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Program and abstracts

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30th SwissSed

March 2, 2024

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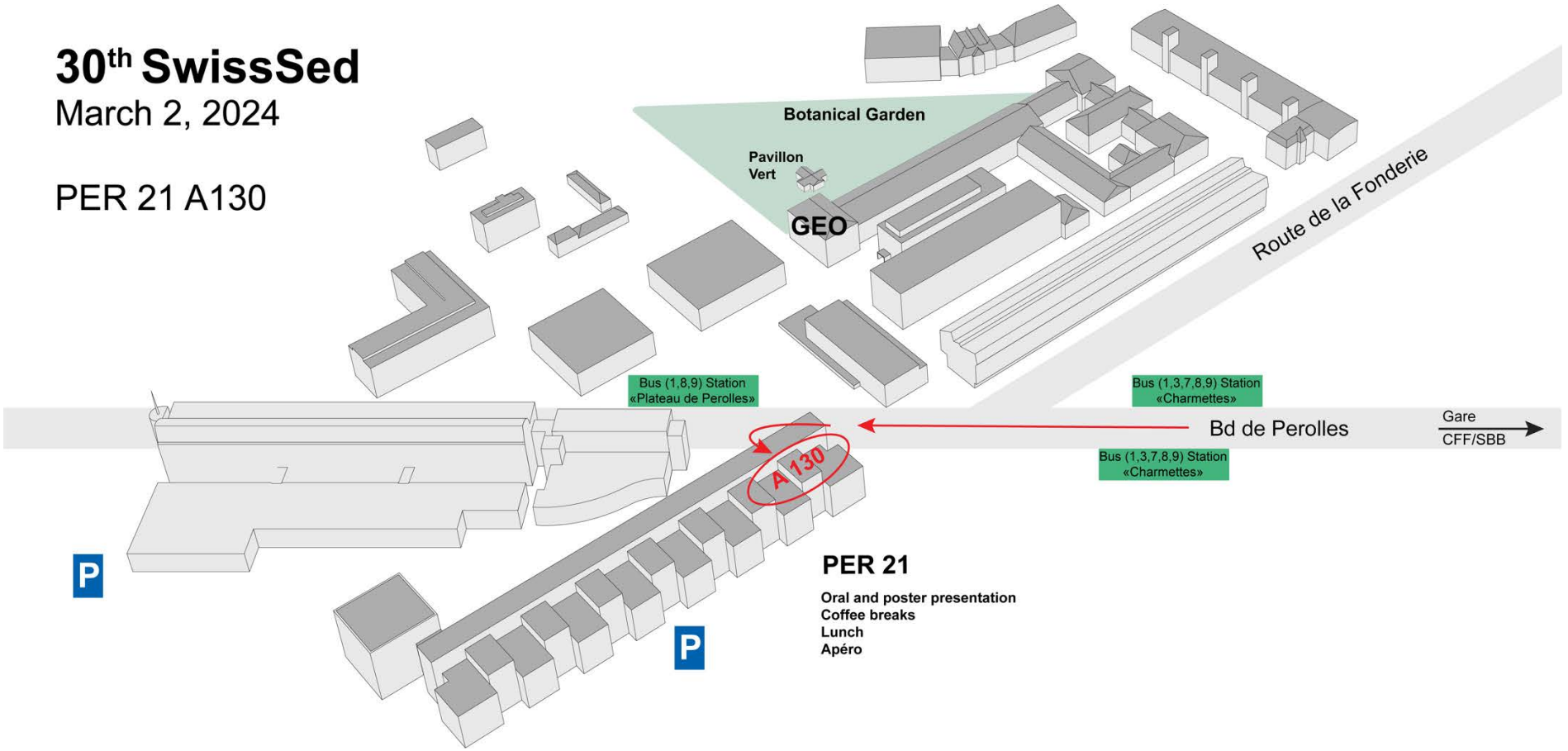

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PROGRAMME

09.00 - 09.30 Morning coffee and croissant

09:30 - 09:40 Opening: Anneleen Foubert

09:40 - 09:50 **Invited talk**
André Strasser: SwissSed - from 1993 into the future

09:50 - 10:35 **Keynote**
Daniel Ariztegui: Exploring the Dynamic Interplay of Biotic and Abiotic Signatures in Lacustrine Carbonates: Applications to the Earth and Planetary Fossil Record

10:35 - 10:50 **Ruchat, A.**, Eberli, G.P., Zampetti, V., Deplazes, G., Samankassou, E.: Seismic expression of a Middle Jurassic coral reef in a clay-rich contourite drift system in Northern Switzerland

10:50 - 11:10 **Endeshaw, A.**, Santodomingo, N., Negga, H., Foubert, A.: Paleoecological characterization of Middle and Late Pleistocene reefs of the Danakil Depression (Northern Afar, Ethiopia)

11:10 - 11:25 **Baumgartner, P.O.**, Hori, R.S., Andjic, G., Baumgartner-Mora, C.: Silica and carbon cycling during the Coniacian-Santonian (OAE3 events) and radiolarian biochronologic correlation to the CLIP-volcanism

11:25 - 11:40 **Blattmann, T.M.**, Lin, B., Siringan, F.P., Haghipour, N., Tinacba, E.J.C., Liu, Z., Eglinton, T.I.: Decadal scale change in the cycling of organic carbon on Luzon island of the Philippines observed in river sediments

11:40 – 12:00 **One-slide Poster presentations** (all poster presenters)

12:00 - 13:00 Lunch and posters

13:00 – 13:30 Posters

13:30 - 14:15 **Keynote**
Anna Harrison: Multipurpose carbonates: From CO_2 storage to paleo-archives

14:15 - 14:30 **Mittelbach, B.**, Brunmayr, A., White, A., Rhyner, T., Haghipour, N., Blattmann, T., Wessels, M., Dubois, N., Eglinton, T.: Pre-aged organic matter dominates modern organic carbon burial in a major perialpine lake system

14:30 - 14:45 **Mhlambi, S.**, van Bever Donker, J.M., Eruteya, O.E., Moscariello, A., Samankassou, E.: Static Geological Modeling for CO_2 Storage Capacity Estimation in the Depleted F-O Gas Field, Bredasdorp Basin, Offshore South Africa

14:45 - 15:00 **Mair, D.**, Witz, G., Do Prado, A.H., Garefalakis, P., Schlunegger, F.: Automated segmentation and measurement of sediment grains in images with high precision

15:00 – 15:15 **Meissner, J.G.C.**: A new perception of pelagic base-of-slope limestone-marl alternations of the Lower Jurassic and Lower Cretaceous Belluno Basin (Southern Alps, Italy)

15:15 - 15:45 ***Coffee break and poster session***

15:45 - 16:00 **Engelhardt, M.**, De Clippele, A., Ludjwera, A., Haghipour, N., Six, J., Drake, T.W., De Groot, L., Van Oost, K., Hemingway, J.D.: Lake archives from tropical Africa: Reconstructing the paleoclimate leading to the African Rainforest Crisis 3000 years ago

16:00 - 16:15 **Schneider, T.**, Lapointe, F., Stein, R., Balascio, N., Perren, B., Bradley, R.S., D'Andrea, W.J.: A promising archive of High Arctic Holocene temperature variability: lake sediments from Lake SW in Peary Land, North Greenland

16:15 - 16:30 **Sauter, G.**, Bouffard, D., Blanckaert, K., Fabbri, S.C., Anselmetti, F., Kremer, K.: Examining sedimentological processes in a sublacustrine delta: from underflows to geomorphic changes (Lake Brienz, Switzerland)

16:30 - 16:45 **Schlunegger, F.**, do Prado, A.H., Norton, K.P., Delunel, R.: The origin of the Quaternary staircase terrace systems in the valleys of Peru

16:45 ***Closure and best presentations award ceremony***
Apéro with poster session

POSTERS

Bijoux, A., **Fantasia, A.**, Adatte, T., Spangenberg, J.E., Baumann, N.B., Regelous, M.: A Multiproxy Record of the Paleocene-Eocene Thermal Maximum at the Contessa Road Section, Italy

Bomou, B., Rachoud-Schneider, A.-M., Haas, J.-N., Spangenberg, J., Adatte, T.: Palaeoenvironmental and palaeoclimatic records in a Swiss Jura palaeolake since the Late Glacial Period

Fantasia, A., Föllmi, K.B., Adatte, T., Spangenberg, J.E., Schoene, B., Scasso, R.A.: The Cañadón Asfalto paleolake, Argentina: A window into continental Middle Jurassic palaeoenvironmental conditions

Fantasia, A., Thibault, N., Adatte, T., Spangenberg, J.E., Mattioli, E., Regelous, M., Bodin, S.: The Cañadón Asfalto paleolake, Argentina: Driving mechanisms of organic carbon burial in the aftermath of the Toarcian hyperthermal event

Mangiagalli, M., De Boever, E., Rime, V., Grobety, B., Atnafu, B., Foubert, A.: Controls on formation and early diagenesis of gypsum microbialites at Lake Afdera (Afar, Ethiopia)

Mueller, M., Walter, B.F., Kluge, T., Immenhauser, A.: "Floating" carbonate clasts evidence sudden, basin-scale fluid expulsion

Russo, N., Lattaud, J., Dubois, N.: Lake Taney, West Valais: A dream study location for a multi-biomarker calibration.

