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Book of Abstracts

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vDEUQUA2021 (2021-09-30 to 2021-10-01)

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Session 1

Quaternary climate and environmental changes

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Oral presentations part I

[Invited keynote]

Into the Mega-Monsoon: Yearly Flood Dynamics of the Nile River During the Last African Humid Period

Cécile Blanchet*†[1]

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Seasonal floods are life-supporting events in the Nile Valley and have been crucial to the development of complex societies. Past and present populations depend on their occurrence but the alternation of fluvial dynamics under climate change remains elusive. In this presentation, I will explore the changes in flood dynamics of the Nile River during a period of high monsoon activity known as the African Humid Period (during the early Holocene). I will use a unique core from the Nile deep-sea fan, which covers the past 9.5 ka BP, ideally located to record past fluvial activity in great detail. The absence of oxygen in the Mediterranean bottom waters during the last Saharan Humid Period allowed preserving the laminated structure of the sediments between 9.5 ka BP and 7.5 ka BP. We examined here the nature of the laminations in order to 1) understand the deposition mechanism and 2) obtain a reconstruction of past fluvial dynamics at high resolution. Microfacies analysis and elemental micro-XRF scanning indicate that couplets of alternating dark- and light-coloured layers represent seasonal deposits of Nile discharge and marine hemipelagic sedimentation, respectively. Preliminary lamination counts suggest that couplets were mostly deposited at an annual rate. Increases in layer thickness are observed around 9.5 and 9.1 ka BP, followed by a gradual decrease until 8 ka. Careful examination of lamination structure and time-series analysis of layer counts will permit to further explore sub-annual changes in flood dynamics during the African Humid Period. Overall, our record has the potential to link reconstructions of seasonal Nile discharge to other regional archives of hydrological changes (e.g., speleothems, lakes) and thereby identify overarching forcing mechanisms.

Keywords: Fluvial Dynamics; Nile River; Saharan Humid Period

Presentation time: Thursday, September 30, 2021 – 10.15 - 10.45 am

*Speaker
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[O01]

Last Glacial Maximum to Holocene Palaeoenvironmental Records Retrieved Using Lacustrine Archives from the Kashmir valley, Western Himalayas

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The Last Glacial Maximum (LGM; ∼ 25 ka BP) was the most recent stage during which ice sheets were at their greatest extent, while the Holocene epoch started at around 11.7 ka BP marking the end of the Pleistocene Epoch. This phase witnessed a climate shift from extreme cold LGM to warm interglacial conditions, and it significantly influenced the geomorphology of the surface and the evolution of the flora and fauna on it. The Holocene Epoch was characterized by the commencement of noticeable rapid deglaciation. However, cyclic dry/cold climate events tentatively linked to climate fluctuations due to North Atlantic ice rafting, known as Bond events have also been reported in the Northern hemisphere during this Epoch.

In this work, we will present results from multiple sediment cores and sediment cores and sediment trenches from lake sediments to understand the evolution of the Last Glacial Maximum (LGM) to Holocene palaeoclimate in the western Himalayan region that was reportedly influenced by by both mid-latitude westerlies and Indian summer monsoon (ISM). The chronology was generated using AMS ^{14}C dating. The results revealed a relatively cold/dry climate from 29–20 ka BP, which peaked at around 26–24 ka BP (LGM stage). The proxy records revealed continuous climatic amelioration from 20–12 ka BP. The multi-proxy analysis on the Holocene sedimentation revealed phases of dry/cold climate from 10.8–10.2 ka BP, 8.7–7.7 ka BP, 6.2–5.7 ka BP, 4.6–3.75 ka BP, 3.1–2.25 ka BP and 0.5–0.35 ka BP during the Holocene. Sediment chemistry revealed strong anthropogenic influence due to forest clearing and agriculture extension during the last 2000 years, and similar observations were also revealed from black carbon (BC) concentration data from the lake sediments.

Our observations reveal that the region has been profoundly influenced by westerly disturbance during the entire LGM – Holocene period.

Keywords: Late Quaternary Palaeoeclimate; Palaeolimnology; LGM; Holocene

Presentation time: Thursday, September 30, 2021 – 10.45 - 11.00 am

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[O02]

New Paleoenvironmental Insights Into a Holocene Freshwater Carbonate System in Southern Bavaria (S Germany)

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Freshwater carbonates serve as excellent archives of terrestrial palaeoenvironmental conditions. Although Holocene palaeoenvironmental dynamics are critical in order to understand recent scenarios of global change, this potential has not been exploited for the numerous freshwater carbonate deposits in southern Bavaria. In this study, the freshwater carbonates of Amberg in the Unterallgäu region (32U 625231, 5324733) were investigated using a modern multiproxy approach based on sedimentologic, micropalaeontologic, geochronologic as well as field and digital mapping methods. In contrast to previous studies, the data obtained suggest a two-phased development involving the primary formation and secondary fluvial reworking and redeposition of calcareous sediments. Fluvial erosion leads to the formation of a complex prograding alluvial fan system. Subrounded fragments of charcoal in the lowermost stratigraphic levels of the alluvial sediments document fire activity in the catchment area. Taking into account first preliminary radiocarbon ages together with results from palynological investigations of peat deposits associated with the carbonates, we discuss potential natural as well as early anthropogenic triggers for this rapid shift in the sedimentary regime during the late Atlantic and early Subboreal (3797 – 3099 cal. BC). We show how these findings compare to the concept of the late-Holocene tufa decline proposed by Goudie et al. (1993). Earthworm calcite granules in the redeposited calcareous material will be used in future follow-up studies to acquire high-resolution quantitative paleoenvironmental data along with radiocarbon ages. These data can be used to further test for trigger mechanisms that explain the signals revealed.

References

Goudie, A. S., Viles, H. A., Pentecost, A. (1993): The late-Holocene tufa decline in Europe. The Holocene, 3(2): 181–186.

Keywords: Freshwater Carbonates; Holocene; Palaeoenvironment

Presentation time: Thursday, September 30, 2021 – 11.00 - 11.15 am

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[O03]

Unravelling the Sedimentation Rate and Time from Downhole Logging Data at Lake Chalco, Central México

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Understanding the evolution of lower latitude climate from the most recent glacial period of the latest Pleistocene to post-glacial warmth in the continental tropical regions has been obstructed by a lack of continuous time series. Here we examine sediments from Lake Chalco, located in the Valley of Mexico, central Mexico (19°30'N, 99°W). The basin represents a hydrologically closed system surrounded by the Trans-Mexican Volcanic Belt, ageing from the Oligocene to the present. We used borehole logging to conduct a cyclostratigraphic analysis of the Lake Chalco sediments. More than 400 m were logged for several geophysical properties including magnetic susceptibility and spectral gamma radiation.
Gamma radiation can be used to identify elemental isotopes in the geological record, which is used for stratigraphic correlation and palaeoclimatic investigations. Among the lake deposit of the Chalco sub-basin, 388 total tephra layers (≥1 mm in thickness) were reported from the core description. Tephra layers with specific gamma-ray signatures, presenting a challenge for extracting the primary signals caused by environmental and climatic agents. Here, we propose a protocol to identify tephra layers embedded in other sediments using high-resolution spectral gamma-ray spectroscopy. This facilitates dividing the overall sediment column into representative horizons of tephra and non-tephra.
After extracting the non-volcanic primary signal, we applied a suite of evolutive cyclostratigraphic methods to the Lake Chalco logging data, with a focus on gamma-ray data. The high-resolution gamma-ray results suggest that the Lake Chalco sediments contain several rhythmic cycles with a quasi-cyclic pattern comparable with the Pleistocene benthic stack. This allowed us to calculate a 500 ka time span for Lake Chalco sediment deposition. By using cyclostratigraphic analysis on data captured by geophysical downhole logging, we demonstrated the potentially broad applicability of this method for well-logging data and provide further insight into the sedimentation history of Lake Chalco.

Keywords: Milankovitch Cycles; Cyclostratigraphy; Downhole Logging Data; Lacustrine Sediments; Evolutive Methods

Presentation time: Thursday, September 30, 2021 – 11.15 - 11.30 am

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[O04]

Lateglacial Lake Level Fall of the Dead Sea Interrupted by a Millennium of Stability

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Climate models predict increasing aridity and more extreme precipitation events for the eastern Mediterranean due to ongoing climate change. For robust climate simulations, the understanding of past climates is crucial. The terminal of the Dead Sea in the eastern Mediterranean is sensitive to even small changes in hydroclimate due to a steep climatic gradient from the sub-humid Mediterranean to hyper-arid Saharo-Arabian climate in its watershed. Even small changes in precipitation are recorded in large-scale lake-level fluctuations and heterogeneous sediment deposition.

Here, we study the later part of the Last Glacial-Interglacial transition from ∼17-11 ka BP, marked by a major lake-level drop of ∼160 m. To reconstruct the hydroclimatic variability we compare marginal sediments from the Masada outcrop and deep-lake facies obtained during the ICDP Dead Sea Deep Drilling Project (core 5017-1). Two prominent gypsum units, likely indicating distinct drops in lake level, are used to correlate the two sites. The deep-lake facies covers the complete lake-level decline, whereas at Masada sedimentation terminates at ∼ 14.5 ka BP when the lake level dropped below this location.

Based on continuous high-resolution microfacies analyses, μ-XRF mapping and XRF core scanning, we find during a period of major lake-level decline a ∼1000 year-long phase of frequent aragonite varve deposition indicating an extended stable phase of higher freshwater input and/or less evaporation resulting in higher lake levels. Few extreme events further indicate stable conditions for up to six decades without shoreline disturbance and/or extreme precipitation events. Intercalation of decadal to centennial-long aragonite varve intervals within the two gypsum units shows that even these periods were not continuously marked by strong evaporation and low lake levels.

This study was funded by the DFG (Grant BR 2208/13-1/-2) and contributes to the Helmholtz Association (HFG) climate initiative REKLIM Topic 8 "Abrupt climate change derived from proxy data".

Keywords: Last Glacial Interglacial Transition; Dead Sea; Hydroclimate; Microfacies; XRF; Gypsum; Varves; Aragonite Varves

Presentation time: Thursday, September 30, 2021 – 11.30 - 11.45 am

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Session 1

Quaternary climate and environmental changes

Oral presentations part II

[O05]

LGM Glaciation of the Central Southern Alps - a Regional LGM Glacier Chronology Derived from the Ticino-Toce Glacier System

Sarah Kamleitner*†[1], Susan Ivy-Ochs[1], Giovanni Monegato[2], Franco Gianotti[3], Naki Akçar[4], Christof Vockenhuber[1], Marcus Christl[1]

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The large end moraine systems along the southern fringe of the Alps are among the most prominent Quaternary landforms. Typically consisting of multiple, concentric ridges, made up of ice-marginal glaciogenic deposits, they are often referred to as (morainic) amphitheatres. The characteristic close spacing between individual ridges complicates the recognition of different glaciations within the end moraine systems. Suggested LGM (and pre-LGM) glacier extents in many of the Italian amphitheatres are consequently strongly divergent. By means of surface exposure and radiocarbon datings, recent studies were able to resolve 'true' LGM glacier limits in several forelands-reaching glacier systems in NW and NE Italy (Monegato et al., 2007; Gianotti et al., 2015; Monegato et al., 2017; Ivy-Ochs et al., 2018). It was thereby recognised that the morphology of the eastern amphitheatres (e.g., Garda, Tagliamento) is mainly a result of the last glaciation. To the west, however, moraine ridges of previous glaciations are preserved downstream of identified LGM ice margins (e.g. Ivrea, Rivoli-Avigliana). Despite the key position within the Alpine chain, LGM extent and timing within the central Southern Alps (corresponding to the Ticino-Toce and Adda glacier systems) remain ambiguous. The presented study aims to overcome this gap by introducing a regional glacier chronology based on cosmogenic nuclide dating of the Ticino-Toce glacier and the corresponding Verbano amphitheatre. Our chronological data promotes an LGM piedmont lobe significantly larger than recently proposed (Bini et al., 2009). Paired with geomorphological observations, the age constraints further suggest a ∼5000-year lasting period of stable glacier conditions and an active ice margin close to the LGM maximum extent. Shortly after the glacier abandoned its LGM maximum position, a glacier re-advance cycle set in as shown by the sedimentological record on site. Final glacier withdrawal from the foreland is assumed to set in no later than 19 ka.

Keywords: Pleistocene Glaciation; Last Glacial Maximum; Ticino Glacier; Toce Glacier; Glacial Geomorphology; Cosmogenic Isotopes; Surface Exposure Dating

Presentation time: Thursday, September 30, 2021 – 1.30 - 1.45 pm

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[O06]

The Mid-Pleistocene Record of the Lower Aare Valley (Northern Switzerland)

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During the Pleistocene, Alpine glaciers repeatedly advanced into the foreland, temporarily covering the majority of northern Switzerland in ice. Despite their severe environmental and geomorphic impact, the number, the timing, and the extent of the individual glaciations – especially of those predating the last glacial maximum – are still poorly constrained. This is a consequence of the fragmentarity of the geological record, and difficulties in resolving, interpreting, and dating it.

