

Thirty-second Meeting of Swiss Sedimentologists

Saturday, March 7, 2026
University of Fribourg

Program and abstracts



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SwissSed is an informal group of (not only) Swiss sedimentologists. It promotes contacts, exchange of ideas, and information on current developments in sedimentology. Membership is free, but SwissSed lives by the interest and initiative of its members.

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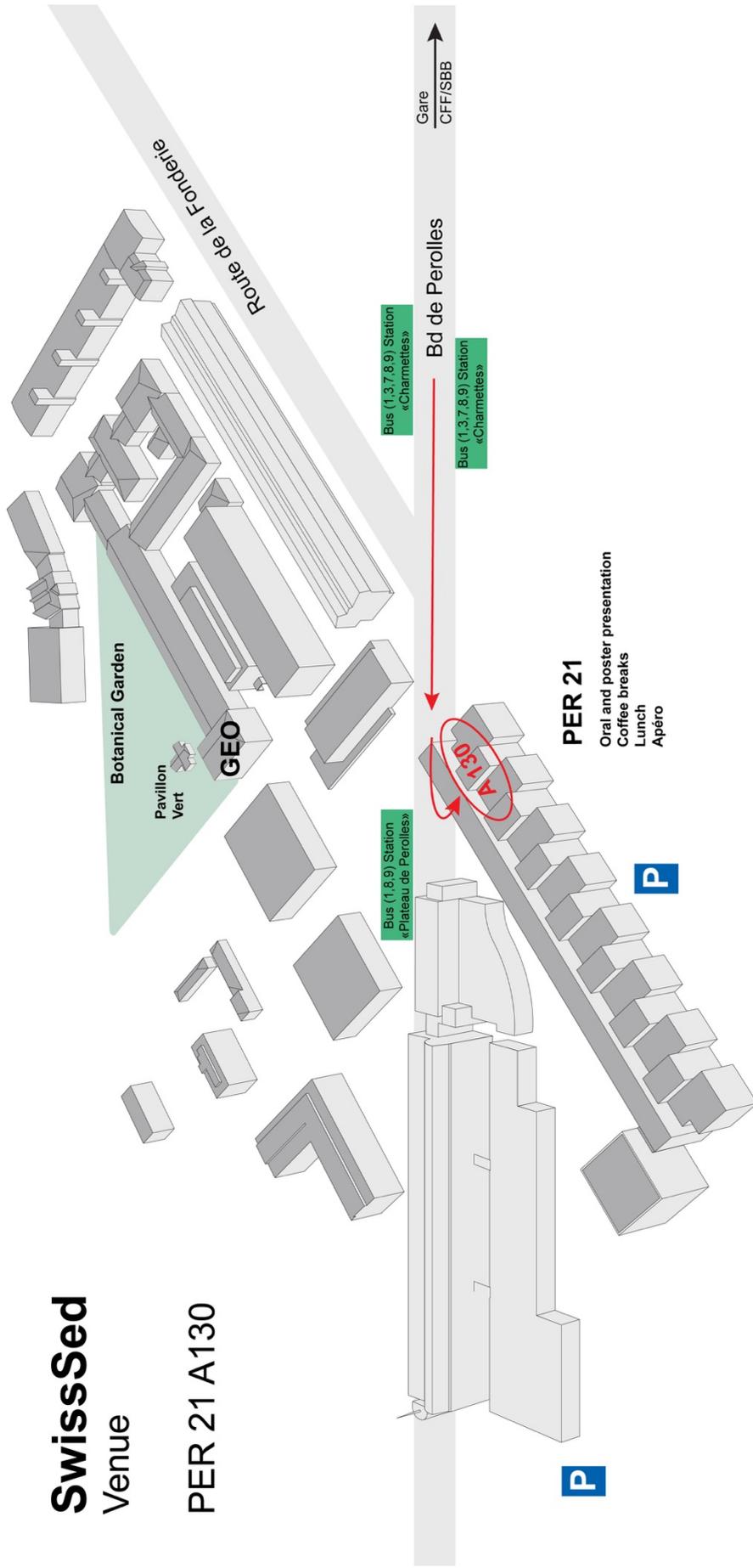
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SwissSed

Venue

PER 21 A130



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PER 21

Oral and poster presentation
Coffee breaks
Lunch
Apéro

Gare
CFF/SBB

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«Charmettes»

Bus (1,3,7,8,9) Station
«Charmettes»

Bus (1,8,9) Station
«Plateau de Perolles»

Route de la Forêre

Botanical Garden

Pavillon
Vert

GEO

A130

PROGRAMME

09.30 - 10.00 **Morning coffee and croissant**

10:00 - 10:15 **Opening:** Anneleen Foubert, Alicia Fantasia, Andres Rüggeberg

10:15 - 11:00 **Keynote: Boris Karatsolis, UNIFR**

Using microfossils to reconstruct paleoclimatic and ocean circulation dynamics during past warm periods

11:00 - 11:30 **One-slide Poster presentations:**

Sofia Benamri, University Abdelmalek Essaâdi

Matteo Borsato, UNIFR

Madeline Duret, UNIFR

Alina Etter, UNIBE

Romain Goncerut, UNIL

Bernard Grobety, UNIFR

Aliisa Laakkonen, UNIBE

Mailys Picard, UNIBE

Margit Rindlisbacher, UNIBE

Veerle Verhoeven, UNIBE

Frank Zwaan, UNIL, UNIFR

11:30 - 11:50 **Sophia Swaton, UNIBE**

Sedimentary architecture of Late Cretaceous to Early Eocene flysch sequences in the Swiss Alps

11:50 – 12:10 **Oliver Neame, UNIFR**

New Insights on the Formation and Dynamics of the Dallol System (Northern Afar)

12:10 – 12:30 **Survey and upcoming events:** Alicia Fantasia, Andres Rüggeberg, Anneleen Foubert

12:30 - 13:15 **Lunch**

13:15 - 14:00 **Poster Session**

14:00 – 14:45 **Keynote: Guillaume Paris, CRPG-Nancy, France**

Sulfur cycle reconstruction through the ages, from the ocean to (sedimentary) carbonates

14:45 - 15:05 **Julien Talon, Université Bourgogne Europe, France**

How can we explain the concomitant formation of dolomite and Mg-fibrous clays in coastal settings? Insights from a Lutetian-Bartonian (Eocene) event in the Paris Basin

15:05 - 15:25 **Alicia Fantasia, UNIFR**

The Early–Middle Jurassic: A turning point toward modern carbon cycling and climate?

