, J.E., Göğüş, O.H., Lapen, T.J., Finney, B., Cardenas, J., Carlotto, V., 2025. Tectonic and climatic controls on late Cenozoic intra-arc basin development in the central Andes of southern Peru. *Earth Planet. Sci. Lett.* 666, 119487. <https://doi.org/10.1016/j.epsl.2025.119487>
- Torrisi, F., Corradino, C., Cariello, S., Del Negro, C., 2024. Enhancing detection of volcanic ash clouds from space with convolutional neural networks. *J. Volcanol. Geotherm. Res.* 448, 108046. <https://doi.org/10.1016/j.jvolgeores.2024.108046>
- Wang, M., Li, M., Kemp, D.B., Boulila, S., Ogg, J.G., 2022. Sedimentary noise modeling of lake-level change in the Late Triassic Newark Basin of North America. *Glob. Planet. Change* 208, 103706. <https://doi.org/10.1016/j.gloplacha.2021.103706>
- Wolf, S.G., Huisman, R.S., Braun, J., Yuan, X., 2022. Topography of mountain belts controlled by rheology and surface processes. *Nature* 606, 516–521. <https://doi.org/10.1038/s41586-022-04700-6>
- Wu, Y., Zheng, Z., Nie, J., Chang, L., Su, G., Yin, H., Liang, H., Pang, Y., Chen, C., Jiang, Z., Bo, W., 2022. High-Precision Vertical Movement and Three-Dimensional Deformation Pattern of the Tibetan Plateau. *J. Geophys. Res. Solid Earth* 127, e2021JB023202. <https://doi.org/10.1029/2021JB023202>
- Yu, C., Lunt, D.J., Ren, X., Zhang, L., Wang, C., 2025. Joint Effects of Coastal and Inland Mountains on East Asian Climate During the Late Cretaceous. *Geophys. Res. Lett.* 52, e2024GL114228. <https://doi.org/10.1029/2024GL114228>
- Zhang, Z., Liu, M., Tan, Y.J., Walter, F., He, S., Chmiel, M., Su, J., 2024. Landslide hazard cascades can trigger earthquakes. *Nat. Commun.* 15, 2878. <https://doi.org/10.1038/s41467-024-47130-w>