Subglacial overdeepenings trapped sediment below the fluvial base level, significantly increasing its preservation potential, and thus contain promising archives of Quaternary environmental change. We investigate the infill of the overdeepened Gebenstorf-Stilli Trough and the glaciofluvial paleochannel system of the Lower Aare Valley, in the confluence area with the rivers Reuss and Limmat.

In four scientific boreholes, we recovered ~ 350 m of drill cores, that are complemented with outcrop studies. Sedimentological and petrographic analyses combined with luminescence dating provide new insights into the regional glaciation history. The depositional record of the Lower Aare Valley reaches back well into the Middle Pleistocene. It reveals multiple phases of glacial / glaciofluvial reactivation of both overdeepening and paleochannel, and allows inferences of ice-margin positions and relative sediment yields from the Limmat, Reuss, and Aare(/Rhone) glaciers.

Keywords: Alpine Foreland; Middle Pleistocene; Overdeepening

Presentation time: Thursday, September 30, 2021 – 1.45 - 2.00 pm

*Speaker
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[O07]

Surface Cracks – Landforms in Northern Germany Indicate Ice Sheet Induced Late Quaternary Halotectonic Movements

Jacob Hardt*†[1]

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In Northern Germany, especially in the young morainic landscapes of Brandenburg, we newly detected more than 160 surface cracks on the basis of LiDAR DEM analysis. These cracks can be several km long, up to more than 20 m deep, and more than 100 m wide. It turned out that beneath almost all of these cracks, Permian salt structures exist in the underground. Permian Zechstein salt structures are widespread in the Central European Basin System. Previous studies reported on the interplay between loading and unloading effects of the Scandinavian Ice Sheet (SIS) and salt structures, such as the relation between terminal moraines of the Weichselian W2 (Pomeranian) phase in Brandenburg and subsurface salt structures. Here we present visible indicators for ice sheet induced salt movement. We interpret the surface cracks as expansion ruptures due to upward movement of salt structures, triggered by loading and unloading processes of the SIS. We analyse the shape and orientation of the cracks with regard to palaeostress fields, their occurrence in the different landscape units of the glacial landscape and the relationship between the frequency of surface cracks and Weichselian ice dynamics. A geometric dependency between the shape of the salt structures and the orientation of the cracks could be observed. We deduce a possible time frame for the formation of the cracks, which indicates halotectonic movements in the region between ca. 30–20 to ca. 15 ka.

Keywords: Surface Cracks; Halotectonics; Ice Loading and Unloading; Weichselian Glaciation; Permian Zechstein Salt Structures; Central European Basin System

Presentation time: Thursday, September 30, 2021 – 2.00 - 2.15 pm

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[O08]

Calibration and Application of Molecular Biomarker Isotopes to Reconstruct Palaeohydrological Changes at South Africa's Southern Cape Coast During the Holocene

Paul Strobel*†[1], Marcel Bliedtner[1], Andrew S. Carr[2], Nadia Du Plessis[3,4], Bruno Glaser[5], Björn Klaes[6], Lynne J. Quick[4], Gary Salazar[7], Julian Struck[1], Sönke Szidat[7], Michael Zech[8], Roland Zech[1], Torsten Haberzettl[9]

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South Africa is a key region to reconstruct past changes in atmospheric circulation patterns; i.e. interactions between the temperate westerlies and tropical easterlies. However, due to an overall scarcity of natural archives and the analyses of rather indirect hydrological proxies, South Africa's climatic evolution during the Holocene remains debated. Molecular biomarkers for instance are direct hydrological proxies, but their application is limited in sediment archives from South Africa's southern Cape coast.

We evaluated compound-specific hydrogen isotopes of leaf wax-derived *n*-alkanes and oxygen isotopes of hemicellulose-derived sugars for (palaeo-)hydrological reconstruction and coupled both water isotopes in an approach dubbed the 'palaeohygrometer' using modern topsoils. The results show the combination of these proxies allows us to disentangle changes in precipitation source, evapotranspiration, relative humidity and enabling robust palaeohydrological reconstructions. We applied this approach with larger multi-proxy studies of two coastal wetlands - Voëlvlei and Vankervelsvlei - ∼100 km apart on South Africa's southern Cape coast. Both

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archives provide palaeohydrological information from ∼8.5 ka cal. BP and ∼7.5 ka cal. BP to present, respectively, and are ideally suited to infer past changes of contributions from Westerlies and Easterlies due to their location at the modern intercept of these atmospheric circulation systems. Both records indicate high contributions from both westerly- and easterly-derived precipitation sources from ∼7.5 ka cal. BP to ∼ 5 ka cal. BP, which resulted in particularly moist conditions. From ∼5 ka cal. BP to ∼3 ka cal. BP, an absence of easterly-derived summer precipitation led to high rainfall seasonality and overall dry conditions. Increasing contributions of easterly-derived precipitation led to moist conditions from ∼3 ka cal. BP until the present day.

Overall, our studies demonstrate that compound-specific isotope analyses on molecular biomarkers can serve as direct hydrological proxies in sediments, enabling robust palaeohydrological reconstructions, providing a coherent picture of the moisture evolution in South Africa's southern Cape coast during the Holocene.

Keywords: Leaf Waxes; Hemicellulose Sugars; Compound Specific Stable Isotopes; Coupled Isotope Approach; Palaeoclimate

Presentation time: Thursday, September 30, 2021 – 2.15 - 2.30 pm

★Lecture award★

[O09]

Reconstruction of a Food Web from the Last Glacial Maximum using Carbon and Nitrogen Stable Isotopes of Bone Collagen – a Case Study from Kammern-Grubgraben, Lower Austria

Lilian Reiss*† [1], Kerstin Pasda[2], Thomas Einwögerer[3], Marc Händel[3], Andreas Maier[4], Ulrich Simon[3], Theresa Stauber[5], Christoph Mayr[5,6]

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The interdisciplinary D-A-CH project "Success, limits, and failure of subsistence strategies in eastern Central Europe during the early Gravettian and the Last Glacial Maximum" aims at a better understanding of the environmental development and human response in the Palaeolithic key-region around the city of Krems (Lower Austria). We combine archaeological analyses (lithic and organic tools, osteoarchaeological information) and geobiological proxy data (geochemistry, stable isotopes, molluscs) in a diachronic perspective to investigate environmental, climate, and cultural changes. Here, we present first results from stable isotope analyses from bone collagen of the diverse assemblage of the open-air site Kammern-Grubgraben. Nitrogen isotopes were analysed to reconstruct the trophic levels of the mammalian fauna during the Last Glacial Maximum (approx. 24–19 ka cal. BP) at the Kammern-Grubgraben site. Almost all herbivorous mammals (reindeer, ibex, horse, bison, and hare) have similar nitrogen isotope composition, except of woolly mammoths, which show larger isotopic variability possibly indicating a larger

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variability of their habitats. Carnivores comprise wolf, polar fox, red fox, and wolverine. Polar fox exhibits a lower trophic level than wolf. Bone collagen carbon isotope values separate reindeer and ibex from other herbivorous species, indicating different diet preferences, while mammoth carbon isotope values distribute between the two groups. The results show a trophic partitioning typical for a tundra steppe-like ecosystem partly comparable to other studies. Ongoing studies will include bone collagen isotope analyses from the site Krems-Hundssteig (early Gravettian, approx. 33–29 ka cal. BP). The envisaged comparison between both sites and additional oxygen isotope analyses will allow to trace climatic and environmental trends during the last glacial.

Keywords: Food Web; Trophic Level; Stable Isotopes; Collagen; Upper Palaeolithic

Presentation time: Thursday, September 30, 2021 – 2.30 - 2.45 pm

Session 1
Quaternary climate and environmental changes
PICO – part I

[P01]

Fires Support Biome Shifts in E Siberia? Interglacial Fire-vegetation-climate Feedbacks Reconstructed from Lake El'gygytgyn Sediments

Elisabeth Dietze*† [1,2,3], Kai Mangelsdorf[2], Andrej Andreev[3], Ulrike Herzschuh[3]

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The ongoing spread of forest fires in the Siberian Arctic raises concerns on how far increasing temperatures and fire occurrence lead to biome shifts from tundra to summer green or evergreen boreal forest. A change in biome and fire regime would strongly affect global biogeochemical and biophysical cycles. However, it is unknown if fire can initiate or support biome shifts under the ongoing amplified warming or if climate drives fire regime and biome changes independently. Here, we investigate vegetation and fire regime shifts during multiple glacial-interglacial cycles at Lake El'gygytgyn in the Russian Far East. We analyze various fire proxies preserved in ICDP sediment core 5011-1A to enable a quantitative reconstruction of changes in fire intensities and the type of biomass burnt: The monosaccharide anhydrides (MAs) are specific biomass burning residues from low-temperature surface fires, analyzed using ultra-high-resolution liquid chromatography coupled to a high-resolution mass spectrometer. Sedimentary charcoal reflects mid-to-high intensity fires and was analyzed in two size classes using classical microscopy. MA isomer ratios and charcoal morphotypes were used to reconstruct the type of biomass burnt. Together with pollen- and non-pollen palynomorph-based vegetation reconstruction, we find different types of centennial-to-orbital-scale biome shifts, mostly related to climatic changes. Yet, only some of them were accompanied by changes in fire regimes suggesting various long-term fire-vegetation-climate feedbacks. To assess the role of fire in driving and/or responding to biome changes, interglacial periods can provide natural system analogues for the future - unbiased from human impact on current landscapes.

Keywords: Fire; Vegetation; Arctic; Quaternary; Multiproxy

Presentation time: Thursday, September 30, 2021 – PICO: 11.45 - 11.46 am, individual discussion: 4.10 - 6.00 pm

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[P02]

Wildseemoor as an Archive of Holocene Environmental Change and Fire History in the Black Forest

Martin Steiner*† [1], Claire Rambeau[2], Frank Preusser[1], Jan-Hendrik May[3], Samuel Marx[4], Hendrik Vogel[5]

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Forest fires pose a great danger to ecosystems, humans, and infrastructure. To estimate potential future fire risk under changing climate, assessing the frequency of fires in the past provides useful information. However, for the Black Forest in SW Germany, knowledge regarding the forest fire history is very limited. To close this gap, a 6 m peat sequence was taken at Wildseemoor, an ombrotrophic peat bog located in the Kaltenbronn nature reserve in the northern Black Forest. An age-depth model, based on seven identified macrofossils dated by radiocarbon, was created using the CRAN R Bacon package in R. Fire history was established by counting charcoal contents of 260 samples under the binocular. X-ray fluorescence spectroscopy (XRF) was used to get a semi-quantitative elemental distribution for the sequence. The Wildseemoor sequence covers the last ca. 9900 years.

Our study reveals several periods of increased elemental input (Ca, Al, Zr) and charcoal deposition to the bog, in particular before 5000 BP, the timing of the probable onset of human settling in the Black Forest. Of particular interest is a potential link to the Holocene Climatic Optimum (Atlantic period – ca 7800–5700 a BP), for which reconstructed mean temperatures are of a similar range to those projected for upcoming climate change. However, the age-depth model suggests periods of reduced sedimentation or even hiatuses that need to be carefully assessed.

Overall, the sequence at Wildseemoor may record enhanced local dust input, increased frequency in forest fires, and/or dryness events for the past 10,000 years. Further research in

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additional bogs in the Black Forest and the nearby Vosges massif will be needed to put these findings into a regional context.

Keywords: Peat; Fire History; Bog; XRF; Forest Fires; Black Forest; Charcoal

Presentation time: Thursday, September 30, 2021 – PICO: 11.47 - 11.48 am, individual discussion: 4.10 - 6.00 pm

[P03]

Neotropical Ostracode Oxygen and Carbon Isotope Signatures - Implications for Calcification Conditions

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Non-marine ostracodes are important geochemical archives that can contribute substantial information on palaeoclimatic and palaeohydrological changes. Investigations of the relationship between the isotopic ranges of calcitic valves of modern ostracode populations and their host water are rare but have the potential to provide important information on local or regional influences.

Here we present the first δ^{18}O-ostracode and δ^{13}C-ostracode dataset of a widespread freshwater ostracode species (Cytheridella ilosvayi) along with a characterisation of the precipitating water - chemical composition, δDwater, δ^{18}O-water, δ^{13}C-DIC values - covering a large geographical range (Southern Florida to Southern Brazil). With this data, we extended a newly developed approach based on the estimation of δ^{18}O values of monthly equilibrium calcites as references for the interpretation of ostracode δ^{18}O. The expected oxygen isotope fractionation of ostracode–H_2O is correlated with temperature with smaller fractionation occurring at higher temperatures. Exceptions, such as unusual high offsets of δ^{18}O values from isotopic equilibria probably reflect the time lag between valve calcification and sampling. The coincidence between δ^{18}O-ostracode and δ^{18}O-calcite_eq is restricted to few months indicating a seasonal calcification of Cytheridella. There is a characteristic pattern in its difference between mean δ^{18}O-ostracode and δ^{18}O-calcite_eq displayed by all studied regions.