Tercier, M., **Rüggeberg, A.**, Raddatz, J., Bernasconi, S., Foubert, A.: Cold-water corals and foraminifera as archive for carbonate mound development at the Melilla Mound Field (Alboran Sea)

Zimmerli, G.N., Wohlwend, S., Deplazes, G., Foubert, A.: Unravelling the depositional model of the Opalinus Clay in Switzerland: first insights from grain-size variability

SwissSed Meeting 2024 - List of participants *(status 28.02.2024, 08:30)*

Adams, Arthur	Lausanne
Adatte, Thierry	Lausanne
Akcar, Naki	Bern
Akhtar, Nosheen	Geneva
Andres, Miriam	Bern
Anselmetti, Flavio	Bern
Ariztegui, Daniel	Geneva
Baumgartner, Peter	Lausanne
Blattmann, Franziska	Lausanne
Blattmann, Thomas	Zürich
Bomou, Brahimsamba	Lausanne
Deplazes, Gaudenz	Wettingen
Do Prado, Ariel Henrique	Bern
Endeshaw, Addis	Fribourg
Engelhardt, Michelle	Zürich
Fabbri, Stefano	Bern
Fantasia, Alicia	Fribourg
Foubert, Anneleen	Fribourg
Garefalakis, Philippos	Bern
Hakimi, Marie	Bern
Harrison, Anna	Bern
Immenhauser, Adrian	Bochum (D)
Indi, Ignatius De Loyola	Bern
Jaimes Gutierrez, Rocio D.P.	Geneva
Li, Baichan	Bern
Mair, David	Bern
Mangiagalli, Matteo	Fribourg
Mavromatis, Vasileios	Bern
Meissner, Jan	Zürich
Mhlambi, Sanelisiwe	Geneva
Mishra, Bhagyashree	Geneva
Mittelbach, Benedict	Zürich
Morard, Alain	Wabern
Müller, Mathias	Bochum (D)
Picotti, Vincenzo	Zürich
Pietsch, Johannes	Basel
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Rüggeberg, Andres	Fribourg
Russo, Nicole	Zürich
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Schaller, Sebastian	Bern
Schneider, Tobias	Dübendorf
Schlunegger, Fritz	Bern
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Vaucher, Romain	Geneva
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Winkler, Wilfried	Zürich
Zeyen, Nina	Geneva
Zimmerli, Geraldine	Fribourg
Zwaan, Frank	Potsdam

Abstracts
(in alphabetical order)

Exploring the Dynamic Interplay of Biotic and Abiotic Signatures in Lacustrine Carbonates: Applications to the Earth and Planetary Fossil Record

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Microbialites offer geological evidence of one of the planet's first ecosystems, possibly preserving long-term interactions between coevolving life and its surroundings. They represent one of the most persistent ecosystems on Earth, while being the oldest witnesses of the combined evolution between biosphere, geosphere and atmosphere. Judith McKenzie's scientific pursuit focused on comprehending the processes that lead to observable phenomena in the geological record. She consistently emphasized to students and colleagues the fundamental importance of this understanding before delving into any attempt to use proxies. In the late nineties, Judy joined us for a field trip in Patagonia, where we conducted fieldwork in the Maquinchao Basin, Argentina. This location hosts both living and fossil microbialites, presenting a unique opportunity to investigate their formation processes—a goal aligned with Judy's scientific philosophy.

The extensive spatiotemporal distribution of microbialites makes them a valuable archive of the evolution of life on Earth while providing an ideal system in the quest for extraterrestrial life. However, the complex interaction loops between environmental and biological forces involved in their formation are still up for discussion, after more than a century of research. In this presentation, I will focus on the recent and fossil formation of microbial mats in two harsh habitats in Argentinean and Chilean Patagonia utilizing both experimental and field data.

The Maquinchao Basin is located in the Argentinean Patagonian foreland 150 km to the east of the city of San Carlos de Bariloche and approximately 350 km to the west of the Atlantic coast. Currently, the basin encloses two shallow water lakes, Carri Laufquen Grande (CLG) in the north and Carri Laufquen Chica (CLC) towards the south with average water depths of 2 m and 3 m, and are hypersaline to brackish water and brackish to freshwater compositions, respectively (Alvarez et al., 2021). The basin contains living and fossil microbialites (Pacton et al., 2016; Eymard et al., 2019; 2020). Their meso- and micro-scale features, in particular their fabric, mineralogy and geochemistry, allow us to better understand and distinguish between primary and secondary microstructures. Furthermore, they permit to assess the impact of early diagenesis and further preservation of these carbonate buildups (Eymard et al., 2021).

Laguna de los Cisnes, which is situated at 53°25'S and 70°40'W in Chilean Tierra del Fuego, was formed at the end of the last ice age. At present the lake encompasses living microbial communities forming carbonate buildups as well as fossil ones (Pollier et al., in review). These organo-sedimentary deposits cover an area of roughly 15 km^2 including a variety of morphotypes. Through a spatial examination of the predominate morphotypes across the basin along with microbiological data, we have investigated the environmental and biological factors ruling the morphology of these microbialites.

The combination of microbiological and mineralogical investigations is now providing a clearer picture of the mechanisms behind various biomineralization processes. By applying these

results to other microbialites outcropping at different spatial and temporal scales, these microbial carbonates provide critical data to improve the reconstruction of the dominant environmental conditions on early Earth and perhaps on other planets.

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Pollier, G. C. L., Guerrero, A.N., Rabassa, J., Ariztegui, D. (in review) The hidden biotic face of microbialite morphogenesis - a case study from Laguna de Los Cisnes, southernmost Patagonia (Chile). Sedimentology.

Silica and carbon cycling during the Coniacian-Santonian (OAE3 events) and radiolarian biochronologic correlation to the CLIP-volcanism

Peter Oliver Baumgartner*[(1)], Rie S. Hori[(2)], Goran Andjic[(1)], Claudia Baumgartner-Mora[(1)]

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Coniacian-Santonian (C-S) epicontinental and oceanic pelagic sequences yield a carbon isotope record with multiple small positive shifts that correlate with siliceous events, such as flint layers in the English Chalk (Jarvis et al. 2006, 2023) and radiolarian-bearing cherts in the Umbrian Gubbio sections. Radiolarians are rare in the English Chalk, largely made of sponge silica, but are abundant and often well-preserved in Alpine-Mediterranean pelagic C-S sections and at many DSDP-ODP Sites of all oceans, as well as on oceanic plateaus, such as the Caribbean Large Igneous Province (CLIP). No major plankton crisis occurred during the C-S, but characteristic radiolarian species allow for precise correlation with sections yielding planktonic foraminifera and nannofossils.

In contrast to the Cenomanian/Turonian Boundary Event (CTBE, or Oceanic Anoxic Event, OAE2) the positive $\delta^{13}C$-events, and hence organic carbon (C_{org}) burial, are ten times less important, but can nevertheless be globally correlated according to the recent synthesis of Mansour & Wagreich (2023). These authors distinguish 3 oceanic anoxic subevents during which C_{org} accumulated in modest quantities in the Atlantic and adjacent basins. Modest accumulation occurred during the C-S also in the CLIP area on the Caribbean Plate, while it was emplaced between the Americas.

The CLIP, among other large igneous provinces (LIPs), has classically been regarded as the principal cause of the CTBE/OAE2 (~94 Ma). However, the main CLIP phase (92–87 Ma) is younger and did not contribute significantly to the climate crisis of the CTBE. Radiolarian biochronological work of the last decades allows us to correlate radiolarian-bearing sediments associated with basalts and intrusive rocks of the CLIP with well-calibrated pelagic sections of the C-S. (OAE3, 89.8 – 83.6 Ma) in the Mediterranean region.

Black, organic-rich radiolarites dated as C-S occur interbedded with and/or directly encroach on basalts of the CLIP phase (Ar/Ar ages of 92-83 Ma) of the Nicoya Complex (Costa Rica), in the Azuero Plateau (Panama), as well as on CLIP basalts located on the Beata Ridge and in the Eastern Caribbean Basin (DSDP Sites 146, 151 and 153). Radiolarian-dated C-S volcano-pelagic, organic-rich strata directly overly CLIP-related basalts in the Manzanillo Terrane (S-Nicoya Peninsula (Andjić et al. 2019), and in the Tireo Group (Dominican Republic).

The C-S globally represents a period with negative $\delta^{18}O$ values, which increase after the CTBE minimum. This is interpreted as a time of hot and humid “hot-house” paleoclimate that progressively cooled during the C-S. Low values $\delta^{18}O$ ~ -4.25‰) during the Coniacian, are followed by a negative extreme at the C/S boundary, interpreted as short term warming resulting in eutrophic conditions and C_{org} burial in some areas. A rapid increase of almost 1‰ during the Santonian is interpreted as a cooling trend that continued during the Campanian.