15:25 – 15:40 **Closure session with voting for “Best presentations award”**

15:40 **Apéro**

POSTER PRESENTATIONS

Sofia Benamri, University Abdelmalek Essaâdi
Studying tsunami deposits in contrasting environments

Matteo Borsato, UNIFR
A multiproxy record across the Sinemurian-Pliensbachian boundary: New insights from the Sarab-e-Ghanbar section, Iran

Madeline Duret, UNIFR
Spatial variability of microbialites in a poly-extreme rift setting (northern Afar)

Alina Etter, UNIBE
Investigating isolated carbonate platforms in Lac de Joux, Western Switzerland

Romain Goncerut, UNIL
Palaeoenvironmental study of the Pliensbachian-Toarcian boundary in the Digne-les-Bains region (SE France)

Bernard Grobety, UNIFR
Sahara dust event of 06.02.21 in Switzerland: Iberulite fall and formation

Aliisa Laakkonen, UNIBE
Diagenetic formation pathways of pyrite in Nam Co, a high-altitude Tibetan lake

Mailys Picard, UNIBE
Sedimentary ancient DNA to reconstruct past biodiversity and functional processes

Margit Rindlisbacher, UNIBE
Proglacial sedimentation in Rhonensee

Veerle Verhoeven, UNIBE
Speleothem-based MIS11 climate from Siberia: implications for future warming

Frank Zwaan, UNIL, UNIFR
Exploring the impact of surface processes on potential natural H₂ resource development in Alpine orogens

SwissSed Meeting 2026 - List of participants (*status 04.03.2026, 20:00*)

Adatte, Thierry	Lausanne	Moradi, Gelare	Lausanne
Anselmetti, Flavio	Bern		
Akçar, Naki	Bern	Neame, Oliver	Fribourg
Benamri, Sofia	Lausanne	Paris, Guillaume	Nancy
Bomou, Brahimsamba	Lausanne	Perruchon, Valentina	Bern
Borsato, Matteo	Fribourg	Picard, Mailys	Bern
Büchi, Marius	Winterthur	Picotti, Vincenzo	Zürich
Deplazes, Gaudenz	Wettingen	Rindlisbacher, Margit	Bern
Duret, Madeline	Fribourg	Rüggeberg, Andres	Fribourg
Eichenberger, Raphael	Bern	Samankassou, Elias	Geneva
Etter, Alina	Bern	Schaller, Sebastian	Bern
		Swaton, Sophia	Bern
Fantasia, Alicia	Fribourg		
Felder, Martin H.	Bern	Talon, Julien	Dijon
Foubert, Anneleen	Fribourg		
Fournier, Maxime	Fribourg	Verhoeven, Veerle	Bern
Garefalakis, Philippos	Bern	Winkler, Wilfried	Zürich
Goncerut, Romain	Lausanne		
Grobety, Bernard	Fribourg	Zwaan, Frank	Lausanne
Karatsolis, Boris	Fribourg		
Laakonen, Aliisa	Bern		

Abstracts
(in alphabetical order)

Studying tsunami deposits in contrasting environments

Sofia Benamri^{*(1)}, Christopher DiPaolo⁽²⁾, Mohamed Najib Zaghoul⁽³⁾, Flavio Anselmetti⁽¹⁾,
Katrina Kremer⁽¹⁾

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In the context of climate change and rapid urban growth, understanding the nature, frequency, intensity, and effects of natural hazards is critical. Among these, tsunamis are particularly impactful: although relatively rare, their consequences are often catastrophic and long-lasting. Tsunamis cause sediment remobilization, both in aquatic environments and onshore, generating distinct sedimentary layers that differ from background deposits. While marine tsunami deposits have been extensively studied and classified, lacustrine tsunami deposits remain underexplored. Very few systematic studies address these freshwater environments, and a comparative approach across marine and lacustrine systems is still lacking. To better understand how tsunamis behave and leave sedimentary imprints across different geological settings, we compare two different sedimentological set-ups: (1) Rabat and Tangier regions (Morocco), located at the Atlantic-Mediterranean and historically affected by the 1755 Lisbon tsunami and other extreme events, and (2) Lake Lucerne (Switzerland), impacted by a destructive lacustrine tsunami in 1601.

Onshore sediment transects and samples have been analyzed from the coast of Rabat using a multimethod approach (sedimentology, micropaleontology, petrology). In addition, new samples have been taken from the region of Tangier and sediment cores from the offshore Lucerne Bay that will be analyzed using the similar multi-method approach.

In this contribution, we present and compare the sedimentary characteristics of high-energy event deposits such as tempestites (marine storm deposits) and tsunami deposits in the Rabat and in the Tangier regions in Morocco and compare them with the lacustrine counterparts in the Bay of Lucerne. These high-energy events affect not only marine coastal areas but also lacustrine environments by influencing sedimentation dynamics and redistributing sediments. Studying these deposits improves our understanding of landscape evolution and supports natural hazard assessment related to future extreme events.

A multiproxy record across the Sinemurian-Pliensbachian boundary: New insights from the Sarab-e-Ghanbar section, Iran

Borsato, M.*⁽¹⁾; Abdi, A.^{(2),(3)}; Bomou, B.⁽⁴⁾; Fantasia, A.⁽¹⁾

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This work presents the first results of a multiproxy analysis of the Sarab-e-Ghanbar succession in western Iran, which was deposited in the Kermanshah Basin across the Sinemurian–Pliensbachian boundary. The Kermanshah Basin opened during the late Triassic and began to close during the late Cretaceous (Abdi et al., 2022) in the northwestern part of the Tethys ocean. The basin lies on the northernmost part of Gondwana, and it was separated from the open ocean by a carbonate platform (Abdi et al., 2022). The presence of a carbon isotope excursion of -2‰ across the Sinemurian-Pliensbachian boundary in different sites (e.g., England: Schöllhorn et al., 2020, Portugal: Duarte et al., 2014, Morocco: Danisch et al., 2019) has been interpreted as the expression of a significant carbon cycle perturbation (Schöllhorn et al., 2020). Sedimentological and geochemical evidence from these sites suggest that the onset of the negative carbon excursion coincides with a shift towards arid and less humid climate conditions, and the development of oxygen-depleted conditions. These environmental changes have been attributed to the impact of the Central Magmatic Province volcanic activity and/or the opening of the Hispanic Corridor (Schöllhorn et al., 2020). To date the global character of the environmental changes is still unclear, and crucial questions still need to be answered: What were the climate and environmental conditions at different sites around the world? What were the drivers of the carbon cycle perturbation and climate change?