This pattern indicates that Cytheridella provides a synchronous life cycle in its geographical range with two calcification periods within the year that are in spring (May, June) and autumn (October). This ubiquitous life cycle of Cytheridella in the entire study area is considered to be phylogenetically inherited. It might have originally been adapted to environmental conditions but has been conserved during the migration and radiation of the group over the Neotropical realm.

Keywords: Palaeoclimate; Stable Isotopes; Ostracodes; Freshwater

Presentation time: Thursday, September 30, 2021 – PICO: 11.49 - 11.50 am, individual discussion: 4.10 - 6.00 pm

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[P04]

Six Degrees Celsius Low-Latitude Land Cooling During the Last Glacial Maximum Inferred from Noble Gas Temperatures

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Knowledge of past climate dynamics can help to better understand present and future climate change. An important example is the magnitude of global cooling during the Last Glacial Maximum (LGM), the coldest multi-millennial interval of the last glacial period, which can be used as a constraint in estimating climate sensitivity. However, substantial disagreements exist between low-latitude reconstructions of LGM sea-surface temperature (SST), while quantitative low-elevation paleotemperature records on land are scarce. Noble gases in ancient groundwater record past land surface temperatures via their temperature-dependent solubility in water, a well-known physical relationship. Several groundwater noble gas temperature (NGT) studies from low to mid latitudes have shown 5-7 °C LGM cooling, which is in line with some land-based proxy data (e.g., snowline and pollen records) but larger than notable low-latitude SST reconstructions. Yet, a comprehensive evaluation of low-latitude LGM cooling from noble gases in groundwater has been prevented by limited spatial coverage and the use of different model frameworks for NGT estimation. Here we present a compilation of four decades of groundwater noble gas data from six continents, all interpreted using a consistent physical framework (Seltzer et al., 2021). We show that NGT estimates are robust with regard to several confounding factors. Furthermore, we confirm their accuracy by comparing noble gas-derived temperatures in late Holocene groundwater with modern observations. Based on LGM noble gas data, we find that the low-elevation, low-to-mid-latitude land surface cooled by 5.8 ± 0.6°C during the LGM. Accounting for expected land-sea cooling differences, our land-surface cooling estimate is remarkably consistent with a recent SST reconstruction that found 4.0 °C cooling over the same low latitude band. Together, these recent land- and sea-surface LGM temperature reconstructions indicate greater low-latitude cooling than prior studies and in turn suggest greater climate sensitivity, with implications for projections of future climate.

Keywords: Palaeotemperature; Noble Gas Temperature; Last Glacial Maximum; Climate Sensitivity

Presentation time: Thursday, September 30, 2021 – PICO: 11.51 - 11.52 am, individual discussion: 4.10 - 6.00 pm

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[P05]

Loess Landscapes of Europe and a New Conceptual Model

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Loess is one of the most important Quaternary deposits in Europe. It spreads from the southern limits of the Pleistocene ice sheets in Britain and northern Europe towards the Mediterranean region. The origin and distribution of loess deposits are indicative for the (paleo-)environment and represent an important edaphic factor for eco-zone evolution, which in turn controls past and present land use. Our mapping and facies approach differentiates six main loess regions in Europe: (I) a proterogenetic zone, comprising loess derivates, sandy loess and mainly sand sheets in front of the Weichselian ice margin up to about 500 km to the south; (II) the Northern European loess belt, which is influenced by periglacial activity (III) loess surrounding the northern margin of the European Alps; (IV) loess in the Carpathian Basin, (V) Eastern European loess and; (VI) Mediterranean loess. We present a new conceptual model of loess landscapes and loess facies based on their spatial analysis in Europe in the form of a 'loess-triangle' (Lehmkuhl et al., 2021a). The Corners of our conceptual 'loess-triangle' represent three eco-zones (nival, humid, and arid environments) peripheral to 'typical' loess formation (placed in the centre). The modes of loess formation are controlled by climatic factors, namely water availability and temperature, which also constrain the prevailing vegetation: Mode 1 - Periglacial and tundra loess; Mode 2 - Temperate and subtropical loess - Mode 3: Desert margin loess. In-between these three peripheral modes of loess facies, we illustrate that 'typical', continuous and silt-dominated loess formation takes place. This model can be adapted to other loess landscapes and mountains in Eurasia, such as the Chinese Loess Plateau (Lehmkuhl et al., 2021b).

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Keywords: Loess; Loess Zonation; Loess Geomorphology; Loess Mapping; Conceptual Loess Model

Presentation time: Thursday, September 30, 2021 – PICO: 11.53 - 11.54 am, individual discussion: 4.10 - 6.00 pm

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[P06]

Spatio-Temporal Variability in Loess Deposition Across Central Asian Piedmonts: Implications for Understanding Aeolian Dynamics and Past Climate in the Region

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Loess deposits form excellent terrestrial archives for reconstructing past climate change, especially in arid and semi-arid continental regions. The extensive loess deposits that drape the piedmonts of the Asian high mountains of Arid Central Asia (ACA) are one of the major loess deposits in the world and lie in a dynamic climatic zone under the influence of the mid-latitude westerlies and north-south shifting polar fronts. Thus, the location as well as the relatively widespread and thick loess deposits of ACA, provide an invaluable archive for understanding the relationships between loess accumulation, palaeoclimate and topography within continental, arid and high terrain environments. However, contrary to popular perception, ACA loess deposits are neither evenly distributed along the piedmonts nor uniform in thickness, and vary substantially in age and the timing of peak accumulation. In this study, we present a high-resolution chronostratigraphic record from five loess sites across a 200 km east-west transect along the piedmonts of the Tien Shan in the Ili basin of southeast Kazakhstan. The new luminescence-based chronology shows that loess deposition across the sites varies from the mid-Holocene to beyond the late Pleistocene, and the accumulation is non-uniform and asynchronous through time across the sites. To better understand the nature and possible drivers of loess accumulation, we further evaluate loess mass accumulation rates by integrating published absolute chronological records of > 30 loess records across the Ili basin and the neighbouring basins in the ACA and East Asia over the past 60 ka. Our results suggest that loess accumulation results from a complex response to the interaction of local wind regimes, topography and local sediment supply and availability. Thus, this study presents a systematic, local to regional scale analysis of how loess accumulation rates respond to climatic and geological controls across the piedmonts of Central and East Asia.

Keywords: Loess; Mass Accumulation Rates; Luminescence Dating; Central Asia

Presentation time: Thursday, September 30, 2021 – PICO: 11.55 - 11.56 am, individual discussion: 4.10 - 6.00 pm

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[P07]

Deciphering Past Desert-Margin Dynamics in Matmata, Tunisia

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The terrestrial dust archives around Matmata (Tunisia) are unique in their morphological setting and grain-size composition. Located in front of the Grand Erg's in a critical zone at the northern edge of the Saharan desert, up to 35 m thick plateau-like loess accumulations cover past landscapes. Sandy loess and intercalated palaeosols attest to rapid and large-impact climate boundary shifts. Some of them may have severely threatened ancient regional cultures, and future changes may put modern settlements and agriculture projects in the region at risk. Palaeolandscape reconstruction, supported by reliable chronologies, chart past and predict possible future scenarios. The 'desert-loess' records around Matmata seem to engulf a wide temporal range back to Marine Isotope Stage (MIS) 9. Trapped charge dating techniques, such as luminescence and electron spin resonance (ESR) dating, are versatile tools to decipher the timing of past landscape changes. Our contribution reports new chronological results for Matmata in Tunisia. We provide luminescence (IR-RF, OSL) and ESR dating results from seven different sites and attempt to link our findings to regional climate fluctuations and drainage alterations observed for the large endorheic salt lakes in the Matmata plateau's close purlieu.

Keywords: Tunisia; Matmata; Chronology; Loess; Middle Pleistocene

Presentation time: Thursday, September 30, 2021 – PICO: 11.57 - 11.58 am, individual discussion: 4.10 - 6.00 pm

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[P08]

High-resolution Proxy Data from Kashmir Loess Imply Predominant Local Dust Sources and Confirm Climate Sensitivity of the Loess-Palaeosol Sequences

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Loess-Palaeosol Sequences (LPS) are valuable archives of climate change and associated terrestrial system responses. Consequently, these records have been frequently employed to study the interface of competing climate subsystems with a special focus on Europe, America, and Asia. While a fast-growing amount of high-resolution multi-proxy data is becoming available from many regions, loess from India is not the focus of research yet. Here we report on high-resolution (2 cm spacing) physical properties of Kashmir loess from the two localities Wanihama and Khan Sahib. These comprise rock magnetic, colourimetric and grain size properties.

The geographic situation of Kashmir being influenced by both the Indian Monsoon and Westerlies, along with the preservation of climate signals, render LPS in Kashmir and India valuable recorders of interactions between these climate systems.

Our results suggest that the loess in Kashmir is a valuable recorder of past environments. Furthermore, we can evidence, that the precipitation during warm phases of the last glacial was considerably higher than in many parts of Eurasia. We suggest the loess to be predominantly of local origin.

Keywords: Loess; Rock Magnetism; Physical Properties

Presentation time: Thursday, September 30, 2021 – PICO: 11.59 am - 12.00 pm, individual discussion: 4.10 - 6.00 pm

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[P09]

Reconstructing Palaeoenvironmental Conditions of the Last Two Glacial-Interglacial Cycles in Northern Armenia from Loess-Palaeosol Sequences

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The Sevkar loess area is situated in northern Armenia on the foothills of the Lesser Caucasus. Loess-palaeosol sequences (LPS) with intercalated tephra layers provide an excellent opportunity for using these sequences as indicators for environmental change. In our study we establish a luminescence-based chronology of three LPS, providing evidence for loess deposition during glacials and stadials and soil formation during interglacials and interstadials. A prominent tephra in the loess unit of the penultimate glacial (MIS6) is found in all of the sections and is probably derived from Nemrut volcano ca. 350 km to the southwest. The comparison with other proxies from the wider area yields a conclusive picture on the past environmental conditions of the last two glacial-interglacial cycles in Armenia.

Keywords: Loess; Quartz Fine Grain Dating; Post-IR IRSL Dating; Tephra; Armenia

Presentation time: Thursday, September 30, 2021 – PICO: 12.01 - 12.02 pm, individual discussion: 4.10 - 6.00 pm

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[P10]

Magnetic Fabric of the Agh Band Loess-palaeosol Sequence (Northern Iran) – Investigating Past Wind Dynamics

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The Northern Iranian loess profiles are important terrestrial archives on the past climate and palaeoenvironmental shifts in the area and are crucial for stratigraphic correlation along the Southern Eurasian loess belt. The Agh Band loess sections are located in the westernmost part of the northern Iranian Loess Plateau and their thickness reaches up to at least 60 m. Previous research on the Agh Band loess-palaeosol sequence suggests that it contains information about climatic shifts and changes in the sedimentological regime between MIS 7 to late MIS 2. For this study, 600 oriented samples were collected. We have conducted environmental magnetic analysis after dividing the profile into five intervals in relation to different depths. We analysed the following properties: Anisotropy of the Magnetic Susceptibility (AMS) such as the Degree of anisotropy (P), the Lineation (L) and the Foliation (F), Temperature-dependent magnetic susceptibility, magnetic enhancement, and directions of the anisotropy of the magnetic susceptibility. The magnetic properties of the Agh Band sequence indicate clearly an aeolian origin of the loess with AMS patterns indicating some quasi-cyclic changes in wind directions. We found no indication of slumping or redisposition of the material on the slope. Here we discuss the reconstruction of prevailing palaeowind directions. The character of the directions of the anisotropy of magnetic susceptibility shows that wind directions were changing in time, which is viable through different grain orientations with different depths; this may indicate a dynamic environment. Here we present results and an interpretation in progress.

Keywords: Magnetic Fabric; Loess; Palaeosol Sequence; Past Wind Dynamics

Presentation time: Thursday, September 30, 2021 – PICO: 12.03 - 12.04 pm, individual discussion: 4.10 - 6.00 pm

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[P11]

Investigating the Loess Sequence of Bahlingen a. K., Germany, using a Multi-methodological Approach

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Loess-paleosol sequences are important archives for paleoclimatic reconstructions. While numerous profiles have been investigated throughout the Eurasian loess belt, state of the art results from the southern Upper Rhine Graben are lacking. The Kaiserstuhl area, widely known for its thick loess cover, has not been investigated since the 1980s (e.g., Guenther 1987; Zöller et al. 1988). Within the scope of this project, a weakly differentiated 5 m thick loess profile near Bahlingen at the Kaiserstuhl is investigated using a high-resolution and multi-methodological approach. The overall aim of this work is to gain a deep understanding of the context of age, sedimentation history and environmental changes, and by this revive loess research in the Kaiserstuhl area.