During the C-S, the global carbon cycle was dominated by oceanic carbonate burial (chiefly nannofossils and planktonic foraminifera), which did not allow large variations in $\delta^{13}C$ values (Weissert and Moor 1995). With the increase in atmospheric pCO_2 during abundant eruptions

of the CLIP and other LIPs, global temperature and water cycling increased, and the pH of ocean water decreased. In contrast to other OAEs, pCO_2 did not increase much since it was buffered by abundant carbonate precipitation and terrestrial silicate weathering that caused a reduction in pCO_2.

We envisage secular silica and carbon cycling in a carbonate ocean as follows: The increase in river input of nutrients and dissolved silica (dSi) to the ocean promoted the production of biogenic silica and C_{org} (sponges, radiolarians, diatoms), accompanied by C_{org} burial and a $\delta^{13}C$ positive trend. This tendency is counterbalanced by ocean acidification: A lower oceanic pH decreased the solubility and recycling of biogenic silica in surface waters and increased the vertical flux of particulate silica, leading to a shortage of dSi in surface waters and punctuated silica burial. This process rapidly reduced the production of biogenic silica via the elimination of opportunistic species. The cycle ends with decreasing silica and C_{org} burial, a new dominance of the carbonate factory and, consequently, a negative $\delta^{13}C$ trend.

Refernces:

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A Multiproxy Record of the Paleocene-Eocene Thermal Maximum at the Contessa Road Section, Italy

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The Paleocene-Eocene Thermal Maximum (PETM, ~55 Ma) records one of the most severe and intensively studied hyperthermal events which is often proposed as a yardstick to current global warming. The PETM was associated with the massive injection of carbon to the ocean-atmosphere system and major environmental changes. The temporal coincidence between the PETM and the emplacement of the North Atlantic Igneous Province suggest that magmatism could have contributed to the initiation of the global-change event. Although several studies have already advanced our understanding of the causes and consequences of the PETM, there are still some aspects of the Earth's climate regulation that remain understudied. In particular, the long-term palaeoenvironmental evolution, the feedback mechanisms enabling the climate to stabilise and regulate across the PETM, and the associated timescales are still highly debated. In this presentation, the Contessa Road succession has been selected to have a deep marine record of the PETM. The study is based on a multiproxy approach, which provides keys to assess the palaeoenvironmental changes associated with the PETM and constrain the feedback mechanisms governing the carbon cycle-climate dynamics. The studied Contessa Road succession encompasses the Paleocene-Eocene transition and is mainly composed of reddish marly carbonates, sometimes bioturbated, with discrete clayey interbeds, which were deposited in the pelagic Umbria-Marche Basin (Italy). The PETM interval is marked by two clay-rich intervals supposed to reflect dissolution levels. This section is correlated to coeval sites by means of organic and inorganic carbon isotope stratigraphy. Whole-rock and clay mineralogy provide constraints on the changes in the palaeoclimatic conditions and weathering rates, total phosphorus content allow us to determine nutrient levels, and mercury and tellurium contents to assess the role of the NAIP volcanic activity in governing the pattern of the PETM. Combined with other findings from worldwide-distributed coeval sites, the new mineralogical and geochemical dataset offers a holistic understanding of the carbon cycle-climate dynamics and of the feedback mechanisms enabling the climate to stabilise after extreme environmental perturbations.

Key words: Global change event, Hyperthermal, Multiproxy approach

Decadal scale change in the cycling of organic carbon on Luzon island of the Philippines observed in river sediments

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Southeast Asia is the region with the highest land-ocean fluxes of sediment in the world. Previously, we have characterized the organic matter composition of riverine sediments from the island of Luzon from the Philippines (Lin et al., 2021). In this study, we returned to the same sampling sites to investigate the changes taking place in the cycling of carbon from this dynamic sedimentary system. Between the time of first sampling in 2007 and the time of second sampling in 2016, we observe marked changes in the radiocarbon age of sedimentary organic carbon appearing to reflect increased erosion of older earthen material into rivers. As the type of organic matter based on stable carbon isotope signatures appears to remain similar on average, these older ages may reveal increased mobilization of deeper soil material. This strong change we observe within the timespan of a decade indicates rapid environmental changes likely related to regional anthropogenic activity and or global climate change. The loss of these deeper soil layers implies that organic carbon that has built up on land over centuries is being transferred to the ocean where it faces an uncertain fate. We emphasize the importance of time series observations for understanding the dynamic changes taking place in our Earth system today and we will present the progress of our interpretations.

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Lin, B., Liu, Z., Eglinton, T. I., Blattmann, T. M., Kandasamy, S., Haghipour, N., and Siringan, F. P., 2021, Organic Matter Compositions and Loadings in River Sediments From Humid Tropical Volcanic Luzon Island of the Philippines: Journal of Geophysical Research: Biogeosciences, v. 126, no. 7.

Palaeoenvironmental and palaeoclimatic records in a Swiss Jura palaeolake since the Late Glacial Period

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During the Late Glacial period, the Amburnex Valley site (Switzerland) was a glacial lake with significant accumulation of lacustrine sediments, providing a complete record of paleoclimatic and paleoenvironmental evolution.
The aim of this study is to reconstruct the paleoclimatic and the paleoenvironmental evolution recorded in lacustrine sediment deposits over the last 15'000 years. The Amburnex core displays a basal morainic deposit from the Würm period, overlain by three meters of lacustrine deposits and four meters of peatland deposits. A multiproxy approach based on palynological, mineralogical and geochemical analyses was used to characterise hydrological and climatic fluctuations, trophic levels, and the origin of organic matter. This approach was employed to reconstruct the paleoenvironmental and paleoclimatic evolution of this area. The analyses included TOC, nitrogen, phosphorus and mercury contents, major and trace elements, and organic carbon isotopes.
The Bølling-Allerød, the Younger Dryas and the beginning of the Preboreal period have been recognised in the Amburnex site, by palynological analyses and carbon 14 dating. The Oldest Dryas was characterised by oligotrophic conditions, as evidenced by the very low concentrations of nitrogen and organic matter. During the warmer Bølling period, there was an enrichment in total organic carbon (TOC), indicating the development of eutrophic conditions. Later, during the Allerød period, low TOC and phosphorus contents, associated with varved carbonate deposits, indicate a return to more oligotrophic conditions. In the interval corresponding to the colder Younger Dryas period, new organic matter enrichments were observed. These trends are quite consistent with those observed in different Jura lakes and reflect significant changes in runoff and nutrient inputs at least at a regional scale.
No evidence of a tephra layer or significant mercury anomalies were found at the Amburnex site. However, significant increases in magnetic susceptibility were observed during the Allerød and Younger Dryas periods. These increases are well correlated with those recorded in other Jura lakes containing tephra layers, corresponding to the Laacher See Tephra and the Vedde Ash, respectively. A significant peak in Ptot is observed at the same level as the magnetic susceptibility peak during the Allerød period.
This peak appears to be independent of nitrogen and TOC and is related to apatite present in tephra glass in the volcanic ash deposits of the Laacher See Tephra.

Paleoecological characterization of Middle and Late Pleistocene reefs of the Danakil Depression (Northern Afar, Ethiopia)

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The Danakil Depression is a tectonically controlled rift, located in the northern Afar at 126 m below the current sea level. Middle and Late Pleistocene reefs are outcropping at the margins of the depression which host diverse communities of the reef coral species. These Pleistocene reef units developed during several flooding episodes that connected the southern Red Sea regions with the northern Afar. During the Middle Pleistocene (240 ka), most reefs were fringing reefs that completed at least one reef growth cycle consisting of *the start-up* phase mainly characterized by sediment-matrix facies with sparse coral colonies, *the catch-up* phase represented by pillarstones – mixstones – rudstones, and *the keep-up* phase comprised domestones and branching coralline algae biostrome. On the other hand, Late Pleistocene reefs (120 ka) mostly developed as patch reefs and coral carpets. The main goals of this study were to (1) characterize the species composition, coral cover, species richness and diversity of these Middle and Late Pleistocene reefs, in order to (2) evaluate spatial variations of the coral taxa composition across the Danakil Depression, and (3) infer Paleoecological successions in these reef terraces. Surveys were performed using Line Intercept Transect (LIT) sampling method with transects ranging from 35 to 50 m parallel to the paleo-coast line. The main coral reef component categories recorded along the LIT include corals, crustose coralline algae and sediment. Corals were identified to the lowest possible taxonomic level. The forereef of the Middle Pleistocene fringing reefs were primarily dominated by the coral genera *Porites, Astraeosmilia* and *Diploastrea* secondary *Lobophyllia, Goniopora* and *Echinopora* with crustose coralline algae (mainly branching *Lithophyllum* sp. and *Porolithon* sp.). While, the reef crest/reef flat were characterized by primarily *Porites* and *Favites* with secondary genera *Astraeosmilia* and *Platygyra*. The patch reefs and coral carpets of Late Pleistocene reefs were primarily dominated by *Porites*, *Dipsastraea*, *Echinopora* and *Pachyseris* with secondary *Platygyra* and *Favites*. Additionally, monospecific stands of genus *Galaxea* and *Goniopora* occur in the Late Pleistocene reefs. This study indicates that the Middle and Late Pleistocene reefs of Danakil Depression hosted diverse coral communities. There is significant variation in the species composition of the Late Pleistocene reefs caused by absence of certain genera from the community. Additionally, differences are observed in dominance of certain groups and community shift between the Middle and Late Pleistocene reef terraces across the Danakil Depression.