To answer these questions, we need to have additional records from other sites around the world and use a multiproxy approach to disentangle global from regional signals. To achieve this, we will study the Sarab-e-Ghanbar section and compare the results with other coeval sites. The Sarab-e-Ghanbar section is composed of marls and limestones lithostratigraphically attributed to the Late Sinemurian - Early Pliensbachian time interval. The methods used in this study are total phosphorous and organic matter characterisation with Rock Eval pyrolysis, to quantify and characterize the type and preservation of organic matter. Future lab work will investigate clay mineralogy, which will allow to characterize regional weathering conditions, and $\delta^{13}\text{C}$ isotopes on organic matter to characterize carbon cycle dynamics. The new data obtained with this work will allow to better characterise the climate and environmental conditions across the Sinemurian-Pliensbachian boundary, especially in the northwestern Tethys realm.

References:

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- Schöllhorn, I.; Adatte, T.; Van de Schootbrugge, B.; Houben, A.; Charbonnier, G.; Janssen, N.; Föllmi, K. (2020). *Climate and environmental response to the break-up of Pangea during the Early Jurassic (Hettangian-Pliensbachian); the Dorset coast (UK) revisited*. *Global and Planetary Change* 185 (2020) 103096. <https://doi.org/10.1016/j.gloplacha.2019.103096>

Spatial variability of microbialites in a poly-extreme rift setting (northern Afar)

Duret, M.^{*(1)}, Foubert, A.⁽²⁾, Negga, H.⁽³⁾, Endeshaw, A.⁽³⁾, and Jaramillo-Vogel, D.⁽⁴⁾

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Microbialites are organo-sedimentary structures resulting of mineral precipitation within a microbial mat involving metabolic processes of the microbial community and/or trapping of particles. Microbialites are known as the oldest evidence of life on Earth and developed in very diverse environments, going from marine to continental settings including hypersaline lakes. Microbial mats can help to preserve sedimentary structures and/or environmental changes through early mineralization. Despite their abundance in the geological record and their occurrence in a wide range of settings (pH, temperature, salinity, ion concentration and hydrodynamics), their mode of formation, the role of early diagenetic overprint, and especially their potential use as paleoenvironmental archives is not well understood. The Danakil Depression (northern Afar) hosts a unique Pleistocene to Recent microbialite archive in an active poly-extreme rift setting. The Pleistocene record in the Danakil Depression was influenced by its intermittent Red Sea flooding during interglacial times and volcano-tectonic activities linked to rifting between the Nubian and Arabian plate since Oligo-Miocene times. Pleistocene microbialites have been preserved within marine coral reef cavities, at the transition between open marine and restricted evaporitic deposits, and within continental conglomerate deposits. This study aims to capture the spatial and temporal variability of microbialites in those poly-extreme rift settings and their potential use as paleo-environmental archives. Microbialites are studied through sedimentary petrography using optical microscopy, mineralogy (XRD) and micro-CT scanning techniques coupled to isotope geochemistry, epifluorescence microscopy, raman spectroscopy and lipid biomarker extraction. Results reveal facies variability at micro- and macro-scale across the different microbialites. The spatial variability of these microbialites is a first approach to better constrain the distinct mechanisms of formation and as such their potential to record paleoenvironmental changes in this poly-extreme rift setting.

Investigating isolated carbonate platforms in Lac de Joux, Western Switzerland

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High-resolution bathymetric surveys of Lac de Joux's lake floor reveal striking morphological features. In various nearshore areas, distinct isolated shallow-water platforms can be identified. Previous investigations, based on short sediment cores and seismic profiles, revealed that these features represent carbonate platforms, consisting of in-situ produced lacustrine chalk. These platforms are interpreted to overlie a substratum of bedrock and glacial sediments, upon which calcareous sediments have accumulated continuously since the Holocene warming of the lake.

The objective of this master's thesis is to document the complete depositional sequence of these platforms through the retrieval of a long sediment core combined with high-resolution seismic investigations. This integrated approach aims to provide a robust understanding of the climate-controlled processes and environmental conditions that governed the formation and evolution of these prominent carbonate platforms. Lacustrine sediments represent valuable natural archives of past climatic variability. Their analysis provides an opportunity to reconstruct postglacial environmental changes in the region, including temperature variability, shifts in precipitation patterns and fluctuations in lake level.

Within this study, a high-resolution seismic survey targeting carbonate platforms in the southwestern part of Lac de Joux was conducted. Based on the seismic data, three coring sites were selected and a total of 17 m of sediment cores were recovered.

Preliminary core analyses indicate strongly laminated calcareous lacustrine sediments in the upper sections, underlain by a pronounced facies transition. This transition is characterized by an increase in density and magnetic susceptibility, accompanied by a distinct colour change. It is currently interpreted as representing the shift from proglacial deposition to fully lacustrine sedimentation, likely corresponding to the onset of the Holocene. Ongoing sedimentological and geochemical investigations, complemented by radiocarbon dating, aim to further constrain the timing and environmental significance of this transition.

The Early–Middle Jurassic: A turning point toward modern carbon cycling and climate?

Alicia Fantasia⁽¹⁾, Thierry Adate⁽²⁾, Jorge E. Spangenberg⁽²⁾, Emanuela Mattioli⁽³⁾,
Stéphane Bodin⁽⁴⁾, Nicolas Thibault⁽⁵⁾, L. Gavillet⁽¹⁾, Guillaume Suan⁽³⁾, S. P. Hesselbo⁽⁶⁾,
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The Early–Middle Jurassic period saw it all—from the emergence of calcifying plankton and the rise of dinosaurs to major evolutionary turnovers. It was a pivotal interval in Earth’s history, marked by substantial changes in continental and oceanic configurations, the emplacement of large igneous provinces, and significant environmental perturbations. These included the collapse of shallow-marine carbonate platforms, first- and second-order mass extinctions, episodes of eutrophication and marine anoxia, and major disruption to the global carbon cycle. Over recent decades, research has focused primarily on the causes and consequences of major Jurassic crises, such as the Triassic–Jurassic boundary, the Pliensbachian–Toarcian transition, the Toarcian oceanic anoxic event and the Bajocian crisis. However, this emphasis has often overshadowed inter-crisis time intervals that shaped the broader background environmental conditions of the Early–Middle Jurassic. Although advances in modelling and geochemical proxy application have improved our understanding of the overall environmental states, atmospheric CO₂ levels, and temperature, important gaps remain to be filled and puzzles to be addressed. What drove its climate fluctuations, their magnitude and how did they influence the evolution of life? To what extent was the Jurassic unique in fostering major revolution in the carbon cycle, climate system, and evolutionary trajectories that shaped the modern world? Central to answering these questions is a high-resolution record of Jurassic environmental conditions, climate and CO₂ – which thus far has been difficult to achieve. Existing records often lack the temporal resolution needed to fully capture dynamics in the Jurassic world. A systemic reconstruction that integrates sedimentological, mineralogical and geochemical analyses from both marine and terrestrial sedimentary archives across multiple spatial and temporal scales is therefore essential. Such a multiproxy approach will allow us to disentangle the relative influences of different forcing mechanisms on CO₂ levels and ocean chemistry, ultimately improving our understanding of the processes that governed carbon cycle and climate.