Classical sedimentological methods such as the determination of grain size, organic carbon and carbonate content are used in combination with Optically Stimulated Luminescence (OSL) dating, Infrared Stimulated Luminescence (IRSL) screening, Mid-Infrared Spectroscopy discriminant analysis and colour measurements. The latter enables an objective differentiation of profile units based on colour changes, which can indicate environmental changes (Sprafke 2016). IRSL screening data show a distinct hiatus at 4 m depth: Loess above presumably formed during the maximum of the last glacial cycle (MIS 2), whereas age determinations of the lowermost loess package are work in progress.

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Keywords: Loess; Kaiserstuhl; OSL Dating; IRSL Screening; Colour Measurements

Presentation time: Thursday, September 30, 2021 – PICO: 12.05 - 12.06 pm, individual discussion: 4.10 - 6.00 pm

[P12]

Investigating the Loess-paleosol Sequence of Köndringen, Germany, using a Multi-methodological Approach

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Loess-paleosol sequences (LPS) are important terrestrial archives for palaeoenvironmental reconstructions. In the southern part of the Upper Rhine Graben, little loess research has been conducted, and most of it before the early 90s (Guenther, 1987). However, further methods and different approaches have evolved in the last decades, including colour measurement that helps to develop a robust stratigraphy based on quantified colour changes (Sprafke, 2016). As part of this project, an LPS in Köndringen is investigated, with the aim to reconstruct environmental changes and to contribute to ongoing loess research and hopefully restarting loess research in the area.

Four well-developed palaeosols are visible along the 260 m long and up to 10 m high loess outcrop of Köndringen, located in the foothills of the Black Forest. This project covers the upper two palaeosols in the northern part of the outcrop, where three profiles with a total height of 10 m have been sampled in high resolution, including samples for grain size analyses, organic and carbonate content, Optically Stimulated Luminescence (OSL) dating and Infrared Stimulated Luminescence (IRSL) Screening, provenance analyses via Mid-Infrared Spectroscopy Discriminant Analyses (MIRS), and colour measurements. The high-resolution parameters considerably refine the field stratigraphy, indicating a complex evolution of the LPS in the interplay of pedogenesis, dust accumulation and reworking. As for the provenance of the loess, MIRS is still a work in progress. According to the IRSL Screening, the LPS may go back to the mid-Pleistocene, however, this must still be proven by OSL dating.

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Würzburg University Press.

Keywords: Loess in Baden; OSL Dating; IRSL Screening; Colour Measurement

Presentation time: Thursday, September 30, 2021 – PICO: 12.07 - 12.08 pm, individual discussion: 4.10 - 6.00 pm

[P13]

Lithology and High-Resolution Geochemical Data for the last 320 ka from the Sediment Trap of Rodderberg near Bonn (Germany)

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The Rodderberg Volcanic Complex of the Quaternary East Eifel Volcanic Field was formed by an eruption 320 ka ago. Today's bowl-shaped crater has a diameter of 800 m and collected atmospheric dust, lacustrine sediments, slope wash and volcanic ashes of the Eifel region since the Middle Pleistocene. In a low-resolution pilot study of core ROD11-1 it was proposed that this sediment archive contains several glacial and interglacial deposits in superposition without significant gaps. The oldest interglacial was tentatively linked to the Holsteinian. In this study we provide a detailed lithofacies description and geochemical data based on the 72 m-long composite profile of cores ROD11-2 and ROD11-3. High-resolution X-Ray Fluorescence (XRF) analysis, Total Organic Carbon (TOC) and Total Inorganic Carbon (TIC) as well as Biogenic Silica (BSi) measurements show distinct changes between the 16 described sediment units. We hypothesize that this variability is in response to environmental changes through time, and primarily related to glacial/interglacial cycles. Especially TOC and BSi data support this hypothesis with higher organic productivity during interglacial units. The lithology shows highly variable sediments with around 47 m of lacustrine sediments documenting different laminations in the deeper part of the record and around 23 m of terrestrial loess and loess-like deposits in the upper part. The transition from the lacustrine to the terrestrial environment is proposed to occur between 25 m and 23 m depth, as the record shows indications of soil formation and distinct changes in high-resolution geochemical data for this part. Especially noticeable are regular bands and layers, which appear almost throughout the entire record. Their origin and formation processes need to be determined by further investigations.

Keywords: Rodderberg; East Eifel Volcanic Field; Middle Pleistocene; Lithology; High-Resolution Geochemical Data

Presentation time: Thursday, September 30, 2021 – PICO: 12.09 - 12.10 pm, individual discussion: 4.10 - 6.00 pm

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[P14]

Äolianitsequenzen als Archiv nordafrikanischer Staubeinträge - Aeolianite sequences as Archive of North African Dust

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Die zwar in nahezu allen Breiten vorkommenden Äolianitsequenzen zeigen ihre mächtigsten Vorkommen aber in den ariden und semiariden Gebieten, da hier die Bildung der nötigen Karbonatsande optimale Bedingungen vorfindet. Das Hauptverbreitungsgebiet liegt demnach im Bereich der niederen Breiten, in dem kontinuierliche Abflussmengen fehlen, die die Bildung der Karbonatsande behindern würden. Der konzeptionelle Ansatz, demnach mit Einsetzen von Meeresspiegelabsenkung eine verstärkte Zufuhr von biogenen Karbonatsanden aus dem flachen Schelfbereich zur Bildung von Dünen auf den Östlichen Kanareninseln (hier als unverfestigte Äolianite) führt, und darüber hinaus die zwischen den einzelnen Karbonatsandgenerationen eingeschalteten schluffangereicherten Paläooberflächen vor allem die Eigenschaften nordafrikanischer Stäube widerspiegeln, deckt sich mit Untersuchungen an marinen Bohrkernen zu Staubdepositionen im Kanarenbecken (Moreno et al., 2001).

Letztere zeigen unter anderem anhand erhöhter Aluminiumgehalte verstärkte Staubeinträge in Abhängigkeit von Variabilitäten der Präzession. Folglich kann der Dünengenese eine Sensitivität einerseits gegenüber Meeresspiegelschwankungen und andererseits gegenüber präzessionsbedingten Insolationsvariabilitäten unterstellt werden. Anhand von Untersuchungen an einem Profil in den Dünenarchiven Lanzarotes konnte der Zusammenhang von Staubeinträgen in Abhängigkeit von Heinrich-Events diskutiert werden, womit eine weitere Sensitivität des Archivs aufgezeigt wird. Datierungen an einem unmittelbar benachbarten Profil im Dünenfeld El Jable auf Lanzarote bestätigen nun die zeitliche Einordnung, und legen den Versuch eines Abgleichs auf überregionaler Ebene nahe. Da den karbonatsanddominierten Äolianiten über ihre Genese als Küstendünen und der damit verbundenen Abhängigkeit vom globalen Meeresspiegel eine direkte Korrelation zu unterstellen ist, wird im nächsten Schritt ein Vergleich innerhalb dieses Archivtyps von den Kanaren bis in den Mediterranraum angestrebt.

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Keywords: Kanarische Inseln; Canary Islands; Düne; Dune; Pleistozän; Pleistocene; Quartär; Quaternary

Presentation time: Thursday, September 30, 2021 – PICO: 12.11 - 12.12 pm, individual discussion: 4.10 - 6.00 pm

[P15]

Sand Dune Mobility under Different Scenarios of Global Warming in the Khuzestan Sand Sea

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The International Panel on Climate Change has clearly reported that global warming is likely to reach 1.5 °C between 2030 and 2052, and even a "hothouse earth" outlook has been raised recently. In fact, climate models project robust differences in regional climate characteristics between the present-day climate and global warming scenarios of 1.5 °C and between 1.5 °C and 2 °C. In Iran, scientific reports show that the temperature will be raised to about 4.5 °C. Recently, we developed a new model of sand dune mobility based on the sand drift potential (DP) and the ratio of precipitation to annual potential evapotranspiration (P/PET). This ratio is the aridity index which directly affected plant growth, and was simulated for different scenarios of temperature increase (1.5, 3, 4.5, and 6 °C) for 21 weather stations around the Khuzestan Sand Sea. The Khuzestan Sand Sea extends from the Wasit and Maysan provinces in Iraq (22 %) to the Ilam (10 %) and Khuzestan (68 %) provinces in Iran. We assumed that the other parameters did not change significantly. The Iraqi part, Ilam, and the western border of Khuzestan are active due to a high DP. In the central area of the sand sea near Ahvaz weather station, the activity decreases due to low DP and high PET. In the southeastern part, the mobility index (MI) increases again because DP reaches up to a medium-class wind energy environment. The assumptions of raising temperature and PET showed that MI will increase by 3 %, 7 %, 10 % and 12 % during the different scenarios of global warming for the weather stations. Since the predicted changes in PET are generally not drastic, the Khuzestan sand sea is not likely to become active.

Keywords: Dune Mobility; Drift Potential; Khuzestan; Sand Sea

Presentation time: Thursday, September 30, 2021 – PICO: 12.13 - 12.14 pm, individual discussion: 4.10 - 6.00 pm

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Session 1
Quaternary climate and environmental changes
PICO – part II

[P16]

Holocene Fluvial Dynamics in the Central Alsatian Upper Rhine Alluvial Plain, NE France

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The Upper Rhine alluvial plain is characterised by a well-preserved network of palaeochannels inherited from the Late Glacial to the Holocene Rhine fluvial system. Despite this excellent fluvial archive, the Upper Rhine hydro-system as a whole and its long- and short-term temporal trajectory under a variety of environmental changes and human actions remain poorly understood.

Here, we present the preliminary results of a comprehensive study to reconstruct the Holocene fluvial dynamics of the Rhine and Ill Rivers in the Alsatian Upper Rhine alluvial plain, defined between Neuf Brisach/Sainte-Croix-en-Plaine and Mackenheim/Guémar. A combination of remote sensing analysis (LiDAR mapping of paleochannels and measurement of morphological parameters), field investigations (characterisation of palaeochannel geometry and sedimentary infillings), and provenance studies of palaeochannel infillings (using mid-IR spectroscopy) was employed to reconstruct former channel network dynamics.

Results reveal the presence of five palaeochannel generations, which differ in terms of morphology, paleo-flow direction, and sediment characteristics, including provenance. The development of these palaeochannels is attributed to significant landscape changes in the area during the Holocene, characterised by an eastward lateral migration of the Rhine River and a westward displacement for its main tributary in the region, the Ill River. The Holocene trajectory of this fluvial system is only partially known; constraining the ages of palaeochannel-fill deposits and additional sedimentological investigations will allow for establishing the timing of the major movements of the Rhine and Ill during the Holocene and discussing possible endogenic or allogenic control factors that directed these movements.

Keywords: Holocene; Upper Rhine; NE France; Fluvial Dynamics

Presentation time: Thursday, September 30, 2021 – PICO: 3.35 - 3.36 pm, individual discussion: 4.10 - 6.00 pm

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[P17]

The Potential of Small Mountain River Systems for Paleoenvironmental Reconstructions in Drylands: An Example from the Binaloud Mountains in Northeastern Iran

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Fluvial sediments are valuable palaeoenvironmental archives of the Quaternary. Since besides environmental factors they are also affected by local tectonics or intrinsic processes, large instead of small catchments should be studied. In drylands covering ca. 45 % of the global terrestrial surface large river systems are generally missing, and most river systems are small rivers originating from mountain ranges. Their sediments are potentially interesting palaeoenvironmental archives but are often affected by intensive tectonics. During this study, to obtain a robust regional palaeoenvironmental signal a small river system in the southwestern Binaloud Mountains in semi-arid NE Iran was exemplarily studied with a combined approach that encompassed both alluvial fan and catchment. By using geomorphological mapping and numerical dating, fluvial aggradation followed by incision was independently identified in larger areas or in different parts of the river system ca. 95–88 ka, 40 ka, 20 ka, around/after the Pleistocene/Holocene transition and possibly ca. 2.6 ka. These could be linked with regional and over-regional palaeoenvironmental data. Furthermore, large boulders on the alluvial fan suggest anthropogenic destabilisation of the catchment during the last decades. Despite strong local tectonics, the fluvial dynamics was mostly controlled by palaeoenvironmental changes and human activity. This indicates that despite their small size, such river systems form valuable palaeoenvironmental archives in drylands where other archive types are largely missing.