Keywords: Coral, Coral cover, Diversity, Fringing reef, Patch reef, Red Sea

Lake archives from tropical Africa: Reconstructing the paleoclimate leading to the African Rainforest Crisis 3000 years ago

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The second largest rainforest biome on Earth lies in the Congo Basin of central Africa. Due to increasing pressure associated with slash-and-burn farming practices as well as climate change, the rainforest may loose its ability to absorb atmospheric carbon. Interestingly, former studies have found evidence for a similar so-called "African Rainforest Crisis" taking place in the late Holocene, around 3000 years ago (Brncic et al. 2009; Garcin et al. 2018). There are some indications that this crisis was caused by the expansion of the Bantu people, who are believed to have migrated to this area to pursue extensive farming at this time. Pollen records, to the contrary, suggest a shift towards a drier climate as the primary mechanism inducing the crisis. Since data from this area are scarce, more information is needed to resolve the exact causes of the African Rainforest Crisis, especially as it is a likely analog for ongoing and future rainforest contraction.

To provide such information, we collected about 30 m of core from in sum 13 lakes along the rainforest-savannah boundary in the Kasaï Basin, Democratic Republic of Congo, which constitutes the southwest portion of the Congo Basin. We developed preliminary age models of the sediment records using bulk radiocarbon measurements to compare the estimated sedimentation rates. Two periods of reduced sedimentation rates around 700 and 3500 years before present have been identified. These can indicate the timing and spatial extent of erosive events usually linked to drying and a shift in vegetation. Additionally, XRF and XRD data will offer insights on the underlying mineralogy. By using mineralogy as an indicator of weathering intensity, we expect to draw conclusions on the hydrology and temperature throughout the late Holocene. To further constrain the paleoclimate reconstructions, triple-oxygen isotope analysis on the clay-size fraction and pollen and charcoal analyses are planned. A holistic interpretation will aim to reveal the role of climate vs. land-use change as a trigger of the African Rainforest Crisis, which serves as an analog to better predict how the Congo rainforest will respond to today's land use- and climate-triggered challenges.

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The Cañadón Asfalto paleolake, Argentina: A window into continental Middle Jurassic palaeoenvironmental conditions

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The Middle-Late Jurassic period was marked by repeated carbon cycle perturbations associated with global climate and environmental changes. Those perturbations are well understood in the marine realm but comparatively understudied in continental records. The Cañadón Asfalto Basin (Chubut Province, Argentina) evidence a unique continental record with the exceptional preservation of Middle-Late Jurassic fauna and flora. Constraining the palaeoenvironmental conditions is hence crucial in order to better understand the carbon cycle and its potential effect on the evolution of life.

This study focuses on the Cerro Cóndor paleolake of the Cañadón Asfalto Basin. Through sedimentological, mineralogical (whole-rock and clay assemblages), geochemical (organic matter characterization, carbon and oxygen stable isotopes, major and trace elements, total phosphorus), and radiometric (high-precision U–Pb ages) analysis palaeoenvironmental conditions are reconstructed. The lacustrine system was influenced by important volcanic activity and lake level fluctuations. The sedimentary succession is composed of organic matter-rich mudstone, sandstone and conglomerate, as well as an important contribution of volcanic and volcanogenic material. Lacustrine stromatolites are common in the studied area and represented by stromatolitic limestones and stromatolitic cherts. The paleolake was marked by well-oxygenated phases alternating with periods characterized by oxygen-deficient conditions. Last favorizes the selective preservation of organic matter. The integrative dataset provides new insights on how local environmental processes and volcanic activity drives regional depositional conditions and how to detangle regional from global environmental trends.

Driving mechanisms of organic carbon burial in the aftermath of the Toarcian hyperthermal event

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Carbon cycle-climate dynamics were nonlinear through Earth's history, driven by changes in internal and external forcing processes acting on various geological timescales. This study focuses on determining the relationship between volcanism, orbital parameters, and organic carbon burial during the Aalenian (Middle Jurassic) - a pivotal time at the dawn of the Mesozoic Marine Revolution, marked by a disruption of the carbon cycle and major climate shifts. Here, new high-resolution magnetic susceptibility and trace elements data are combined with previously published organic carbon isotopes and total organic carbon data from two sites in France and Chile. Our dataset shows for the first time a temporal coincidence between the major carbon cycle perturbation during the middle–late Aalenian and the onset of enhanced volcanic activity, suggesting a causality link. We propose that volcanic activity triggered a transient warming episode within the long-term Middle Jurassic coldhouse and played a key role in shifting organic carbon burial from the ocean to terrestrial settings. This period therefore contrasts with other Mesozoic carbon cycle perturbations, which generally record enhanced marine organic matter burial in oxygen-depleted environments during volcanism-triggered warming events.

Multipurpose carbonates: From CO_2 storage to paleo-archives

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Carbonate minerals are an important archive of paleo-environmental conditions; their mineralogical, isotopic, and trace metal compositions record a history of the surrounding environment. The crystal structures of carbonates also serve to lock carbon dioxide out of the atmosphere over geologic timescales, and they are thus envisioned as a potential trap for anthropogenic emissions to help mitigate climate change. Whether we are interested in these minerals as a paleo-archive of past environmental conditions or for geochemical CO_2 storage, it is important to identify what controls their formation, stability, and composition. In a series of experimental studies, we have examined the impact of various formation pathways on carbonate mineralogical, isotopic, and chemical composition to shed light on both the security of CO_2 storage and the robust interpretation of isotopic compositions of carbonates. We show that during transformation of metastable carbonate phases to stable phases, the isotopic composition of carbonates is substantially altered, but CO_2 remains securely stored. Moreover, isotopic and trace element compositions of stable carbonates can be altered in the absence of net dissolution-precipitation, in some cases hindering the interpretation of isotopic compositions. In both natural and engineered environments, the type of carbonate formed and its stability are strongly dependent on the relative abundance of Mg, Ca, and Fe. We show that the relative proportion of Mg-Ca-Fe governs the fate of CO_2, and the composition of the background electrolyte influences the rate of Mg-carbonate precipitation. Yet, we observe that the availability of water, or water activity, is an overarching control on the precipitation of carbonate minerals, irrespective of the composition of the carbonate. We find that carbonate minerals can readily crystallize from an amorphous precursor, and by replacement of Mg- and Ca-hydroxides even in the absence of bulk water, provided that sufficient adsorbed water is present at the mineral surface. Together, our experimental results outline the conditions that impact utilization of carbonate minerals both as paleo-archives of past environmental conditions, and as CO_2 sinks.

Automated segmentation and measurement of sediment grains in images with high precision

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Accurately characterizing sediment particles' size and shape is essential for understanding erosion, transport, and deposition mechanisms in sedimentary processes. Hence, grain morphometry data is critical in understanding sediment production and transport dynamics in various environments. However, traditional field methods are labor-intensive, and results may suffer from a limited number of observations. At the same time, and despite recent improvements through deep learning, remote measurements in images or point clouds still need improvements for accuracy (e.g., Miazza et al., 2024; Mair et al., 2022) or time-consuming manual corrections (e.g., Steer et al., 2022). These challenges are even more pronounced for images with complex scenery or high grain size variability, and they hinder routine acquisition of size and shape information.

Here, we build on our recent and deep neural network approach (Mair et al., 2023) for obtaining shape information on coarse fluvial sediment particles from segmented images. We update our approach to segment individual grains in pictures with more considerable variation in settings and grain size range (Fig. 1). To achieve this, we leverage the flexibility of the used architecture (Stringer et al., 2021) that allows easy re-training of the algorithm to adapt to new image conditions, which can be achieved with comparatively few data. This allows for custom models for different settings that we successfully trained for orthoimages from gravel bars on several continents, for images of gravel pit outcrops, and micro CT images of sand grains (Fig.1). Our quantitative method validation includes assessing segmentation performance against ground truth from annotated images and evaluating the measurement quality by comparing results to independent measurements in the field and in images. In addition, we can confirm that higher segmentation quality directly leads to improved precision and accuracy for grain size and shape data.