Palaeoenvironmental study of the Pliensbachian-Toarcian boundary in the Digne-les-Bains region (SE France)

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The Pliensbachien/Torcion boundary (Pl/To) in the lower Jurassic precedes the Torcion Oceanic Anoxic Event (T-OAE) by about 1 Myr. This period corresponds to a second order mass extinction, with a global collapse of the shallow marine ecosystems. At the present time, the precise sources of disturbances and the responses of the environment are still indistinct due to the presence of numerous hiatus phenomena, particularly in the area surrounding the Pl/To boundary.

The present study proposes a regional approach, which involves four distinct sites, composed of marls and limestones, located in the surroundings of Dignes-les-Bains (SE France). The implementation of this study will contribute to a potential reduction of hiatuses and the enhancement of comprehension of regional settings. Bulk mineralogy, Carbon and Oxygen isotopes on organic and inorganic matter, phosphorus, mercury and Rock-Eval will be the main analysis to correlate sites and study the regional palaeoenvironment.

The focus of this study is to better understand the history of formation of microbialite crusts associated with pyrite at the Pl/To boundary. These formations show successive appearances during this transition and are linked to pre-anoxic event in shallow seas. The limit also shows unique structures and tilting of the seabed. The presence of multiple filled fractures is notable. Understanding local tectonic and dynamics will be key to grab the full story of the region.

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- Bodin, S., Fantasia, A., Krencker, F.-N., Nebstjerg, B., Christiansen, L., Andrieu, S., 2023. More Gaps than Record! A New Look at the Pliensbachian/Toarcian Boundary Event Guided by Coupled Chemo-Sequence Stratigraphy. *Palaeogeography, Palaeoclimatology, Palaeoecology* 610: 111344. <https://doi.org/10.1016/j.palaeo.2022.111344>.
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Sahara dust event of 06.02.21 in Switzerland: Iberulite fall and formation

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Extended dust clouds were transported from the Moroccan-Algerian border towards Central Europe during the strong Saharan Dust Event (SDE) at the beginning of February 2021. In Western Switzerland, strong iberulite falls (IF) were observed in situ. Iberulites are spherical dust aggregates, 100 - 500 microns in diameter, which have been reported for the first time on the Iberian Peninsula (Díaz Hernandez and Parraga, 2008), but, to our knowledge, never from Central Europe. Because of the meteorological station in Payerne, the atmospheric conditions during the IFs were well documented. The dust cloud over Fribourg had three layers: the most dense between 1000 m and 3000 m, and two smaller ones, one on the ground and the third one at 4000 m within the rain clouds.

In contrast to the previous IFs observed in the Iberian Peninsula, this IF occurred under lower temperature conditions in the cloud and at the surface, which were both around the freezing point. The relative humidity (RH) in the first 1000m below the clouds decreased from 70 to 40%. The particle size distribution compared to the PSD measured inside the dust cloud (at Jungfrauoch) has, for the range between 0.3 and 1.0 μ m, a much lower concentration. This Greenfield (1957) gap, the meteorological conditions, and the microstructure of the iberulites point to below-cloud scavenging as the most likely formation mechanism. The dust particles are thus captured, whereas snowflakes and, at lower altitudes, rain droplets fall through the main dust layer beneath the cloud cover.

References:

Díaz-Hernández, J. L. and Párraga, J. (2008) The nature and tropospheric formation of iberulites: Pinkish mineral microspherulites, *Geochimica et Cosmochimica Acta*, 72, 3883–3906, 10.1016/j.gca.2008.05.037.

Greenfield, S. M. (1957) Rain scavenging of radioactive particulate matter from the atmosphere.

Using microfossils to reconstruct paleoclimatic and ocean circulation dynamics during past warm periods

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Microfossils are widely used as paleoceanographic proxies due to their high abundance, continuous record, and good preservation in marine sediments. Among the major microfossil groups, calcareous nannofossils are produced by unicellular photosynthetic organisms known as coccolithophores. Because these organisms play a dual role in the carbon and carbonate cycles and occur across a wide range of latitudes and ocean basins, they are valuable for reconstructing past ocean productivity and climate dynamics throughout the Cenozoic. Particular attention is given to past warm periods, which provide important insights into how the biological pump responded to elevated atmospheric CO₂ levels and higher ocean temperatures. The Late Miocene and Pliocene represent two such periods and have therefore been frequently used as analogs for understanding the potential impacts of ongoing global warming. In this talk, I present three case studies spanning these periods in different ocean basins. These studies focus on how we can use calcareous nannofossil abundances and biogenic carbonate sedimentation to reconstruct marine primary productivity and shifts in major ocean circulation systems, such as the Leeuwin Current and the Atlantic Meridional Overturning Circulation.

Diagenetic formation pathways of pyrite in Nam Co, a high-altitude Tibetan lake

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The Tibetan Plateau, with its average elevation of 4000 m above sea level, is the highest plateau on Earth. It is the third largest store of ice after the Arctic and Antarctic, which is why it is sometimes referred to as the Third Pole. It is an area sensitive to climate shifts and is expected to go through significant warming in the future. Due to its location in the modern monsoon regime, Nam Co was chosen as the study lake for the ICDP drilling project NamCore, which aims to reconstruct the Quaternary climate history of the region.

Lake sediments act as paleoenvironmental archives; minerals forming in the water column record the prevailing environmental conditions during deposition. However, post-depositional processes such as early diagenesis cause alteration in mineralogy, structure and/or chemistry of deposited sediments. This happens through the action of compaction, fluid circulation and physico-chemical changes, often mediated by microbial activity *in situ*.