Keywords: Fluvial Geomorphology; Palaeoenvironmental Reconstruction; Drylands; Late Quaternary; Tectonics; Alluvial Fans; Iran

Presentation time: Thursday, September 30, 2021 – PICO: 3.37 - 3.38 pm, individual discussion: 4.10 - 6.00 pm

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[P18]

Changes in the Environment During the Last Interglacial in the Basin of Mexico

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The Basin of Mexico is located at the east of the Trans-Mexican Volcanic Belt. In the south of the basin Lake Chalco is found, a shallow lake whose sedimentary record shows an age up to 400 ka. Its location makes the lake an important location for palaeoclimate research due to its response to changes in climate forcing such as the Intertropical Convergence Zone. The variability of lake productivity, changes in lacustrine levels, vegetation, and fire events in the Basin of Mexico to orbital changes from late MIS 6 to MIS 3 (146–35 ka) are presented based on geochemical (Ti, TIC, TOC, C/N), charcoal (CHAR), diatoms and pollen data of the sediment core CHA08 from Lake Chalco. The palaeoenvironmental reconstruction identifies the MIS 6 as a wetter period, low forest cover and low fire activity. A sudden change from wetter to dry environments with low to high forest cover and fire activity episodes characterised the end of the MIS 6 (132–130 ka). Variations in vegetation composition, with a tendency towards higher forest cover, fire-activity, runoff, and organic matter availability, are recorded during the MIS 5, MIS 4, and MIS 3. Spectral analysis based on the titanium concentration record of Lake Chalco suggests a precessional forcing on runoff variations. We explored the impact of the Intertropical Convergence Zone latitudinal migrations which have been related to the summer insolation at 65° N by comparing runoff data with other sedimentary records from North and Central America. Our results highlight the sensitivity of the high-altitude tropical basin to climate variations.

Keywords: Basin of Mexico; Paleofires; Interglacial; Geochemistry; Lake Chalco

Presentation time: Thursday, September 30, 2021 – PICO: 3.39 - 3.40 pm, individual discussion: 4.10 - 6.00 pm

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[P19]

A Holocene Temperature Record from the High-Altitude Lake Archive Garba Guracha, Ethiopia, Eastern Africa

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In the last 15,000 years, eastern Africa experienced substantial climatic variations for which the drivers are not yet fully understood. Several studies have enhanced our knowledge about Holocene precipitation changes in eastern Africa in the last decades. Yet, few studies have reconstructed the temperature history of eastern African lakes and none at the Horn of Africa. In order to contribute to this and to reconstruct the Holocene temperature history of the afroalpine Bale Mountains, Ethiopia, within the DFG Research Unit 2358 *'The Mountain Exile Hypothesis: How humans benefited from and re-shaped African high-altitude ecosystems during Quaternary climate changes'*, we re-cored Lake Garba Guracha. This site represents one of the best dated Late Glacial - Holocene continuous, high altitude (3,950 m a.s.l.) paleoenvironmental archives in Eastern Africa. We reconstructed the Holocene mean annual temperatures based on brGDGTs and compared our findings to lake level reconstructions from the same archive, Garba Guracha. Reconstructed mean annual temperatures (n=20, 3-10 °C) indicate that colder conditions prevailed in the high-altitude Bale Mountain ecosystem during the Younger Dryas. Moreover, we reconstructed a delayed response to insolation warming during the Late Glacial and a mid-Holocene thermal optimum following the insolation maximum at 10 ka. The highest temperatures coincide with overflowing open lake conditions until 7 ka. A trend towards relatively more closed lake conditions and decreasing temperatures begins between 7 ka and 5 ka. Our results suggest that the link between temperature and hydrology is more pronounced in the Horn of Africa region than in equatorial and southern Africa.

Keywords: brGDGT; Biomarker; Isotopes; Lake Level Reconstruction; Eastern Africa

Presentation time: Thursday, September 30, 2021 – PICO: 3.41 - 3.42 pm, individual discussion: 4.10 - 6.00 pm

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[P20]

Bayesian Age-Depth Model Applied to Annually Laminated Holocene Sediments from Holzmaar (West-Eifel Volcanic Field, Germany) to Investigate High-Resolution Geochemical Data

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Lake sediments are precious archives to analyse past climate change and anthropogenic influences at regional catchment and at global scales. Lacustrine sediment analysis however is only as good as its chronology, which is mostly obtained by radiometric measurements and rarely by distinct and well-known event layers (tephra), historic flood events or varve counting. Varves are laminations that show a rhythmic and seasonal alternation in colour and composition. Under optimal conditions, varves are preserved in the sediment and can be counted similarly to tree rings. This results in a highly accurate chronology for the sedimentary sequence. The West-Eifel maar lake Holzmaar is a well-known example of a well-preserved and continuous varved sediment record with a chronology that extends back into the Late Pleistocene. In 2019, Holzmaar was revisited and a new sediment core (HZM19) was retrieved. The previous varve chronology was transferred to HZM19 using predefined marker layers and their corresponding varve ages including counting uncertainties. With this information and additional radiometric Pb-210 and Cs-137 analyses, a Bayesian age-depth model was generated. We also include the updated age for the Laacher See Tephra and discuss the result of different methods of adopting the varve chronology. This has advantages especially for sections where counting uncertainty is higher and radiocarbon data are less frequent.
With this newly generated absolute chronology, we present the first high-resolution geochemical record from Holzmaar for the entire Holocene, obtained with micro X-ray fluorescence scanning. Applying this new chronology enables us to provide insights into environmental changes and their control mechanisms on sediment flux into the lake throughout the Holocene with a temporal resolution not attained by previous studies.

Keywords: Holzmaar; Lacustrine Sediments; Bayesian Age Depth Model; Varves; XRF

Presentation time: Thursday, September 30, 2021 – PICO: 3.43 - 3.44 pm, individual discussion: 4.10 - 6.00 pm

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[P21]

Centennial to Millennial-Scale Variability of Holocene Climate Dynamics in the Western Mediterranean (Lake Sidi Ali, Middle Atlas, Morocco)

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The Western Mediterranean region including the North African desert margin is considered one of the most sensitive areas to future climate changes. In order to refine long-term scenarios for hydrological and environmental responses to future climate changes in this region, it is important to improve our knowledge about past environmental responses to climatic variability at centennial to millennial timescales. During the last two decades, the recovery and compilation of Holocene records from the subtropical North Atlantic and the Mediterranean Sea have improved our knowledge about millennial-scale variability of the Western Mediterranean palaeoclimate. The variabilities appear to affect regional precipitation patterns and environmental systems in the Western Mediterranean, but the timescales, magnitudes and forcing mechanisms remain poorly known.

To compare the changes in Holocene climate variability across temporal scales, we analysed a 19.63 m long sediment record from Lake Sidi Ali (33°03' N, 5°00' W, 2,080 m a.s.l.) in the

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sub-humid Middle Atlas that spans the last 12,000 years (23 pollen-based radiocarbon dates accompanied with ^{210}Pb results). We use calibrated XRF core scanning records with an annual to a sub-decadal resolution to disentangle the complex interplay between climate changes and environmental dynamics during the Holocene. A multivariate view of time series analysis (Redfit, Wavelet) revealed long-term changes in lake behaviour. Three main proxy groups were identified (temperature proxies: 2 ka, 1 ka and 0.7 ka cycles; sediment dynamic proxies: 3.5 ka, 1.5 ka cycles; hydrological proxies: 1.5 ka, 1.2 ka, 0.17 ka cycles).

All groups show specific periodicities throughout the Holocene, demonstrating their particular climatic and geomorphological dependencies. Furthermore, we discuss these periodicities relating to global and hemispheric drivers, such as the North Atlantic Oscillation (NAO), El-Niño Southern Oscillation (ENSO), Intertropical Convergence Zone variability (ITCZ) and North Atlantic cold relapses (Bond events).

Keywords: Holocene; Millenial Scale Variability; Mediterranean

Presentation time: Thursday, September 30, 2021 – PICO: 3.45 - 3.46 pm, individual discussion: 4.10 - 6.00 pm

[P22]

Sediment Records from Drying-Up Urmia Lake (NW Iran) Aid Palaeoenvironmental Reconstruction Back to the Last Glacial

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Urmia Lake in NW Iran is globally the second-largest hypersaline lake (130 km long N-S, up to 30 km wide E-W). During the past decades, this shallow lake (< 3 m water depth) is undergoing a heavy environmental crisis as obvious from various studies. For example, a temporal series of satellite data over the past 20 years shows that the lake has been shrinking and giving way to a circum-lacustrine km-wide salty to muddy margin. Multiple lake sediment cores demonstrate that over the same time a salty crust up to 3 m thick has been evolving especially over the deeper lake parts. In a follow-up study, we examine a set of lake cores in order to assess the sedimentary variation before this drastic environmental change started to take place. The cores are up to 25 m in length, and they all have an overlying salt crust that increases towards the inner lake to more than 1.5 m thickness. We focus on mineral compositional changes of the underlying non-salty deposits for inferring environmental variability back in time. In addition, we use carbon and oxygen isotope data measured from lake carbonates. Depending on core position the average sedimentation rate in the siliciclastic material is known to be 0.3 mm/a, which then points to a maximum age of our records to the Last Glacial Maximum. Cored sediments are dominated by mud, which is rich in Artemia pellets. This sediment unit makes up more than 50 % of each core. Partly dm-thick layers of marl or silty mud are intercalated. Subordinately dm-thick sandy layers are distinct. At deeper layers, sediments are rich in secondary gypsum, whereas in the upper core parts layers of organic-matter rich ooze are observed. Our palaeoenvironmental interpretation considers sediment type variation, water level fluctuations, and possible provenance signal change.

Keywords: Late Quaternary; Urmia Lake; Sediment Archive

Presentation time: Thursday, September 30, 2021 – PICO: 3.47 - 3.48 pm, individual discussion: 4.10 - 6.00 pm

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[P24]

Extent and Timing of Late Pleistocene Glaciation on Jakupica Mt. (North Macedonia)

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This study provides results of geomorphological mapping and glacial reconstruction of a succession of glacial landforms in the Jakupica Mt. (North Macedonia) aiming to improve the understanding of Late Pleistocene glacier development in the currently mainly unglaciated area (Ruszkiczay-Rüdiger et al., 2020a). ^{10}Be cosmic-ray exposure (CRE) ages are provided for the local maximum ice extent during the Last Glacial Maximum (LGM) and following deglaciation.

In the Jakupica Mt. ($\sim$ 41.7°N, $\sim$ 21.4°E; Solunska Glava, 2540 m a.s.l) a large plateau glacier was reconstructed (max. area $\sim$ 45 km^2, max. thickness: $\sim$ 260 m) (Ruszkiczay-Rüdiger et al., 2020b). The study area comprises the northeastern part of the former ice field and six formerly glaciated valleys. The lowest mapped moraines in the valleys are at elevations of 1490-1720 m a.s.l. suggesting the former existence of glacier tongues of $\sim$ 3 km length. The geomorphological mapping enabled us to reconstruct the maximum ice extent and five phases of glacial stabilization during deglaciation.

The equilibrium line altitude (ELA) of the reconstructed ice-field and glaciers is 2073+37/-25 m for the most extended phase. The ^{10}Be CRE age (n=8) of this phase was estimated at 19.3+1.7/-1.3 ka, conformable with the LGM. CRE ages from the next moraine generation paced the first phase of deglaciation to 18.2+1.0/-3.0 ka (n=8). The samples from the moraine of the penultimate deglaciation phase (n=5) provided CRE ages with large scatter and biased towards old ages, which is probably the result of inherited cosmogenic nuclide concentrations within the

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rock (Ruszkiczay-Rüdiger et al., 2021).

A comparison of estimated LGM ELAs in the Jakupica Mt. and published ELA estimates in other ranges in the area will be presented, with implications to LGM moisture transport directions.

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Keywords: Balkan Peninsula; Deglaciation; Cosmogenic Nuclides; ^{10}Be

Presentation time: Thursday, September 30, 2021 – PICO: 3.51 - 3.52 pm, individual discussion: 4.10 - 6.00 pm

[P25]

Late Pleistocene Deglaciation History of the Southern Black Forest, Germany: Insights from Geomorphological Mapping, ^{10}Be Cosmic-ray Exposure Dating and Equilibrium Line Altitude Reconstructions

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The Black Forest temporarily hosted a 1000 km^2 large ice cap and its outlet glaciers during the Late Pleistocene. Multiple groups of moraines inside the last glaciation maximum extent document highly dynamic deglaciation. However, the chronology of periods of moraine formation remains largely unknown.

To fill this gap, moraines in Sankt Wilhelmer Tal, a well-developed trough valley north-west of the Feldberg were mapped with a high-resolution digital terrain model (DTM) and raster files derived from the DTM. This was complemented with geomorphological field mapping. Moraines with suitable boulders were sampled for ^{10}Be cosmic-ray exposure (CRE) to establish a regional glacier chronology. Previously published ^{10}Be CRE ages from the mountain regions of Central Europe and their forelands were recalculated for suitable comparison. Equilibrium line altitudes (ELAs) during moraine formation were reconstructed to assess whether palaeo-ELAs can be used as a tool for relative dating of moraines. Geomorphological mapping reveals moraines of 18 ice-marginal positions in the main valley and moraines of multiple ice-marginal positions in two tributary valleys. The CRE ages suggest that the deglaciation of the study area occurred during the last termination and provide evidence for two distinct periods of moraine formation. ELA reconstructions show that the ELA varied considerably across the study area during the second phase of glacier fluctuations. Differing ELAs impede the use of palaeo-ELAs as a tool for relative dating of moraines.