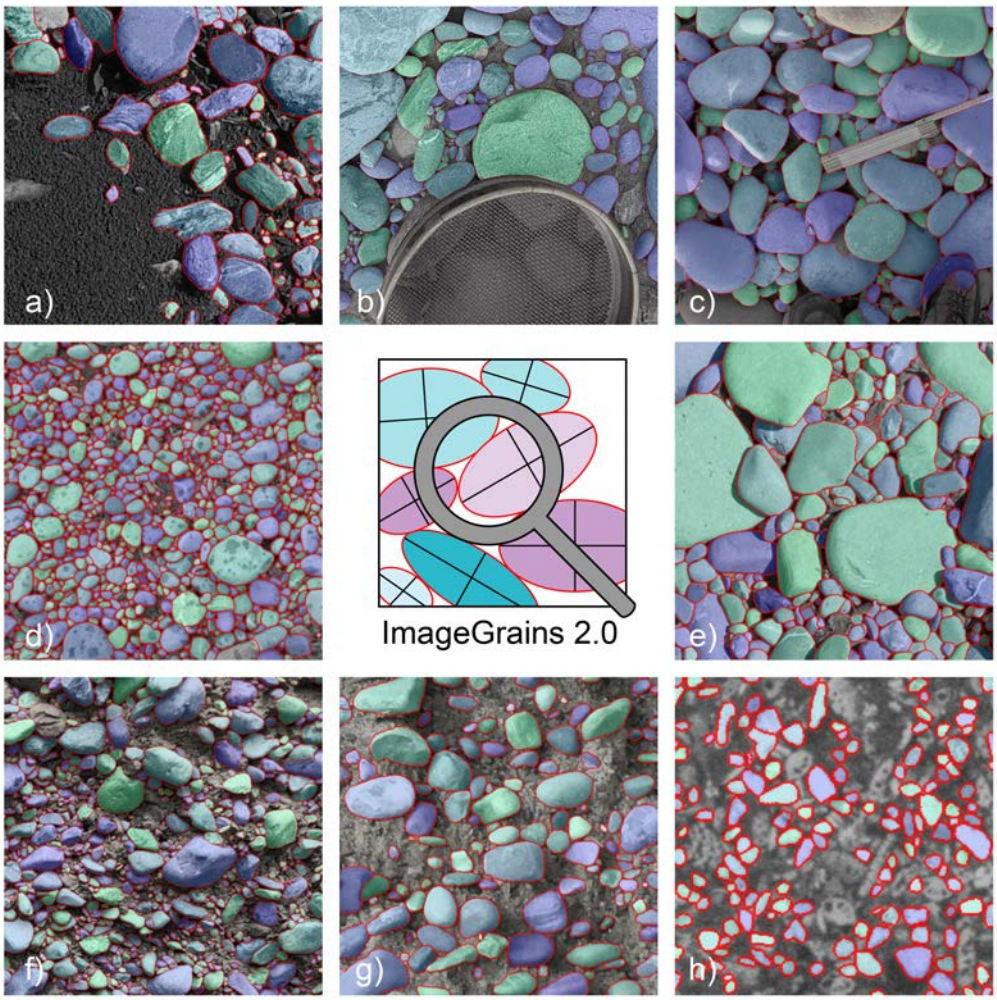

Figure 1. *Individually segmented grains in sediment images for a variety of settings: a-e) nadir images of fluvial gravel bars in Switzerland, Peru, and New Zealand; f-g) Outcrop and gravel pit pictures from New Zealand and Switzerland; h) Micro CT images of sand grains from the Caribbean. All grains are heterogeneous in size, shape, and lithological composition.*

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Controls on formation and early diagenesis of gypsum microbialites at Lake Afdera (Afar, Ethiopia)

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The Danakil Depression, located in the northern part of the Afar, forms an active rift zone related to the break-up of the Afro-Arabian plateau since Oligo-Miocene times. Within the southern part of the Depression, Lake Afdera forms a *NaCl*-bearing hypersaline lacustrine setting featuring important gypsum deposits. Gypsum deposits manifest mainly on Franchetti Island as crusts, concretions, and meter-sized mounds. They consist of cauliflower gypsum, lenticular gypsum crystals and gypsum laminations associated with microbial mats. This study focuses on the formation and early diagenesis of these gypsum structures, emphasizing the potential role of microbial films on fabric and texture.

Gypsum deposits are characterized using standard sediment petrological techniques, fluorescence microscopy, X-ray diffractometry (XRD), X-ray micro-computer tomography and Scanning Electron Microscopy (SEM). Water samples were analyzed for their major elemental composition, pH, alkalinity, salinity and T. Samples were collected along two proximal-distal transects (from the island's inland part to the open lake). Results indicate correlation between macro-morphologies, micro-scale fabrics, and mineralogy (gypsum/anhydrite) along the transects. SEM and micro-CT scanning evidence the close spatial relationship between gypsum crystals and biofilms. Microbial films are playing an important role in the precipitation of gypsum within the mats, leading to unique gypsum microbialites. Results also highlights the value of gypsum microbialites as accurate indicators of lake water level fluctuations.

This study provides new insights into the characteristics and formation of gypsum microbialites in Lake Afdera. Further investigations will contribute to the characterization of these gypsum deposits in the geological record of which the formation mechanisms are often debated and poorly understood.

A new perception of pelagic base-of-slope limestone-marl alternations of the Lower Jurassic and Lower Cretaceous Belluno Basin (Southern Alps, Italy)

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Limestone-marl alternations (LMAs) are a specific type of calcareous rhythmite. Many of them are believed to be the result of cyclic paleoenvironmental signals. Some pelagic LMAs from the Jurassic and Cretaceous have been interpreted as reflecting carbonate productivity cycles, particularly with those of calcareous nannoplankton, which have been the principal contributors to pelagic micrites since the Early Jurassic. However, various studies challenged these interpretations, suggesting that the rhythms observed in some of these successions were overprinted or even entirely produced by secondary diagenetic processes. Thus, to interpret a calcareous rhythmite as being produced by an external trigger, its primary sedimentary origin must be proven first, and the effects of burial diagenesis must be resolved.

Associated with this discussion, many researchers questioned the primary origin of LMAs because the origin of the mud-grade low-magnesian calcite component or cement in limestones that formed in pelagic and hemipelagic environments is generally unclear. This research project integrates petrographic, geochemical, and calcareous nannofossil analyses to investigate the nature of the pelagic base-of-slope LMAs from the Early Jurassic (Lower Toarcian) and Early Cretaceous (Aptian to Albian) of the Belluno Basin (Southern Alps, Italy).

As preliminary field and microscopic observations indicate that differential diagenesis was effective, we want to address the following research questions in this study: (1) Do these rhythmites reflect a primary cyclic signal? (2) Where could the mud-grade component of the limestone come from? (3) What role did diagenesis play in forming these successions? Therefore, we will consider the current key diagenetic models that were proposed for the redistribution of carbonate during burial in donor-acceptor systems by Cook & Egbert (1979 and references therein), Ricken (1986, 1987), and Munnecke & Samtleben (1996). We are confident that this study will bring valuable new insights into one of the oldest problems in carbonate sedimentology. It may be useful for future (re-)investigations of coeval successions found in other Tethyan basins and even lead to a new perception of differential diagenesis. This study is likely the first to use cathodoluminescence imaging and EPMA element mapping to study the transition between the limestone and marl lithotypes.

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Static Geological Modeling for CO_2 Storage Capacity Estimation in the Depleted F-O Gas Field, Bredasdorp Basin, Offshore South Africa

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The heightening global concern about climate change has prompted immediate measures to reduce greenhouse gas (GHG) emissions, specifically carbon dioxide (CO_2) resulting from fossil fuel combustion (UN, 2015). Tackling anthropogenic CO_2 emissions is a critical global imperative, particularly for nations heavily dependent on fossil fuels (Hicks et al., 2014). This study evaluates the geological suitability of the nearly depleted FO Gas Field (Figure 1) for offshore Carbon Capture and Storage (CCS) in South Africa. The objective is to determine the static CO_2 storage capacity through a comprehensive approach integrating geological and geophysical data, reservoir characterization, and petrophysical property modeling.

The geological attributes of the field are pivotal considerations when assessing its viability as a CO_2 storage site. Insights from past exploration and production activities have provided crucial information about reservoir characteristics and potential challenges associated with CO_2 storage. Dominated by Valanginian-age upper shallow marine deposits (USM) (Mudaly et al., 2009), the field is highly faulted and features a tight sandstone reservoir with low porosity, typically around 10%, and exceptionally low permeability, averaging 1 millidarcy (mD) but ranging from 0.1 mD to 20 mD. Key sedimentary facies within the reservoir, encompass Clay, Shale (Heterolithic), Sandy Shale (Heterolithics), and Shallow Sand. Notably, there is a pronounced concentration of sand content, particularly in the upper sand unit (USM), positioned centrally within the FO structure, aligning seamlessly with corresponding well log observations (Figure 2). Variations in porosity and permeability across different wells emphasize the essential role of sedimentological modeling. This modeling is crucial for predicting clean sand distributions and improving petrophysical properties in this complex geological setting.

Preliminary assessments indicate a CO_2 storage capacity of 243.98 $MtCO_2$, showing potential for Carbon Capture and Storage (CCS) initiatives. However, ongoing uncertainties underscore the need for additional validation. The study highlights diverse challenges arising from the structural complexities and reservoir properties of the depleted FO Gas field. Refining models, understanding fault dynamics, ensuring seal integrity, and strategically optimizing CCS methodologies are crucial steps toward unlocking the full CO_2 storage capacity within the FO Gas Field.