The present work reports results on authigenic minerals and mineral evolution in Nam Co. The aim is to target different diagenetic formation pathways of pyrite by combining detailed structural and compositional data, such as high-resolution X-ray computed micro-tomography (μ CT), X-ray fluorescence scanning, and sulphur isotope analyses. We hypothesise that the formation of pyrite in Nam Co happens through different diagenetic processes and pathways driven by changes in hydrology and limnology, tectonically induced fluid flow, and microbial activity. The overarching aim is to disentangle these different formation processes, and to assess whether environmental and tectonic controls can be distinguished using the sulphur isotope composition of pyrite.

New Insights on the Formation and Dynamics of the Dallol System (Northern Afar)

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The Dallol Complex (Northern Afar, Ethiopia) is a unique and extreme hydrothermal, hypersaline and hyperacidic system that forms part of the tectonically active Danakil Depression. It constitutes a polyextreme environment due to the mixing of meteoric and seawater fluids interacting with the sedimentary record, magmatic processes, and rift tectonics. The extreme conditions and unique surface geochemistry at the Dallol Complex identify the region as one of the best Martian-analogue sites on Earth. Together with its location within an active rift basin close to continental break-up, the Dallol Complex is pivotal in our understanding of both rift basin dynamics and the potential of finding life on other planets. It is generally assumed that the Dallol Complex represents an early-stage proto-volcano. However, many competing models exist to explain its evolution due to the lack of subsurface datasets. This study for the first time integrates subsurface data (seismics, cores, down-hole logs), surface mapping, mineralogical data and Digital Elevation Models to present a holistic evolutionary model explaining the formation of the Dallol Complex.

From the basin margins to the centre, facies change from predominantly siliciclastic-rich to evaporite-rich with interbeds of siliciclastics and clays. Seismic profiles show regions of disturbed chaotic reflections within the Dallol Complex. These regions correlate with areas of hydrothermal activity at the surface. Time-series surface mapping suggests that minor fluctuations in quantity and location of hydrothermal activity occur. We interpret the seismically disturbed regions to represent large-scale fluid migration pathways, which originate from the complex interplay between meteoric fluids, local rift tectonics, sediments and magmatic activity. Fluid migration pathways are fed by groundwater channelized through both permeable sedimentary units and an active subsurface fault network. Fluids are heated through the interaction with the shallow magma reservoir before they resurge at the surface. Short-term fluctuations in the location of fluid flow likely represent minor variations in fault activity and fluid-sediment interactions. The high annual variability of hydrothermal fluid activity at the surface results probably from both fluctuating source fluid availability, fluid-salt interactions and magmatic activity. The presence and location of fluid migration pathways observed in subsurface data, along with changing fluid fluxes of surface hydrothermal activity, highlights the important role that fluid-salt interactions play in the evolution of the Dallol Complex.

Sedimentary ancient DNA to reconstruct past biodiversity and functional processes

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Sedimentary ancient DNA is a relatively recent addition to the suite of paleolimnological proxies used to reconstruct past biological communities. Since the publication of the first sedimentary ancient DNA (sedaDNA) dataset in 1998, methodological advances have facilitated the application of sedaDNA to various sedimentary records and target organisms.

This work introduces contextual information on DNA and how to recover it from sediment cores, including its sources, the types of research questions it can address, how it complements (and can be complemented by) other paleoenvironmental proxies, and main considerations for sampling strategy, sediment type, and data outputs. We applied this approach on Lake Nam Co (Tibetan Plateau), a high-altitude, alkaline, oligotrophic lake, at the intersection of westerly and monsoonal air masses. There, alongside multiple proxies, we aim to reconstruct past shifts in biodiversity and functional processes (genes related to photosynthesis) using sedaDNA from sediment cores drilled to a depth of 512 meters during the 2024 International Continental Scientific Drilling Program (ICDP) campaign.

Proglacial sedimentation in Rhonensee

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The proglacial Rhonensee formed ~15 years ago in an overdeepened depression in front of the Rhone Glacier as the ice retreated back over a bedrock cliff. It increases in size each year as the Rhone Glacier retreats further up the valley. As a result of its young history, the Rhonensee presents a unique opportunity to study lacustrine glacial sedimentation since lake formation, which then can be compared to the glacial history at an annual scale.

Proglacial lakes act as sediment sinks, and the interpretation of lacustrine sediments, such as clastic varves, can be used to construct a geochronological archive that records seasonal and annual patterns as well as climatic and meltwater fluctuations (Carrivick and Tweed, 2013). Proglacial lakes and their overdeepened basins are relevant topics in several contemporary applications, such as in the hazard assessment of glacial outbursts, water reservoirs, hydropower prospects, nuclear waste repositories, and tourism (Blass et al. 2003). This project aims to quantify and describe glacial sedimentation including sedimentary facies and structures, which eventually will be compared to climatic conditions and glacial activity.

Three surveys were conducted in 2015, 2021 (bathymetry), and 2024 (reflection seismics), respectively, which document the morphological changes of the lake basin. The lake almost doubled in size from the 2021 survey to the 2024 survey as the glacier retreated. Currently, the lake consists of two main basins, the North East (NE) basin and the South West (SW) basin, separated by what has been interpreted to be a moraine ridge (Fig. 1). The NE basin is younger and ~5 m deeper than the SW basin, having opened up only after the 2021 survey. Thus, it is expected that active deposition has shifted from the SW basin to primarily the NE basin. Additionally, seismic stratigraphy and seismic sequence analysis reveal that 3 centers of deposition occur, characterized by ~5 meters of sediment infill that usually pond the till and/or bedrock morphological depressions (Fig. 1).

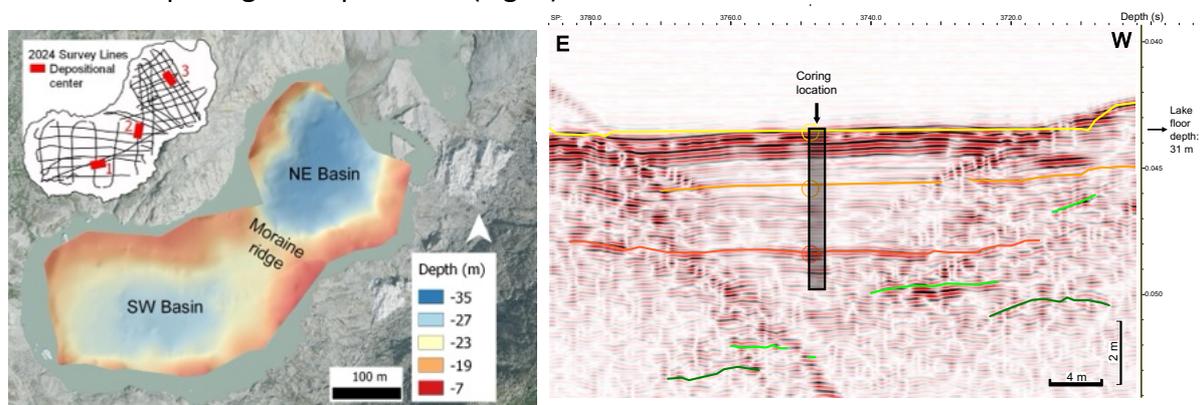


Figure 1. The low-resolution bathymetric map (left) from the 2024 seismic survey, superimposed on a 2024 aerial photograph from swisstopo. Seismic profile (right) of depositional center 1, with the coring location identified.