The CRE age-based glacier chronology significantly increases the knowledge of glacier variations in the mountain regions of Central Europe and provides important data for future palaeoclimatic

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reconstructions. As it could not be answered whether the outermost sampled moraine formed during the last glaciation maximum, ^{10}Be CRE dating and other suitable dating methods should be applied to moraines in other parts of the southern Black Forest to determine the timing of this event.

Keywords: Glacier; Moraine; Geomorphological Mapping; Cosmogenic Nuclide Dating; Equilibrium Line Altitude; Black Forest

Presentation time: Thursday, September 30, 2021 – PICO: 3.53 - 3.54 pm, individual discussion: 4.10 - 6.00 pm

[P26]

Post-Glacial Landslides in the Central Andes of Argentina

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Glacial landscapes in active tectonic environments around the world had been proven to be subject of the paraglacial effect, recording landslides and massive rock slope failures immediately or some time after the deglaciation. Nevertheless, very few studies have been performed in the Central Andes of Argentina, which has the highest mountain peaks of South America and was heavily glaciated during the Pleistocene, with the exception of the Aconcagua National Park. The active tectonic environment adds an extra difficulty in assuming the pre-conditioning and triggering factors of such events, as the seismic forcings are coupled with climatic forcings. This is the reason why establishing the timing of such events helps to elucidate their intrinsic and external mechanisms, and thereby to assess the hazard in high mountain environments affected by past glaciations. Age determinations in such environments are extremely difficult, as these are highly dynamic and only few techniques are suitable, such as exposure dating which takes into account several correction factors associated to altitude, snow cover and topography shielding. On this note, so far there are no exposure ages on any landslide or slope failure recorded around the Mercedario Peak in the Central Andes of the San Juan province, Argentina. During this study, three landslides in the Rio Blanco basin were dated with cosmogenic ^{10}Be and ^{26}Al, representing the first exposure ages from surficial boulders on landslides recorded in the area. After a detailed geomorphological and chronostratigraphical study, these landslides were dated to 20.9 ± 1.4 ka, 12.8 ± 0.9 ka and 10.8 ± 0.7 ka, getting older with lower stratigraphical position. These ages are a first approach to link the deglaciation process to a readjustment of the slopes via large landslide events.

Keywords: Landslides; CRN Dating; Central Andes

Presentation time: Thursday, September 30, 2021 – PICO: 3.55 - 3.56 pm, individual discussion: 4.10 - 6.00 pm

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[P27]

Investigation of Pleistocene Sand Wedges in the Pannonian Basin using Image Analysis Methods

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The study of the primary filling material of relict sand wedges can help understand the forms' origin. The application of granulometric proxies on relict sand material can be used to reconstruct the paleoenvironmental conditions. Therefore, we aimed to identify fingerprints related to the environment and the transport medium (e.g. type, time). Two methods were applied to investigate the wedges from Kemeneshát mesoregion and the Mogyoród gravel pit (Pest Plain). 470 individual grains were examined applying SEM to identify microstructures and the level of roundness of grains using Krumbein's method. During a more accurate and representative characterisation method, $> 10^3$ grains were scanned by the built-in Nikon Eclipse microscope (and CCD camera) of a Malvern Morphologi G3-ID automatic image analyser. The size distribution of the investigated grains was determined, and also the distribution of different shape parameters (e.g., circularity, convexity).

Based on SEM, conchoidal fractures, crescentic gouges, breakage blocks, V-shaped percussion cracks, linear and arc-shaped steps on the surface of the grains were identified and classified according to their frequency of occurrence. According to Krumbein's scale, nearly two-thirds of the examined grains belonged to groups 0.3 and 0.4; thus, there was no significant difference between the Mogyoród and Kemeneshát samples. Based on the robust granulometry data, the Kemeneshát and the Mogyoród site wedges can be distinguished.
In general, the Mogyoród site had more regular, rounded, and circular grains than the majority of the samples from the Kemeneshát site. Although, it was also possible to differentiate between the Kemeneshát samples based on the shape parameters. Examination of microstructures suggests that some of the grains may have undergone periglacial processes; however, their surfaces had been affected by various transport media. Continuing this work can give a more detailed insight into the palaeoenvironmental properties of the Pannonian Basin during the Late Pleistocene.

Keywords: Frost Cracks; Pannonian Basin; Late Pleistocene; Image Analysis; SEM

Presentation time: Thursday, September 30, 2021 – PICO: 3.57 - 3.58 pm, individual discussion: 4.10 - 6.00 pm

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Session 4
Applied Quaternary research at the interface to modern societies

[Invited keynote]

Applied Quaternary Research for Drinking Water Supply in Lower Saxony

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Groundwater is essential for life. In Lower Saxony, about 86 % of drinking water is obtained from groundwater, it is needed for agriculture and many industries. Most of the wells used to extract groundwater are located in Quaternary deposits. To ensure sustainable use of this renewable resource, a good knowledge of the structure of the aquifer systems and the characteristics of the Quaternary deposits is required. The assessment of groundwater reserves requires a good knowledge of aquifer distribution and thickness. The properties of the aquifers determine, for example, the type and development of wells and have a significant effect on the quality of the groundwater. Fine-grained layers separate different groundwater levels from each other or protect the aquifer system from surface influences, e.g. by pollutant input or agricultural fertilisation. The usually borehole-based construction of subsurface structures as a tool, e.g., for flow or solute transport modelling requires, on the one hand, a good stratigraphic classification of layers, and on the other hand a good knowledge of Quaternary sedimentation systems.

Keywords: Groundwater; Sustainability; Lower Saxony

Presentation time: Thursday, September 30, 2021 – 2.45 - 3.15 pm

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Evening programme (Abendprogramm)

[Invited talk]

Was haben Eiszeiten mit der Sicherheit eines Endlagers zu tun?

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Traditionell beschäftigt sich die geowissenschaftliche Forschung mit der Rekonstruktion von Prozessen, Ereignissen oder Umweltbedingungen in der Vergangenheit. Diese Erkenntnisse aus der geologischen Vergangenheit lassen sich natürlich auch nutzen, um potentielle zukünftige Entwicklungen zu prognostizieren. Prognosen zukünftiger geogener Entwicklungen, auch in geologischen Zeiträumen, sind ein wichtiger Beitrag zu Langzeitsicherheitsanalysen für die Endlagerung radioaktiver Abfälle.

In Deutschland sieht das "Gesetz zur Suche und Auswahl eines Standortes für ein Endlager für hochradioaktive Abfälle" (Standortauswahlgesetz) vor, dass der dauerhafte Schutz von Mensch und Umwelt vor ionisierender Strahlung über einen Zeitraum von einer Million Jahre gewährleistet sein soll. Bei der Betrachtung eines derart langen Zeitraums ist es unbedingt notwendig, auch die Auswirkungen möglicher zukünftiger Eiszeiten zu berücksichtigen. Während der Eiszeiten im Pleistozän hat insbesondere die Erosion durch Gletscher und Schmelzwasser die Landschaftsentwicklung erheblich beeinflusst und es ist zu erwarten, dass vergleichbare Erosionsprozesse auch während zukünftigen Eiszeiten auftreten werden. Daher wird die Sicherheit eines Endlagers vor "eiszeitlich bedingter intensiver Erosion" ausdrücklich im Standortauswahlgesetz gefordert.

Besonders große Erosionstiefen können bei der Bildung subglazialer Rinnen durch Schmelzwasser unter Gletschern erreicht werden. Beispielsweise sind in Norddeutschland maximale Tiefen pleistozäner subglazialer Rinnen von mehreren Hundert Metern bekannt. Trotz einer langen Forschungsgeschichte bestehen noch zahlreiche offene Fragen zur Genese und Entwicklung dieser subglazialen Rinnen. Für die Prognose einer zukünftigen Rinnenbildung ist eine detaillierte Kenntnis der entsprechenden eiszeitlichen Prozesse notwendig.

Keywords: Endlager; Eiszeiten; Endlagersicherheit

Presentation time: Thursday, September 30, 2021 – 6.00 - 7.00 pm

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Session 2
Quaternary human-environment interactions
Oral presentations

[Invited keynote]

Variability in Fluvial Geomorphic Response to Anthropogenic Disturbance: Implications for Sediment and Carbon Storage at Holocene Timescales

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Humans have greatly impacted the processes and intensities of erosion, sediment transport and storage since the introduction of agriculture. In many regions around the world, accelerated floodplain sedimentation can be related to increases in human pressure on the environment. However, the relation between the intensity of anthropogenic disturbance and the magnitude of change in fluvial sediment dynamics is not straightforward, and often non-linear as a variability in geomorphic, and tectonic setting, slope-channel (dis)connectivity, the existence of thresholds or tipping points within fluvial systems as well as the variability in duration, intensity, spatial pattern and typology of human impact. Hence, different trajectories in fluvial development can be recognised since the Neolithic which controls the importance of floodplains in sediment and carbon budgets at millennial timescales. It also implies that unravelling the human impact from current-day sediment archives and predicting the impact of future human disturbances on fluvial sediment dynamics remain a major challenge.

Keywords: Fluvial Systems; Human Impact; Carbon Budget

Presentation time: Friday, October 1, 2021 – 10.00 - 10.30 am

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[O10]

Holocene Landscape Evolution and Human Influence in the Fotsch Valley, Stubai Alps, Austria - Interrogating Biomarkers, Macrofossils and Stable Isotopes from a Subalpine Mire Archive

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The archaeology of high mountain regions attracts much attention since the discovery of the copper age mummy called "Ötzi" in the Ötztaler Alps in 1991. Results of former archaeological research projects show that Mesolithic hunter-gatherers lived in alpine regions since the beginning of the Holocene about 11.7 ka ago.

Many archaeological artefacts, as well as fireplaces, were found at different sites in the Fotsch Valley, which provides evidence for the presence and the way of living of our ancestors. Existing mire archives show high potential for biogeochemical investigations and represent in combination with the mesolithic site Ullafelsen very important study sites.

Within an ongoing DFG project, we aim at addressing research questions related to the investigation of past vegetation and climate changes using n-alkane biomarkers, macrofossils as well as compound-specific stable isotopes (δH-2-n-alkane and δ^{18}O-sugar). Furthermore, we try to reconstruct human history based on these biomarkers. The influence of vegetation, climate and human on the pedogenesis of the predominating soils at the Ullafelsen and surroundings

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was considered in our studies for a better understanding of the landscape evolution of this high mountain region.

First results from the "Potsdamer Hütte" mire core suggest that (i) the dominant modern vegetation can be chemotaxonomically distinguished based on leaf-wax derived *n*-alkane biomarkers, (ii) a robust chronostratigraphy can be established based on 12 radiocarbon ages for the last 9 ka, and (iii) marked vegetation changes likely associated with alpine pastoralism since the Neolithic/Bronze Age are well documented in this Holocene mire archive.

Keywords: Geoarchaeology; Biomarker; Alkanes; δ^2h; δ^{18}O; Neolithic/Bronze Age; Alpine Pastoralism; Mesolithic Site Ullafelsen

Presentation time: Friday, October 1, 2021 – 10.30 - 10.45 am

[O11]

Pathways and Linear Soil Erosion: A Case Study from the Ethiopian Highlands

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Human movement creates pathways, which flatten the surface and decrease the water permeability potential. As a result, surface runoff is promoted, which may lead to either the initiation of gullies downslope or to incisions in the footpaths, forming shallow Sunken Lanes (SL). If gullies initiate downslope, they can form an obstacle for human movement, as linear landforms dissecting the landscape. Gullies are therefore considered to be a cost for human movement, forming impassable barriers destroying present path networks. Humans are likely to form new pathways to avoid these obstacles, which may promote further gully erosion downslope. However, once an SL is formed, it may lead to less gully erosion downslope, due to lower overbank flow from the footpath. Additionally, in footpaths, Sunken Lanes seem to follow the direction of the local stream network. We investigate the spatial relationship between pathways and linear forms of soil erosion in the Ethiopian Highlands.

Keywords: Gullies; Pathways; Footpaths; Sunken Lanes

Presentation time: Friday, October 1, 2021 – 10.45 - 11.00 am

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[O12]

Eemian Landscape Response to Climatic Shifts and Evidence for Northerly Neanderthal Occupation at a Palaeolake Margin in Northern Germany

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The prevailing view suggests that the Eemian Interglacial on the European Plain was characterised by largely negligible geomorphic activity beyond the coastal areas. However, systematic geomorphological studies are sparse. Here we present a detailed reconstruction of Eemian to Early Weichselian landscape evolution in the vicinity of a small finger lake on the northern margin of the Salzwedel Palaeolake in Lower Saxony.

We apply a combination of seismic, sediment coring, pollen analysis and luminescence dating on a complex sequence of colluvial, paludal and lacustrine sediments. Results suggest two pronounced phases of geomorphic activity, directly before the onset and at the end of the Eemian period. During the Mid-Eemian a prolonged period of remarkable landscape stability lasted for several thousand years. The dynamic phases were largely driven by incomplete vegetation cover but were likely accentuated by a fluvial incision in the neighbouring Elbe River valley. Furthermore, we discovered Neanderthal occupation at the lakeshore during Eemian pollen zone E IVb/V, which is chronologically in line with other known Eemian sites of central Europe.