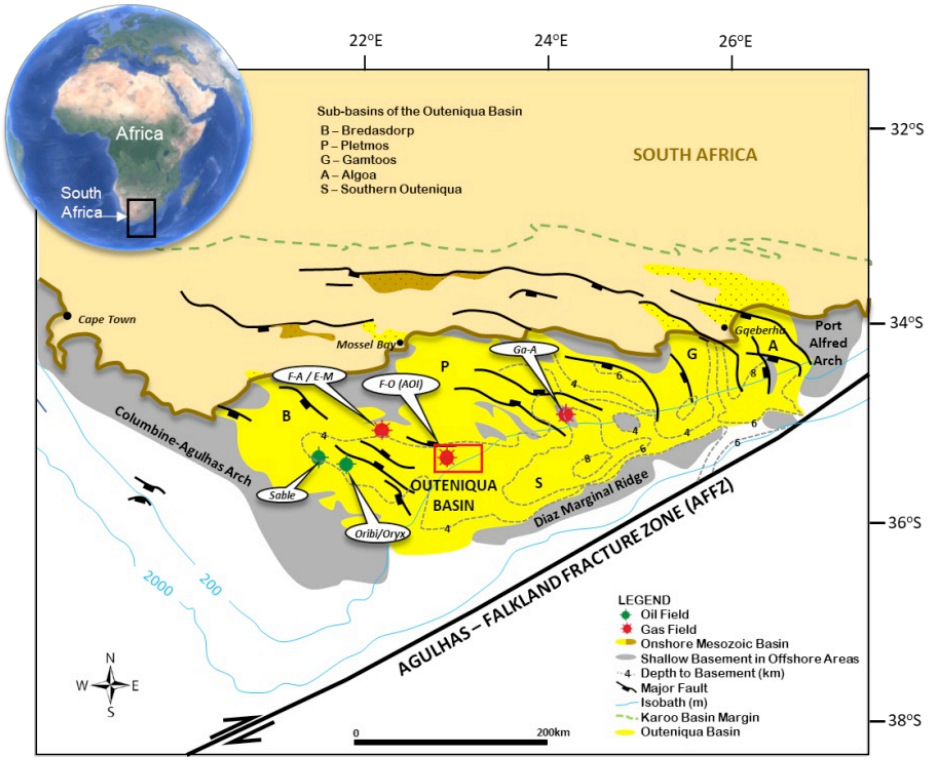

Figure 1. *Locality map of the FO Gas Field and adjacent satellite fields situated in the Bredasdorp Sub-basin of the Outeniqua Basin, offshore South Africa.*

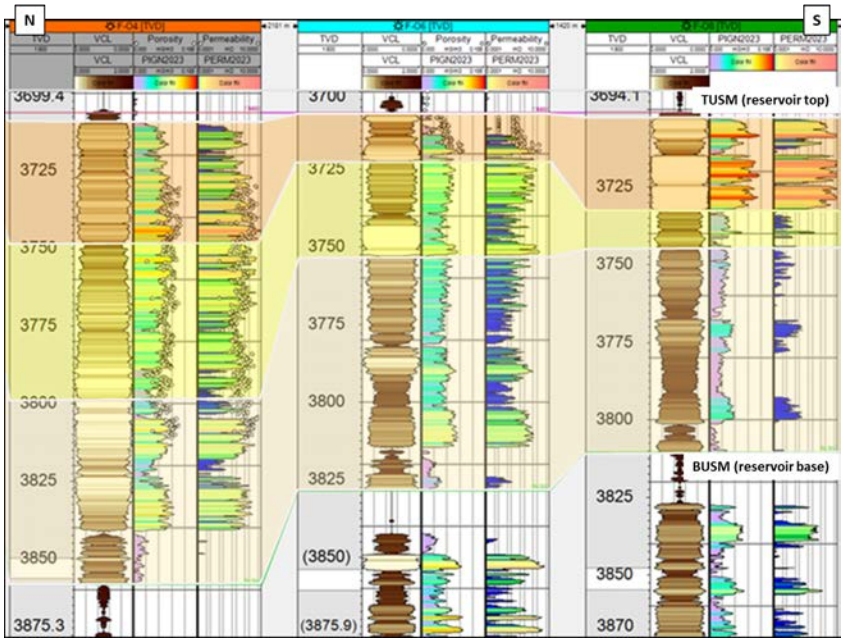

Figure 2. *Well Correlation displaying upper, middle, and lower sand units with permeability and porosity logs, as well as core measurements.*

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Pre-aged organic matter dominates modern organic carbon burial in a major perialpine lake system

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The storage of organic carbon (OC) in terrestrial sediments plays a central role in the global carbon cycle and has a major impact on climate dynamics. This study investigates the complex interplay of OC sources and turnover times in Lake Constance and uses high-resolution radiocarbon (14C) analyses to disentangle sources of sedimentary OC. Our study provides a detailed understanding of OC dynamics and distinguishes between different sources, including aquatic, pre-aged soil, and fossil rock-derived OC. Using a Bayesian modelling approach integrating 14C and 13C data, we show that soil-derived OC is the predominant component within the sedimentary OC pool. This finding emphasizes the substantial contribution of terrestrial inputs to OC accumulation in lake sediments, which has important implications for long-term carbon storage.

Furthermore, our results shed light on the temporal dynamics of OC turnover and show different mean transit times for different carbon pools. OC in soil shows a mean transit time of about 100 years, which includes storage, mobilization, and transport processes in the catchment. In contrast, dissolved inorganic carbon (DIC) in the lake shows a faster turnover with an average transit time of about 10 years, indicating a rapid uptake of atmospheric ^{14}C into aquatic OC.

A kriging-based spatial analysis highlights the heterogeneous distribution of OC deposition across the lake, with key areas such as the Alpine Rhine delta and the deepest regions of the lake bed identified as primary hotspots for allochthonous OC influx. This spatial variability underlines the interplay of local geomorphological and hydrological dynamics in shaping sedimentary OC accumulation patterns. The quantification of OC accumulation fluxes shows an average deposition rate of approx. 47 gOC/m²/year. This comprehensive assessment underscores the complex nature of OC deposition in perialpine lake sediments and highlights the need for an approach that includes both temporal and spatial dimensions when constructing lake OC budgets.

In summary, our study provides valuable insights into the complex interplay of OC sources, transit times and spatial variability in Lake Constance sediments with implications for other large perialpine lakes. It improves our understanding of the role of inland waters in the global carbon cycle and their response to ongoing climate and ecosystem changes.

"Floating" carbonate clasts evidence sudden, basin-scale fluid expulsion

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This study presents field, fluid-inclusion, and petrographic evidence for near-instantaneous precipitation of large volumes of calcite cement encasing dolostone host-rock clasts up to 0.3 m in diameter (Figure 1). Cement occludes a hydraulic fracture system within a regional fault zone. According to the model presented, hydraulic fractures burst open when a critical threshold value in an overpressured basin was reached during regional uplift and basin inversion in the context of a seismic event. Pressure release resulted in sudden (less than one hour) regional-scale pore-fluid dewatering of Palaeozoic sedimentary rocks through connected fracture porosity. Decimeter-sized dolostone hostrock fragments broke off from the walls of the opening hydraulic fractures and floated in the upward-gushing fluid. Fluid-inclusion data suggest that the upward expulsion of basinal saline brines resulted in mixing with fluids rich in bicarbonate. Our calculations document that an upward-directed fluid flow with a 5-9 m/s velocity is required to prevent clasts with several decimeters diameter from sinking gravitationally against the fluid flow. In a near-surface environment, mixing and CO_2 degassing resulted in fluid oversaturation for $CaCO_3$ and the near-instantaneous nucleation (< sec) and fast (< 30 min) precipitation of large volumes of calcite cement encasing clasts. Abrupt dewatering events of that magnitude are significant, albeit comparably rare, in the geological history of basins. Data presented here serve as a litmus test for recognizing such events.