During an August 2025 coring campaign, the SW basin was cored with a piston-coring system from a floating platform. The sediment cores reached a total of 5 m depth. Preliminary results of core analysis reveal mostly fine-grained sedimentation punctuated by larger clasts, interpreted to be dropstones. The lowermost 40 cm consist of till (Fig. 2). Initial clast orientation analysis of the till conducted by machine-learning based image segmentation of CT scan data using the ImageGrains 2.0 model (Mair 2026, Schuster et al. 2025) provides insight into the depositional mechanism of the clasts. The analysis of these cores will contribute further to understanding subglacial ice-contact processes and the sedimentological history of the lake.

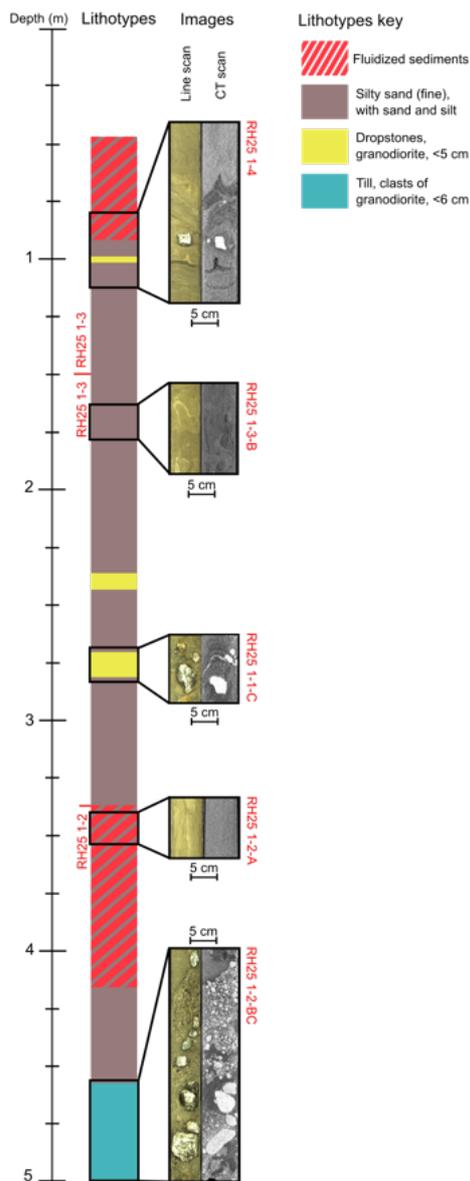


Figure 2: Preliminary composite core log, with line scan and CT scan images of key lithotypes.

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Sedimentary architecture of Late Cretaceous to Early Eocene flysch sequences in the Swiss Alps

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The Campanian/Maastrichtian to Lutetian Alpine flysch sequences of the Schlieren- and Gurnigel nappes record deposition in an ocean-continent subduction setting related to the Alpine orogenesis. Despite extensive studies of these flysch deposits, the existence of a source-to-sink relationship between the two units remains debated. Here, we logged 50 – 70 m-thick successions of the Gurnigel and Schlieren deposits at two sites, respectively, at a scale of 1:20. The ages of the analysed sediments range from the Thanetian to the Lutetian (Weidmann, 2005; Funk et al., 2013). Paleoflow directions were measured using sole marks and cross-bedding, and drone surveys were conducted to document the large-scale depositional architecture. Our aim was to reconstruct a potential proximal-to-distal relationship between the two sequences.

The Gurnigel sequences are dominated by a succession of sandstone beds with mudstone interbeds. Sandstone beds are < 1.5 m thick. They have planar, at times erosive, bases, are medium- to fine-grained (grain sizes ranging from c. 0.1 to 0.6 mm) and show a fining-upward trend. Individual beds display a succession of sedimentary structures occasionally starting with a massive fabric, followed by mm-scale planar lamination, ripple marks with convolute bedding, and sub-mm laminations towards the top. Mudstone interbeds, up to 30 cm thick, are massive to parallel laminated and strongly bioturbated, comprising up to 40% of the surveyed outcrop. Drone imagery shows that laterally continuous, horizontally layered beds dominate the overall architecture. However, lenticular sandstone beds with scours up to 50 cm deep occur locally. Sole marks and cross bedding indicate bimodal paleoflow directions to the S and W.

By contrast, the analysed sediments of the Schlieren nappe are dominated by coarse-grained (grain size up to 2 mm) sandstone beds that are < 4 m thick, characterised by a matrix-supported fabric and sole marks at their generally erosive bases. The finer-grained sandstone beds (grain size up to c. 0.6 mm) are < 50 cm thick. They display a massive, grain-supported fabric with normal grading at the base, followed by parallel lamination and occasionally ripple marks at the top. Mudstone beds (clay and silt fraction) are up to 25 cm thick. They are massive to parallel-laminated and locally show bioturbation. Mudstone beds contribute < 10% to the entire suite. Paleoflow directions scatter between the NE and SE. Drone surveys reveal the presence of troughs up to 7 m deep and extending laterally over tens of meters. They cut into sandstone beds and are backfilled with coarse-grained, massive to laminated sandstones.

The sedimentary structures in the Gurnigel sediments most likely accumulated from surge-like turbidity flows driven by dynamic pressure (Mulder and Alexander, 2001). In contrast, the Schlieren sediments were deposited predominantly by (hyper)concentrated, friction-controlled flows and concentrated currents in which grain-grain interactions dominate (Mulder and Alexander, 2001). Although the inferred surges recorded in the Gurnigel

sediments could, in principle, have resulted from flow separation and the associated grain-size partitioning – with coarse-grained material accumulating in the more proximal Schlieren area and finer-grained fractions being deposited in a more distal setting such as the Gurnigel realm – we discard this interpretation. This conclusion is supported by the opposite paleoflow directions, which indicate that no source-to-sink relationship existed between the two depositional systems in the Alpine foredeep.