Our highly-resolved spatio-temporal data substantially contribute to the understanding of climate-induced geomorphic processes throughout and directly after the last interglacial period. It contributes to research on Eemian landscape dynamics between the coastal areas to the north and the loess belt to the south.

Keywords: Landscape Evolution; Eemian Interglacial; Palaeolake; Pollen Analysis; Neanderthal Occupation

Presentation time: Friday, October 1, 2021 – 11.00 - 11.15 am

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[O13]

Holocene Floodplain Evolution at the Central European Climate Boundary: Fresh Insights from the Upper Unstrut Catchment (NW Thuringia)

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Floodplain deposits form important palaeoenvironmental sediment archives to reconstruct the sedimentary dynamics of streams and to track landscape changes within their catchment. During the Holocene, climatic developments, regional weather extremes and anthropogenic land-use activities significantly influenced fluvial systems. Chronostratigraphic studies of fluvial sediment sequences provide insights into the Holocene landscape evolution. The upper Unstrut catchment in NW Thuringia drains a typical Central European loess landscape that was occupied almost continuously since the Neolithic. We applied electrical resistivity tomography profiling (ERT), vibracoring and sedimentological investigations combined with ^{14}C and OSL dating to a sedimentary sequence without major hiatuses. The results confirm that particularly Late Pleistocene to Holocene climatic changes and anthropogenic influences caused significant environmental changes in the floodplain, which can be divided into three phases:

1) A first Late Pleistocene/Early Holocene fluvial activity phase, when calcareous silty to clayey overbank fines were deposited above coarse-grained basal gravels and sands. Climatic changes were the main driver for the intensified fluvial dynamics, whereas other drivers are unlikely for this period.

2) A phase of predominant fluvial stability with comparatively high groundwater levels that prevailed into the Atlantic or Subboreal period. This period is indicated by the regionally so-called “Rieth series” (organic-rich mud, peat, and carbonate-rich sediments). However, widely preserved silty overbank fines intercalated into these sediments point towards significant sediment transfers into the fluvial system ca 4.8–3.4 ka. This corresponds with intensive settlement phases during the Late Neolithic and Early Bronze Age.

3) A phase dominated by thick silty overbank sedimentation, documenting a phase of strong

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fluvial activity. Aggradation started approx. 2.9 ka and slightly enhanced during the Middle Ages and pre-industrial modern times (< 1.2 ka). This formation can be explained by intensified land use and several highly erosive precipitation events.

Keywords: Floodplains; Holocene; Fluvial Activity; Central European Climate Boundary; Unstrut Catchment

Presentation time: Friday, October 1, 2021 – 11.15 - 11.30 am

Session 2
Quaternary human-environment interactions
PICO

[P29]

The Sacred Waterscape of the Temple of Bastet at Ancient Bubastis, Nile Delta (Egypt)

Julia Meister*† [1], Philipp Garbe[1], Julian Trappe[1], Amr Abd El-Raouf[2], Tobias Ullmann[1], Roland Baumhauer[1], Eva Lange-Athinodorou[3]

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The temple areas in ancient Egypt were most sacred and characterised by a multitude of elements that emphasised their importance and enabled daily cultic activities. Very specific and important features of such temples were sacred water canals or lakes, the so-called Isheru, which provided water for all kinds of purification rites and activities. In addition to textual records, preliminary sedimentological analyses of core drillings and geophysical surveys provided geoarchaeological evidence of sacred water bodies at the Temple of Bastet in the ancient city of Bubastis, located in the eastern Nile Delta. 34 drillings and five 2D geoelectrical measurements were carried out in 2019 and 2020 in Bubastis to explore the location, shape, or course of an already detected canal and to find evidence on the existence of a second waterway described by Herodotus in the 5th century BCE. Drilling and sediment analyses revealed loamy to clayey deposits with a thickness of up to six meters near the northern and southern enclosures of the Temple of Bastet. 2D electrical surveying confirmed the drilling results, indicating trenched layers of low resistivity values. The recovered deposits were interpreted as fluvial/limnic sediments, most likely deposited in a very low energy fluvial system, e.g., a canal or lake. Evidence of these sediments in numerous boreholes allowed the reconstruction of two separate sacred canals both north and south of the Temple of Bastet. In addition to the course, the width of the canals of about 30 m fit Herodotus' description of the sacred waterways. The presence of numerous artefacts, such as ceramic and limestone fragments or charcoal in the fluvial/limnic sediments, proved the anthropogenic use of the ancient canals. Presumably, these waterways were connected to the Nile through a tributary or canal located north or northwest of the temples of Bastet and Pepi I.

Keywords: Ancient Egypt; Tell Basta; Isheru; Sacred Lakes; Herodotus; ERT; Drilling

Presentation time: Friday, October 1, 2021 – PICO: 11.30 - 11.31 am, individual discussion: 3.10 - 4.45 pm

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[P30]

Reconstructing Landscape, Climate and Human History in Semi-Arid Mongolia using a Multi-Proxy Biomarker Approach

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Humans have become a major factor during the Anthropocene, controlling landscape and environmental changes. Especially semi-arid regions are expected to suffer increasingly from human-induced climate and environmental changes during the next decades. Therefore, a better understanding about past climate and anthropogenic influences in such regions is essential, what holds particularly true for semi-arid Mongolia. This region is highly sensitive for the consequences of global warming and strongly increased human activity including soil erosion and pressure on natural resources.

To address those issues, we present our recently funded DFG project that aims at reconstructing climate and human-induced landscape changes in semi-arid Mongolia, and to disentangle between both effects by using a multi-proxy biomarker approach on lake sediments. The project will use the very promising ∼8 ka sediment core from Lake Shireet Naiman Nuur, an endorheic high-altitude lake with a small catchment in the central Mongolian Khangai Mountains. Here we present first chronological, sedimentological and geochemical results, and we especially give a general overview of the project that includes the following multi-proxy biomarker approach: i.)

We will establish the best possible chronology by ^{14}C-dating of terrestrial macrofossils and compound-specific radiocarbon analyses of specific terrestrial and aquatic biomarker compounds. Comparison of the different ^{14}C-ages will give valuable chronological information about the timing of sediment deposition, but also about potential "mean transfer times" of organic/biomarker material through the catchment, i.e. as an indicator for soil erosion. ii.) The presence of humans and their livestock in the lake catchment and their potential influence on landscape changes and

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soil erosion will directly be traced by fecal biomarkers analyses. iii.) We will finally reconstruct the palaeoclimatic background signal by compound-specific isotope analyses of δ^2H on terrestrial and aquatic biomarkers to disentangle climatic and anthropogenic signals.

Keywords: Mongolia; Lake Sediments; Biomarker; Compound Specific Isotope Analyses; Compound Specific Radiocarbon Analyses

Presentation time: Friday, October 1, 2021 – PICO: 11.32 - 11.33 am, individual discussion: 3.10 - 4.45 pm

[P31]

Human-environment Interactions Since Medieval Times Recorded by the Landslide-dammed Lago di Vedana (Dolomites, NE Italy)

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The second-largest rock avalanche of the Dolomites - the Monte Peron Landslide near Belluno – created a landslide-dammed lake almost 3000 ka ago. Its successor is Lago di Vedana, a lake that archived human-environment interactions from today back to Medieval times. In this study, we apply high-resolution limnogeological and geochemical techniques to investigate these lacustrine sediments with the aim of unveiling the regional post-landslide evolution of the landscape. Eutrophication of a clastic (river-fed) and oligotrophic lacustrine ecosystem started around AD 1150 with intensified human occupation related to establishing a guesthouse for travellers. This process ended ca 150 years later, when the river was diverted back into its original bed. Most likely, this occurred due to the artificial opening of a river dam that blocked the natural river course since the emplacement of debris from the rock avalanche. In consequence, Lago di Vedana was isolated from an open lake with the dominance of minerogenic deposits to a much smaller and endorheic lacustrine system with organic and carbonaceous sediments. After the monastery Certosa di Vedana was founded in the vicinity of the lake in AD 1456, a second and intensified eutrophication process was initiated due to land-use change linked to construction work and deforestation. Deposition of organic matter decreased in the 18th and 19th centuries AD, a process coinciding with climatic (the climax of the Little Ice Age) as well as with cultural and political changes (fall of the Venetian Republic, Napoleonic Kingdom, Habsburgian reign, Kingdom of Italy), which caused an interruption of monastic activities for more than a century. Conversational measures are the likely reasons for a trend towards less eutrophic conditions since AD 1990. However, accumulation rates of organic matter display a distinct signal related to the “Great Acceleration” of the Anthropocene.

Keywords: Landslide; Lake Sediments; XRF Scanning; Cultural Eutrophication; Late Holocene; Italy

Presentation time: Friday, October 1, 2021 – PICO: 11.34 - 11.35 am, individual discussion: 3.10 - 4.45 pm

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[P32]

Earthworms, Darwin, and Prehistoric Agriculture - Chernozem Genesis Reconsidered

Stefan Dreibrodt* [1], Robert Hofmann[1], Marta Dal Corso[1], Hans-Rudolf Bork[1], Rainer Duttmann[1], Lorenz Schwark[1], Michail Videiko[2] Marie-Josée Nadeau, Pieter Meiert Grootes, Wiebke Kirleis, Johannes Müller

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Chernozems are among the most fertile agricultural soils on Earth and are important terrestrial carbon reservoirs. Since the Miocene-advent of grassland-ecosystems, they develop on fine-grained calcareous parent materials, generally in continental climates. So far, no theory explains all Chernozem occurrences. This limits, e.g., modelling of their long-term soil carbon dynamics. Insights gained on Chernozems that buried prehistoric archaeological features in central Ukraine provide a key. Prehistoric agriculture favoured anecic earthworm abundance, and anecic earthworm surface casting delivers the best explanation for coeval Chernozem genesis, its properties, and distribution, an idea originally put forward by Darwin. While zonal Chernozems form under climate conditions that exclude epigeic and endogeic earthworms naturally, the patchy and time-transgressive azonal European Chernozem occurrences would reflect sites where the proliferation of anecic earthworms at the expense of the former ecological groups resulted from early Anthropocene landscape transformations. We will have to add anecic earthworms to the Neolithic Package that identifies the socio-economical transformations related to sedentarism and evolving agrarian production modes of cereal cultivation and animal husbandry.

Keywords: Chernozem; Anecic Earthworms; Soil Formation; Trypillia Chalcolithic Giant Settlement Sites; Anthropocene; Central Ukraine

Presentation time: Friday, October 1, 2021 – PICO: 11.36 - 11.37 am, individual discussion: 3.10 - 4.45 pm

*Speaker

[P33]

Bringing Light into the Darkness – Chernozem Evolution in Central Germany Clarified by Single-Grain Luminescence Data

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Chernozems are among the most productive soils worldwide, as they unite several favourable factors such as high fertility, favourable pH, a granular structure and high moisture retention capacity. Therefore, they typically show a high agrarian value and often provide long records of intensive human land-use reaching back several millennia.
However, many important aspects regarding chernozem formation – e.g. whether natural or human factors were more important - are still poorly understood (Eckmeier et al. 2007). One important drawback in this context is the lack of powerful methods to get grip on timing and rates of chernozem evolution. Recently, it has been suggested that the nexus of soil mixing and soil evolution can be clarified through single-grain luminescence analyses (Reimann et al. 2017). In this study, we apply that protocol for the first time to two chernozem profiles in southern Saxony-Anhalt (Central Germany) that were buried by the Early Bronze Age burial mound Bornhöck ca. 3.8 ka. Our goals were (i) to test the newly developed luminescence methodology, and if successful, (ii) to date start and stop of chernozem formation. First results suggest that chernozem formation probably started during the early Holocene and ceased between ca. 5.5 and 5.0 ka. Furthermore, our data demonstrate that chernozem formation was characterized by very intensive vertical soil mixing, most likely related to intensive bioturbation. Already at this stage of research, we can confidently conclude that we are able to trace key processes of chernozem formation through the analyses of single-grain luminescence data.

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Keywords: Geoarchaeology; Palaeopedology; Chernozem Soils; Luminescence Dating; Central Germany

Presentation time: Friday, October 1, 2021 – PICO: 11.38 - 11.39 am, individual discussion: 3.10 - 4.45 pm

[P34]

The Late Weichselian- to Holocene Transition at the Elbe-valley near Dresden – Linking Sediments, Soil Formation and Archeology

Christian Tinapp* [1], Johnnes Selzer[2], Susann Heinrich[3], Norman Döhlert-Albani[1], Birgit Fischer[4], Tobias Lauer[3], Birgit Schneider[2], Frauke Kreienbrink[1], Harald Stäuble[1]

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In the course of the EUGAL-pipeline project, a sedimentary sequence representing the transition from the late Weichselian to the Holocene was exposed and excavated in the Elbe valley near Coswig (located north-west of Dresden). The archaeological findings indicate multiple occupation periods in the study area during the Early Mesolithic (including a chipping floor), the Early- and Middle Neolithic as well as the Bronze- and Iron Age and the Slavic period. The sedimentary sequence was sampled for multi-proxy analyses including geochemistry and micromorphology, as well as for radiocarbon and OSL dating. The geochronological methods are in good agreement with each other and allow us to build up a robust chronological framework for the section. The results bring new light into the palaeoenvironmental shifts and fluvial processes at the transition from the Weichselian to the early Holocene, and illustrate the linkage between changing environments and human occupation.