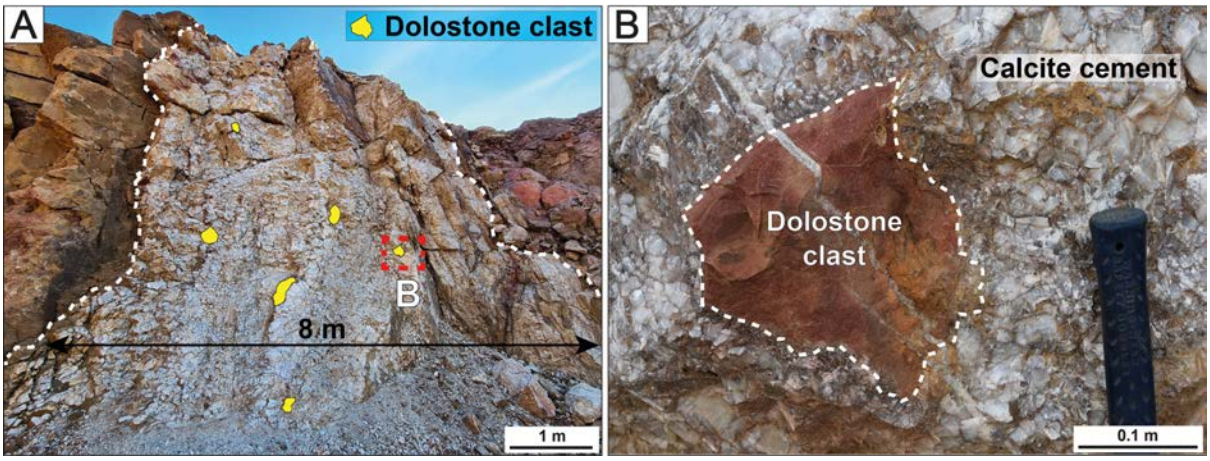

Figure 1. *(A) Eight meters thick hydrofracture breccia vein containing dolostone clasts (yellow) in dolomitized Devonian carbonates in Steltenberg Quarry (Germany). (B) Closeup of a dolostone clast from (A) surrounded by calcite cement grown on the clast surface.*

Seismic expression of a Middle Jurassic coral reef in a clay-rich contourite drift system in Northern Switzerland

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Middle Jurassic coral reefs have been reported but are considered to be secondary geological features within the northern Swiss alpine foreland basin. Traditionally, Middle Jurassic formations in this region are characterized by oolithic limestones, along with marls or clays in basin settings.

The acquisition of a new seismic dataset, acquired during exploration activities in the “Nördlich Lägern” area of northern Switzerland by the National Cooperative for the Disposal of Radioactive Waste (Nagra) to assess potential sites for nuclear waste repositories, has shed unprecedented light on the Middle Jurassic formations throughout northern Switzerland. This study used 2D and 3D seismic data to meticulously delineate and define a previously unidentified coral reef unit, designated as the "Herrenwis Unit". This exploration not only clarifies the unit's geometry and its regional geological context, but also elucidates the underlying structures and formations that support its existence.

Seismic facies analysis not only clarifies the unit's geometry and its regional geological context but also elucidates the underlying structures and formations that form its foundation. The comprehensive analysis depicts the lateral extent of the “Herrenwis Unit” and offers new insights into the impact of marine currents on the geological rock record of this part of Switzerland—a factor previously underestimated in geological models.

Moreover, the integration of seismic mapping techniques with well log correlations has revealed new aspects of the Swiss realm during the Middle Jurassic. It provides compelling evidence that coral reef tracts could develop atop clay formations with minimal relief and within a dominantly current-influenced setting. This revelation not only expands our understanding of the environmental and geological conditions conducive to coral reef development during the Middle Jurassic along the Tethyan margins, but also improve our comprehension of the geological history of Northern Switzerland.

This study represents a significant advance in our understanding of Middle Jurassic coral reef development in the alpine basin of northern Switzerland, challenging previous hypotheses and laying the foundations for future research.

Lake Taney, West Valais: A dream study location for a multi-biomarker calibration

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Lake Taney is a natural sanctuary nestled in the western Valais at an elevation of 1400 meters, with a maximum water depth of 35 meters. It remains untouched by heavy human footprints, as no villages was ever built nearby, with the exception of a few “chalets”. The only traces of human occupation are bone remains found in nearby shelters, dated 40’000-35’000 BP (*Praz and Curdy, 2000, Praz et al. 2000*). It is the perfect candidate to study the contemporary and historical dynamics of an undisturbed lake system.

The project will focus on understanding the modern dynamics of different types of lipid biomarkers, which will then serve as proxies to understand past environmental and climatic changes. The biomarkers which we will investigate include alkenones produced by haptophytes algae (*Martin et al., 2024*), long-chain diols produced by eustigmatophytes, unicellular algae (*Lattaud et al., 2021a*), isoprenoid and branched glycerol dialkyl glycerol tetraether produced by Archaea and bacteria, respectively (*De Jonge et al., 2020*), and short-chain fatty acids produced by phytoplankton (*Lattaud et al., 2021b*).

We will monitor the modern dynamics through monthly sediment traps, and water samples throughout the upper water column. Vegetation and soil samples will also be collected. From these samples, biomarkers will be extracted. Once the seasonal and multiannual production is defined and environmental controls understood, we will look for them in sedimentary records. First from a short 90 cm long core sampled in 2020, and second from a longer Holocene record, which will be cored in the coming months.

The short core will help us understand recent changes, highlighting the effect of human-induced climate change on this isolated lake, whereas the long core will help reconstruct Holocene environmental and climatic changes. Preliminary results from the short core show the deposition of varves, highlighting the optimal sediment preservation in Lake Taney.

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Examining sedimentological processes in a sublacustrine delta: from underflows to geomorphic changes (Lake Brienz, Switzerland)

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Slope failures within subaquatic deltas have the potential to induce underwater mass movements that can be tsunamigenic. Historical cases of subaquatic delta failures have been documented in marine contexts (Anthony & Julian, 1997; Bailey et al., 2021) and lacustrine settings (Girardclos et al., 2007; Hilbe & Anselmetti, 2015). However, the traces and failure planes of these mass movements are rapidly buried due to the high sedimentation rates caused by incoming rivers so that detailed process studies of such failures are challenging.
Given the rise in population near shorelines, there is a need to gain a deeper understanding of this hazard. By monitoring present-day sedimentation processes, we can gain insights into the dynamics of erosion, deposition, and potential slope failures. As lakes are more accessible than marine settings yet share similar sedimentation processes, lacustrine deltas can serve as natural laboratories for any deltaic system.
Our study employs a multi-method approach to monitor sedimentation processes within the Aare Delta of Lake Brienz, situated in a Swiss perialpine lake known for historical delta failures (Girardclos et al., 2007). This approach comprises (i) analyzing bottom currents derived from an Acoustic Doppler Current Profilers (ADCPs) campaign conducted from June to September 2022. These data are compared with river parameters (discharge, temperature, turbidity; from Federal Office of Environment) and meteorological data (rainfall, wind speed, directions; from Federal Office of Meteorology) to evaluate the governing processes of underflows, and (ii) examination of high-resolution bathymetric difference maps derived from two surveys conducted in 2018 and 2023. This assessment seeks to understand geomorphic changes over time and establish connections between these changes and the observed bottom currents.
We show the results of these campaigns that offer valuable insights into sedimentation processes within lacustrine deltas. Repetitive bathymetric surveys highlight substantial geomorphic changes in submerged channels, while ADCPs moored in those areas reveal the presence of underflow currents. Yet, the exact triggers behind these events remain unclear, challenging our understanding of sediment-transport mechanisms within the Aare Delta.

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The origin of the Quaternary staircase terrace systems in the valleys of Peru

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River terraces are among the most intriguing geomorphic features that have been reported from the Peruvian Andes hosting some of the most classical staircase terrace systems. Here, we explore how the large-scale tectonic architecture of the Andes in combination with cyclic variations of climate has impacted the generation and routing of sediment and the formation of these terrace systems (Schlunegger et al., 2023). We invoke a hydroclimatic and geomorphic control where the landscape steepness and precipitation rates need to exceed a threshold for the release of sediment stored on the hillslopes, so that aggradation begins downstream in the valley. Once the sediment reservoirs on the hillslopes are void of material, the trunk streams start to recycle the previously deposited material, thereby forming a terrace level. Several of such out-of-phase cyclicities between water and sediment discharge have occurred during the Quaternary, and they were synchronous with the glacial periods at the global scale. Most of these climate shifts in Peru are explained by orbitally controlled changes in the solar insolation of the southern American continent and the Altiplano, which impacted the strength of the Andean jet. On its way towards the south, the jet becomes diverted towards the SE and thus away from the Andes where it intercepts with the mountainous topography of the Bolivian Orocline on the eastern flank of the Andes. These are also the latitudes where we mapped the thickest terrace deposits and the highest frequency of terrace occurrence along the Peruvian coast. Accordingly, the large-scale tectonic architecture of the Andes in combination with orbitally controlled variations in insolation has not only influenced the cyclic change in the strength of the Andean jet, but it has also conditioned the region along the Peruvian margin where the out-of-phase cyclicities between water and sediment discharge was large enough for thick staircase terraces to form.

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A promising archive of High Arctic Holocene temperature variability: lake sediments from Lake SW in Peary Land, North Greenland

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Global warming exhibits heterogeneity, leading to alarming rates of warming and amplified impacts, particularly in temperature-sensitive regions such as the Arctic. In the Arctic, this phenomenon is referred to as Arctic amplification and rapidly changes terrestrial landscapes and lacustrine ecosystems. To constrain the sensitivity of High Arctic sites and make meaningful predictions about future warming, we have to examine the sensitivity of these regions to past changes using natural archives. Here, we will report on the potential of the varved lake sediments of "Lake SW" in Peary Land (82.1°N, 35.7°W), located 3km northeast of the Storm Iskappe glacier, as a high-resolution temperature archive to expand the regional temperature history beyond the instrumental measurement period. The sediments were collected in August 2021 and a robust chronology was established using a combination of varve counting and radionuclides (^{210}Pb, ^{137}Cs, ^{241}Am and ^{14}C). A suite of scanning techniques was then employed (computed tomography, µX-ray fluorescence scans, hyperspectral imaging) together with alkenone-thermometry (U^{K}_{37}), C/N- and diatom analyses to reconstruct the lake's productivity (green pigment concentrations and fluxes, *GP*), anoxia (bacterio pheophytin concentrations and fluxes, *BPhe*), and temperature histories over the last millennium.