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How can we explain the concomitant formation of dolomite and Mg-fibrous clays in coastal settings?

Insights from a Lutetian-Bartonian (Eocene) event in the Paris Basin

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The syndimentary or early diagenetic formation of dolomite under near-surface conditions has long remained enigmatic. A major breakthrough in solving this so-called “dolomite problem” came with the demonstration of microbial activity’s influence on these processes in alkaline to evaporitic settings (Vasconcelos et al., 1995; Bontognali et al., 2010; Sánchez-Román et al., 2025). In such environments, dolomite may be associated with magnesian fibrous clays (palygorskite and sepiolite), which precipitate directly from solution or transform from precursor minerals (Weaver & Beck, 1977; Singer, 1979; Pozo & Calvo, 2018). The formation of these clays has also been linked to microbial activity in hypersaline lakes (Perri et al., 2018; Del Buey et al., 2021). While some studies suggest palygorskite may form diagenetically from dolomite dissolution (Inglès & Anadón, 1991; Ryan et al., 2019), the mechanisms behind the simultaneous early formation of dolomite and fibrous clays remain unclear.

This study focuses on the ‘Marnes et Caillasses’ Formation (late Lutetian–early Bartonian) in the Paris Basin, where microcrystalline dolomite associated with fibrous clays has been observed. Through sedimentological, petrographic, mineralogical (XRD, SEM, TEM), and geochemical ($\delta^{13}\text{C}_{\text{org}}$, LIBS) analyses of five sites (Le Tillet, Saint-Maximin, Isles-les-Meldeuses, Ussy-sur-Marne, and Maise), we propose a new model for the early formation of dolomite and fibrous clays in coastal bay environments (Talon et al., 2025).

In these environments, the concomitant early formation of dolomite and palygorskite depends on highly variable physico-biogeochemical conditions, facilitated by microbial activity and associated extracellular polymeric substances (EPS). This high variability is further amplified by the combination of a restricted environment, linked to a Pyrenean deformation, and the Late Lutetian Thermal Maximum, a hyperthermal event whose record is proposed here for the first time in a coastal environment.

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Speleothem-based MIS11 climate from Siberia: implications for future warming

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Permafrost thawing is one of the most critical feedback mechanisms in the climate system. These melting processes release carbon dioxide, methane and other climate-relevant gases previously bound for millennia in the frozen soil, further exacerbating global warming and significantly impacting today's ecosystems (Schuur et al. 2015; Zimov et al. 2006). Despite intensive research, the exact relationships between permafrost thawing, climate and vegetation dynamics have not yet been completely understood. In particular, there is a lack of in-depth knowledge about the temperature sensitivity of permafrost deposits, and about the processes influencing thawing and stability. Investigating the geological past and particularly focusing on past warmer-than-present periods, can therefore provide valuable insights towards understanding current and future permafrost stability.

This study examines three stalagmites from the Okhotnichya cave in the Siberian permafrost region, which provide a record of the Marine Isotope Stage 11 (MIS 11) interglacial period – one of the longest and warmest warm phases of the Quaternary. These archives enable us to reconstruct paleoclimate and environmental conditions during MIS 11, allowing to draw conclusions about climate, vegetation and infiltration during this period. High-resolution microdrill sampling is used to obtain material samples for analysis of stable isotopes ($\delta^{18}\text{O}$ and $\delta^{13}\text{C}$) and various trace elements. In combination with a precise age model based on U-Th dating, temporal fluctuations in these signals can be detected.

The geochemical variations in the stalagmites reflect processes in the soil and karst system, including changes in vegetation, dissolution and transport mechanisms, hydrological dynamics, and extreme climatic events (Fairchild & Treble, 2009). Evaluating these signals will reveal new insights into the environmental conditions during MIS 11 and their significance for permafrost stability. The aim is to use the results of this work to improve understanding of climate-permafrost interactions, as well as to reconstruct long-term (centennial and millennial) ecosystem development after permafrost retreat. This will contribute to creating a basis for assessing possible developments under current and future climate warming.

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Exploring the impact of surface processes on potential natural H₂ resource development in Alpine orogens

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Clean hydrogen gas (H₂) is a potential alternative for polluting fossil fuels, but current synthetic H₂ production is highly energy intensive and often comes with extensive CO₂ emissions (Howarth & Jacobson 2021). Instead, natural hydrogen gas (H₂) generated through the serpentinization of mantle rocks is a promising solution that has come into the limelight in recent times (e.g. Gaucher et al. 2023, Ellis & Gelman 2024). For large-scale serpentinization and associated natural H₂ generation to occur, the mantle rocks need to be brought into an optimal temperature range of ca. 200-350°C (the serpentinization window, following Emmanuel & Berkowitz 2006 and Liu et al. 2023) and into contact with water. Alpine-style rift-inversion orogens, which have formed during the closure of rift basins, provide excellent environments for serpentinization-related natural H₂ generation (Zwaan et al. 2025). Moreover, such orogens also harbouring extensive volumes of sediments in which economical natural H₂ accumulation could develop, which could subsequently be drilled and exploited. In such orogens, erosion is known to have an important impact on exhumation processes and sediment distribution, but to what degree erosion efficiency influences natural H₂ resource potential remains poorly understood. For this study we use a numerical geodynamic modelling approach to explore and, importantly, quantify the relative roles of erosion, sedimentation, and tectonic processes during rift-inversion evolution by applying different erosion efficiencies and initial rift phase durations in our numerical simulations (Fig. 1).

Our geodynamic modelling shows that, regardless of erosion efficiency, initial rift duration is a dominant factor during both the extension and inversion phase. Prolonged rifting causes increased mantle exhumation, a higher chance at large-scale serpentinization and thus more natural H₂ generation potential. Erosion efficiency exerts a secondary effect, in that more efficient erosion modestly reduces serpentinization and H₂ generation potential by narrowing the serpentinization window in such systems. Inversion of advanced rift basins results in asymmetric orogens in which mantle material is incorporated into the overriding wedge, a configuration that is highly favourable for large-scale serpentinization and the associated generating of large volumes of natural H₂. Nevertheless, efficient erosion of otherwise symmetric orogens that tend to form after a limited phase rifting allows for a shift to an asymmetric style typical of systems with prolonged rifting, including significant mantle exhumation leading to a spike in serpentinization and natural H₂ generation potential.