Highest *BPhe* values were observed between ~1490-1900CE suggesting a phase characterized by prolonged anoxia. Simultaneously, the diatom assemblage along with low alkenone-derived temperatures indicate cold and dark icy conditions characteristic for heavy ice cover. This phase coincides with the LIA, and thus might be caused by regular perennial ice-cover extents that increase thermal stratification of the water column (oxygen depletion). Between ~1900-1990CE an increase in *GP*, and a diversification in the benthic diatoms may be associated with larger moating around the lake, more nutrient input and slightly higher water temperatures. The period after ~1990CE is characterized by the arrival of planktonic diatoms, the warmest observed alkenone-derived temperatures, and a significant decrease in *BPhe* suggesting extended periods of open water. Further statistical comparison of the *GP* and temperature will reveal whether the productivity is limited by temperature, which would allow proxy-to-proxy-calibration to increase temporal resolution of the temperature record.

We present evidence that sediments from "Lake SW" are a promising high-resolution archive of local temperature variability for the late Holocene in an area that is lacking high-resolution terrestrial paleoclimate records.

Cold-water corals and foraminifera as archive for carbonate mound development at the Melilla Mound Field (Alboran Sea)

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In a context where ocean acidification and global warming has a considerable impact on the development and proliferation of cold-water coral ecosystems, the results of this study suggest that carbonate mounds change over time in response to climatic variations such as glacial/interglacial cycles. Cold-water corals and foraminiferal assemblages are robust paleoclimatic archives, but reefs are also fragile and among the most vulnerable marine ecosystems. Therefore, to understand carbonate mound formation and cold-water coral reef adaptation to environmental changes can help to predict the evolution of cold-water coral mounds with the future climatic changes.

In this study, skeletal samples of cold-water corals (*Desmophyllum pertusum* and *Madrepora oculata*) and tests of planktonic foraminifera (*Globigerina bulloides* and *Turborotalita quinqueloba*) of sediment core MD13-3455G were collected from Brittlestar Ridge 1 of the Melilla carbonate mounds, southern Alboran Sea, in June 2013 during the EUROFLEETS cruise MD194 Gateway on board the RV Marion Dufresne II. The foraminifera samples were prepared for geochemical analyses of the element ratios (Sr/Ca, Mg/Ca, Mn/Ca, Fe/Ca, Al/Ca) and stable isotopes ($\delta^{18}O$ and $\delta^{13}C$), while the coral samples were analysed for Li/Ca, Mg/Li, Li/Mg, Mg/Ca, P/Ca, Sr/Ca, and U/Ca.

The aim of this study is to understand the interaction between environmental changes in the eastern Melilla coral province and coral growth during the first half of Greenland Interstadial 1 (~13.7–14.7 kyr BP). Today, cold water corals are adapted to water temperatures between 4 and 14° C with the upper limit for CWC in the Mediterranean Sea. In the Alboran Sea, they thrive at temperatures around 13°C. Paleotemperatures obtained using different proxies and species show decreasing temperatures with depth with *G. bulloides* dwelling at 50-100 m water depths*, T. quinqueloba* at the pycnocline around 100-150 m water depths and the *D. pertusum* at the seafloor at 320 m water depth (Table 1).

The T-proxies Li/Mg used in CWC *D. pertusum* seems to be the most reliable proxies only affected to a minor degree by calcification processes, growth speed and/or internal pH-upregulation. Other environmental parameters like seawater pH or nutrients obtained from the coral skeletons are indicated in figure 1. The pH values estimated from the U/Ca ratio range between 7.6 and 8.4 and the dissolved inorganic phosphorus (DIP) values obtained from the P/Ca ratio are between 0.33 µmol/L and 2.27 µmol/L. These data indicate that during the Greenland Interstadial 1 period the waters around and above the CWC reefs at Brittlestar

Ridge 1 were slightly cooler than today. Seawater pH was in the same range as today (8.1–8.3) with a decreasing trend from the early stage of GI-1 (Fig. 1). Apparently, mound formation profited from CWC reef growth under cooler conditions with higher pH and an increased nutrient availability at the beginning of the GI-1 (i.e. Bølling, 14.7–14.2 kyr BP).

Table 1. *Present-day temperatures compared to reconstructed temperatures for the Greenland Interstadial 1 using different archives and proxies. *Estimates too high due to secondary calcite precipitates. § Reconstructions based on present-day $\delta^{18}O_{SW}$ of 1.3‰. GI-1 = Greenland Interstadial 1.*

Depth (m)	Present T (°C)	Species	Proxy	GI-1 Avg. T. (°C)	Reference
50-100	15-16	*G. bulloides*	Mg/Ca d ^{18}O	20-22* 11-13§	Cisneros et al. (2016) Mulitza et al. (2003)
100-150	13.8	*T. quinqueloba*	Mg/Ca δ^{18}O	12-14 8-10§	Cisneros et al. (2016) Mulitza et al. (2003)
320	13	*D. pertusum*	Li/Mg Mg/Li Li/Ca Sr/Ca	9-11 8-10 9-11 10-14	Montagna et al. (2014) Raddatz et al. (2013) Raddatz et al. (2013) Raddatz et al. (2013)

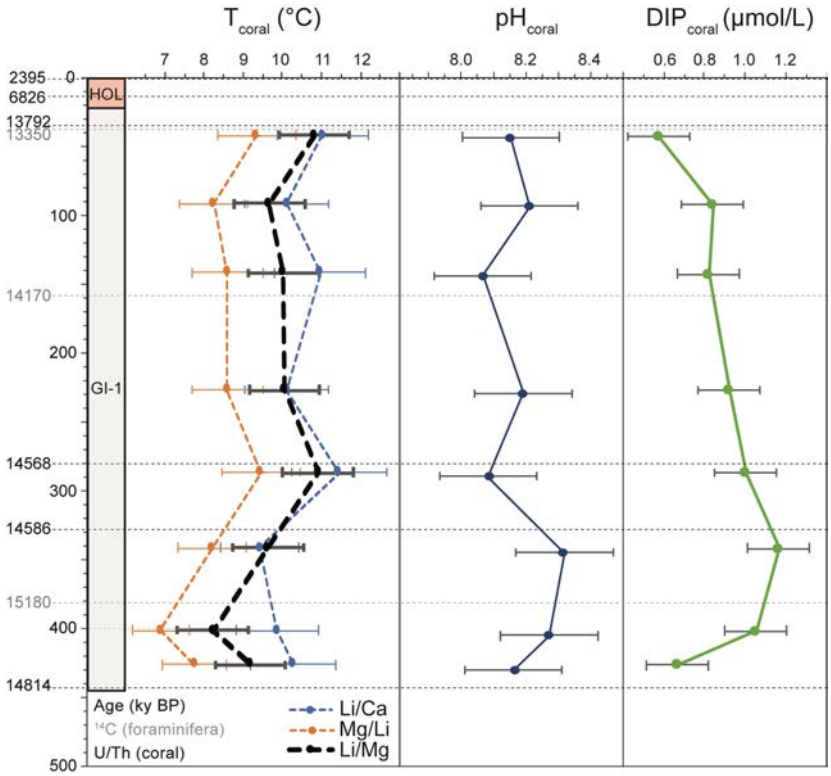

Figure 1. *Reconstructed temperatures, seawater pH, and dissolved inorganic phosphorous (DIP) from coral samples through the Greenland Interstadial 1. Ages and stratigraphy from Fentimen et al. (2020).*

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Unravelling the depositional model of the Opalinus Clay in Switzerland: first insights from grain-size variability

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The Opalinus Clay, a silty to sandy claystone formation, deposited during the Early to Middle Jurassic age (latest Toarcian to Aalenian), holds significance in Switzerland as the selected host rock for deep geological disposal of radioactive waste. Over more than thirty years, extensive geotechnical, mineralogical and sedimentological studies have addressed the Opalinus Clay, such as those conducted within the Mont Terri Project and the deep drilling campaigns of Nagra (National Cooperative for the Disposal of Radioactive Waste).

Based on subfacies descriptions, elemental content (XRF logging) and mineralogy (XRD), small-scale vertical facies variations are identified in newly drilled OPA cores. Classical grain-size analyses (laser particle size analyses on bulk samples and component analyses based on thin sections) combined with 3D X-ray CT-scanning (representative elementary volumes) resulted in the assessment of grain-size variations and mean sortable silt to reconstruct past current dynamics in the Opalinus Basin. The observed complex facies variability requires to revise and develop an improved depositional model for the Opalinus Clay at both regional and basin scale.