However, efficient erosion and associated fast exhumation of relatively hot material in orogens can also decrease the vertical extent of the serpentinization window and thus reduce serpentinization and natural H₂ generation potential. Moreover, rapid erosion can remove the otherwise abundant potential reservoir rocks and seals needed for exploitable natural H₂ accumulations to form, in particular the early syn-rift deposits that tend to be uplifted during inversion. Indeed, the sediment distribution over time, as can be observed in the models, is a key factor for understanding where “conventional” natural H₂ resources (involving H₂ accumulation in reservoir rocks) could develop. Still, these negative effects of erosion on conventional natural H₂ resources may in fact be favourable for “unconventional” natural H₂ resource potential; systems with relatively hot mantle material close to the surface could be quite suitable for stimulated (“orange”) natural H₂ exploitation efforts, involving direct drilling of the mantle source rock itself (Osselin et al. 2022).

Thus, although erosion efficiency is not the dominant factor, it can still have a considerable impact on natural H₂ resource potential in rift-inversion orogens by impacting the orogenic style and thermal structure that controls serpentinization potential and associated natural H₂ generation, as well as the distribution (and preservation) of the sediments that may provide crucial reservoirs and seals for natural H₂ accumulations to form. Therefore, a thorough understanding of the evolution of those orogens targeted for exploration, will be of great importance. This challenge can be aided by numerical geodynamic models such as those presented here, with which we perform a first-order speculative analysis of natural examples from the Pyrenees, European Alps, and the Betics in SE Spain.

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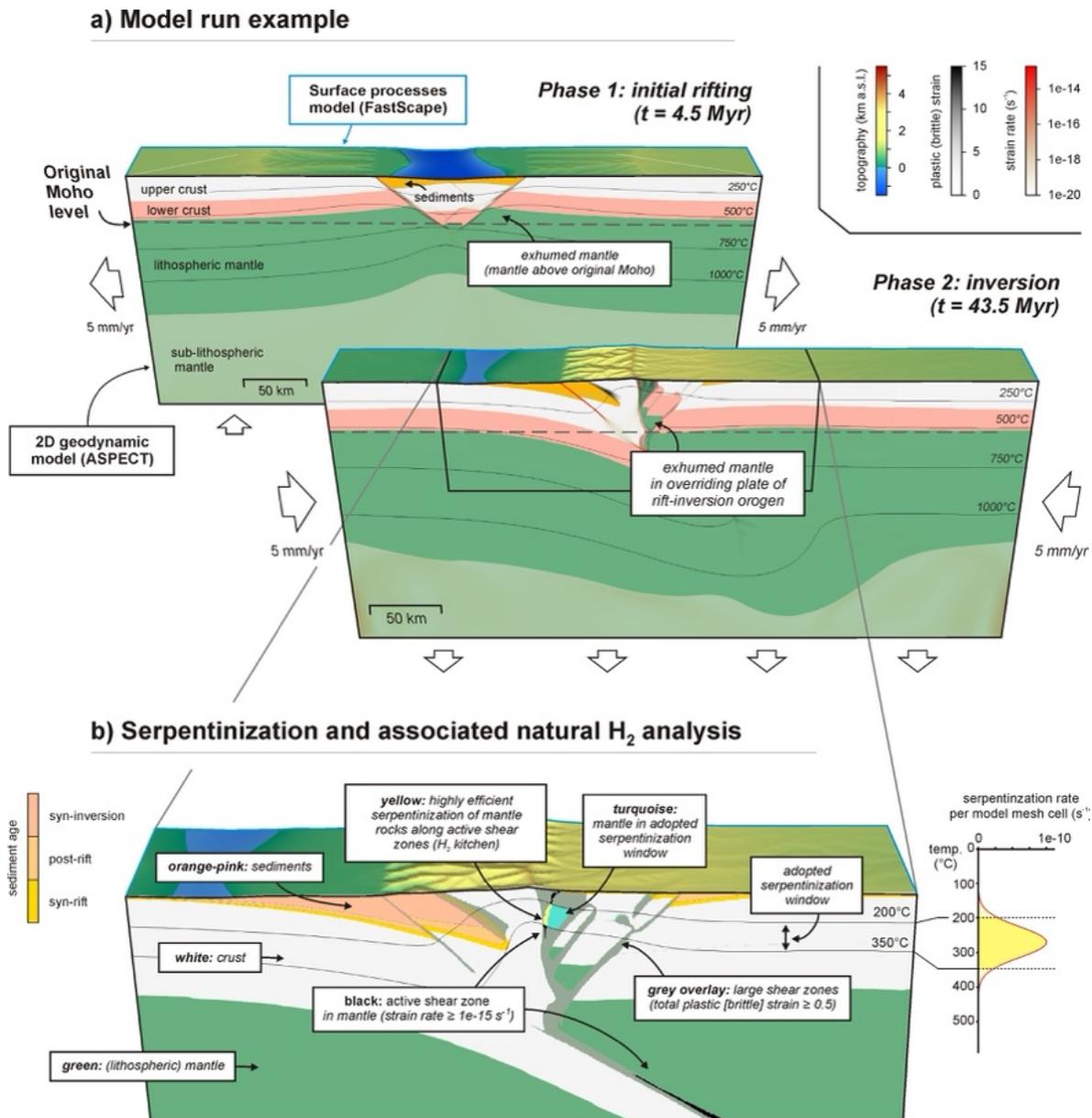


Figure 1. Example of (a) a model run (Model A3 with 5 Myr of initial rifting and with efficient erosion), and (b) natural H₂ potential analysis. (a) The two-dimensional ASPECT model addresses the deep geodynamics of the system. The FastScape surface processes model in turn interacts with the top boundary of the ASPECT model, altogether providing a quasi-three-dimensional result. (b) For the analysis of serpentinization and natural H₂ generation during the evolution of rift-inversion orogens, we adopt the 200° to 350°C temperature range (i.e., the “serpentinization window”). This allows us to conservatively visualize the H₂ kitchen (in yellow). Here, efficient serpentinization is expected to occur along large active faults that allow for ample water circulation. We base our adopted serpentinization window on the temperature-defined formulas for serpentinization from (Emmanuel & Berkowitz, 2006; Liu et al., 2023), which we use for the actual estimation of serpentinization and associated H₂ generation. These formulas illustrate how the highest serpentinization rates fall within the adopted serpentinization window, with near-zero rates outside of it. Image modified after Zwaan, Brune et al. (2025).