Keywords: Geoarchaeology; Elbe Valley; Micromorphology; Fluvial Environments; OSL Dating

Presentation time: Friday, October 1, 2021 – PICO: 11.40 - 11.41 am, individual discussion: 3.10 - 4.45 pm

*Speaker

[P35]

Man-environment Interaction in the Bronze Age, North-eastern Poland

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The aim of the study is an interaction between man and environment in NE Poland (Podlasie Voivodeship) at Jatwieź Duża archaeological site of the Lusatian Urn Fields culture from the Late Bronze Age and Early Iron Age. The site is located on the youngest sandur plain which borders the valley bottoms of the Brzozówka river and its left-bank tributary, the Biebla River. This site is a part of the Prehistoric settlement network which includes 27 structures with similar construction and location features. They are founded on a circular plan with two areas - the protective zone consisting of a system of moats and embankments and the central zone consisting of a flat yard. At that time this region was an ecumene and the communities were the first to capture this area on a large scale by establishing an extensive and stable network of facilities. This is confirmed by data from the Archaeological Map of Poland for the microregion of the site (radius of 5 km from the site). Within this area, 64 points of community activity from the Bronze Age, 1 from the Mesolithic, 4 from the Neolithic, 9 from the Iron Age and 1 from the Middle Ages were recorded. This expansion, which has led to the remodelling of the nearby environment through extensive use of its resources for the needs of this community, can be observed in the catchment area of the river Brzozówka and its tributary Bieble (left-bank tributary, the Brzozówka River). Intensive deforestation of the area marked a decline in the organic matter content in the peats, which grew here since the Preboreal (9770–9180 BP). This change took place in the Brzozówka and Biebla valleys after 3660±50 and 1870±60 BP respectively.

Keywords: Archeology; Geoarchaeology; Environment; Bronze Age; Lusatian Culture; Jatwieź Duża Site

Presentation time: Friday, October 1, 2021 – PICO: 11.42 - 11.43 am, individual discussion: 3.10 - 4.45 pm

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[P36]

Changes of Selected Early Medieval Strongholds Around Przemyśl (SE-Poland) in the Anthropocene

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The Early Medieval strongholds in the Carpathians around Przemyśl are the old heritage of the borderland between the Polish Kingdom and the Kiev Rus, representing geotouristic attractions. The aim of the study was the fortification changes in the last centuries, especially in the Anthropocene.

The field prospection carried out in July 2021 allowed to capture differences and similarities in location, structure, and transformation of strongholds due to natural and anthropogenic processes. The most northern stronghold at Tuliglowy is a very extensive fortification covered with forest. The surroundings of it were strongly damaged as a result of forest management. The harvesting of trees by heavy machinery resulted in the formation of numerous ruts, which are cut during heavy rainfall. The defensive rampart was interrupted by a forest road, and locally it was destroyed by numerous fox's holes. There were also anthropogenic trenches, probably made by illegal artefact hunters. The fortified settlement at Nowosiólki Dydyńskie is located near Kalwaria Paclawska, one of the pilgrimage sites in Poland. A chapel was built on the hill fort, and internal ramparts were almost completely destroyed. Tourist erosion on the path to the chapel exposed the flysch basement, deeply cutting and removing the external rampart. The stronghold is also destroyed by the source funnel of the erosion valley ("debrza") and a landslide. The monumental hill fort at Trepcza is the best preserved. Its location is on a forested ridge watershed with very steep slopes. This significantly impedes access to it. There are no traces of present-day human activity and intense morphogenetic processes here. Only wind throw denudation was found.

The next step will be a visualisation with photos and maps by GIS tools. The idea of building hill forts in the Early Middle Ages is certainly an interesting question in geoarchaeological analyzes.

Keywords: Anthropocene; Przemysl; Medieval; Strongholds; Hill Forts; Carpathians

Presentation time: Friday, October 1, 2021 – PICO: 11.44 - 11.45 am, individual discussion: 3.10 - 4.45 pm

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[P37]

Occupation of a Middle Palaeolithic Cave Site in the Romanian Carpathians during MIS 6–5

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As one of the presumed corridors for dispersal of the Upper Palaeolithic into central and western Europe, southeastern Europe represents a key area to better trace the spatio-temporal spread of modern human lithic technologies in relation to the techno-complexes existing before, i.e. the Middle Palaeolithic. However, the record of Middle Palaeolithic collections in south-eastern Europe is rather sparse, and even fewer sites were radiometrically dated. The Karst region around the Varghis Gorges hosts a number of caves and rock shelters, such as the Abris 122 site, with archaeological sequences bearing considerable potential for providing important information on Middle Palaeolithic occupation and evolution as well as on associated palaeoenvironments. Previous dating attempts for the Abris 122 using infrared stimulated luminescence (IRSL) and optically stimulated luminescence (OSL) suggested a depositional age of at least marine isotope stage (MIS) 5 for one of the productive horizons. Here, we present new data for the Abris 122 rock shelter aimed at extending the existing temporal framework for human presence in the area. Three charcoal samples for radiocarbon dating and four sedimentary samples for OSL dating were collected in 2019. While radiocarbon dates span the range 25–11 ka cal. BP and are not in stratigraphic order, OSL samples taken from the same section (but covering a larger vertical distance) yield ages corresponding to MIS 7 to MIS 5. Considering the distribution of lithic artefacts and faunal remains in relation to the chronostratigraphy allows concluding that Middle Palaeolithic cave sites in the Romanian Carpathians were inhabited during both glacials and interglacials since at least MIS 6.

Keywords: Geoarchaeology; Romania; Middle Palaeolithic; Chronology

Presentation time: Friday, October 1, 2021 – PICO: 11.46 - 11.47 am, individual discussion: 3.10 - 4.45 pm

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Session 3

Through time and space: new methods and concepts in Quaternary research

Oral presentations

[Invited keynote]

Seeing the Past in a New Light: How Advances in Luminescence Geochronology are Shaping Our Understanding of the Hominin Record

Geoff Duller*† [1]

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Time underpins our view of the Quaternary, and throughout the development of Quaternary science, the chronological methods available to the community have had a profound impact upon the discipline. This presentation will focus on a number of key advances in our understanding of the hominin record that have been made possible using luminescence dating, such as the development of behavioural modernity in southern Africa, and the dispersal of anatomically modern humans from Africa across the Middle East and into Australia. A key theme that will be explored is what happens when geochronological methods reach their limits, and what we can learn from such occurrences. The presentation will also consider some current archaeological challenges and the potential for future advances in luminescence geochronology.

Keywords: Geochronology; Quaternary; Hominin Records; Geoarchaeology; Luminescence Dating

Presentation time: Friday, October 1, 2021 – 1.00 - 1.30 pm

*Speaker

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[O14]

Automatic Classification of Sediment Facies Applying Geochemical Data from Coastal Sediments (East Frisian Wadden Sea, Germany)

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Sediment facies provide fundamental sedimentological information in space and time, building the necessary background for environmental reconstructions. Conventional classification of sediment facies is based on macroscopic descriptions of physical and chemical properties performed by expert scientists. The general interest in sediment classification increases with rising interests related to sediment research, like studying climate variability and geomorphological evolution. However, conventional methods are more and more not efficient and objective enough for coping with this rising demand. Therefore, a new approach to assist scientists in classifying long sediment records is needed. This study implements machine learning techniques to develop an automatic sediment classification scheme that uses fast, non-destructive and high-resolution elemental data as input and delivers sediment facies as output. The database was built by 92 and up to 5 m long sediment cores from a tidal flat, channel and off-shore environments around the island of Norderney. These sediments were classified by the conventional method into 12 different facies, varying from Pleistocene terrestrial to Holocene shallow marine facies. Additionally, the elemental data were acquired by μXRF core scanning. After a series of pre-processing steps, the transformed data were investigated by supervised machine learning algorithms. Our study provides confusion and conjunction matrices to evaluate the classification machine's performance. The optimal machine with the highest accuracy is built by the Support vector machine algorithm based on the cross-validation result of a grid search. The optimised machine integrated with post-process has an accuracy (60 %) on the test set; promising when considering the moderate amount of ambiguous sediments. In addition, it offers confidence scores of classification for scientists to concentrate on sediments with low confidence levels instead of working through the entire sediment record. We expect our approach to contribute to the development of a more comprehensive and accurate automatic sediment-facies classification in the near future.

Keywords: Wadden Sea; μXRF Core Scanning; Machine Learning; Sediment Facies Classification

Presentation time: Friday, October 1, 2021 – 1.30 - 1.45 pm

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[O15]

Testing SEM-EDX on Experimentally Charred Biomass to Assess the Oxygen and Carbon Content as a Proxy for Paleofire Intensity Reconstructions

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Understanding the impact of forest fire intensity on active layer depth and post-fire recovery in permafrost regions is essential to assess fire impacts on sensitive ecosystems and landscapes. Whereas past fire events can, for example, be identified by peak analysis of charcoal accumulation rates (CHAR, e.g. Glückler et al., Biogeosciences, accepted), approaches to quantify the fire intensity have remained challenging. A common approach in the analysis of biochar properties that has not yet been applied to palaeofire research are observations of the oxygen and carbon content of charcoal produced by pyrolysis. Earlier studies have proposed that there is a negative correlation between the charring temperature and the oxygen-to-carbon (O/C) ratio of a sample. Here, we present our reproduction of a measurement series using artificially charred biomass samples of Larix needles and twigs and Poaceae under oxygen-restricted conditions. To determine the O and C content, we applied energy-dispersive X-ray spectroscopy (EDX), which is a fast and comparatively easy approach that can be performed with a scanning electron microscope (SEM) equipped with an EDX detector. We find that increasing charring temperatures did not always reveal a clear trend in O/C ratios. Accordingly, we address problems and solutions in the charring experiment setup and issues that come with the EDX measurement of carbon-rich samples. Future comparisons of laboratory values to those derived from a sedimentary charcoal record may prove as a promising method for quantitative palaeofire intensity reconstructions.

Keywords: Fire; Wildfires; Palaeofire; Charcoal; EDX; EDS

Presentation time: Friday, October 1, 2021 – 1.45 - 2.00 pm

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[O16]

^{18}O Analyses of Bulk Lipids as a Novel Palaeoclimate Tool in Loess Research - a Pilot Study

Jakob Labahn*† [1], Philip Hirschmann[1], Lucas Bittner[1], Christopher Roettig[1], Diana Burghardt[2], Slobodan Markovic[3], Bruno Glaser[4], Michael Zech*[1]

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The analysis of the stable oxygen isotopes ^{18}O and ^{16}O has revolutionised palaeoclimate research since the middle of the last century. Particularly, ^{18}O of ice cores from Greenland and Antarctica is used as a palaeotemperature proxy and ^{18}O of deep-sea sediments is used as a proxy for global ice volume. Important terrestrial archives to which ^{18}O as palaeoclimate proxy is successfully applied are speleothems, lake sediments or tree rings. By contrast, ^{18}O applications to loess-palaeosol sequences (LPSs) are scarce, despite for instance a compound-specific ^{18}O analytical tool for sugar biomarkers was developed and presented already years ago (Zech et al., 2014). Here we present a first continuous ^{18}O record (n=50) for the LPS Crvenka in Serbia, SE Europe, spanning the last glacial-interglacial cycle. From a methodological point of view, we took advantage of a recently proposed palaeoclimate/-hydrological tool/proxy based on bulk ^{18}O analyses of plant-derived lipids. The ^{18}O lipid values range between $-10.2\,‰$ and $+23.0\,‰$ and are systematically more positive in the interglacial and interstadial (paleo-)soils compared to the loess layers. In our presentation, we compare our ^{18}O lipid record from the LPS Crvenka with the marine oxygen-isotope stages as well as with the Greenland ^{18}O ice core records revealing the famous Dansgaard-Oeschger events (stadials and interstadials). Concerning the interpretation of our LPS ^{18}O lipid record, we will discuss several influencing factors, such as temperature-control on ^{18}O, evaporative leaf water enrichment, post-sedimentary effects and pool-effects.

Keywords: Oxygen; ^{18}O; Stable Isotopes; Loess; Palaeosol; Lipid; Palaeoclimate; Palaeohydrology; Water Balance

Presentation time: Friday, October 1, 2021 – 2.00 - 2.15 pm

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[O17]

Implication of Mammoth Teeth in Palaeoenvironmental Reconstructions at Different Temporal Resolutions

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Stable isotopes from mammalian tooth carbonate have been increasingly implemented in archaeological and paleontological studies for palaeoenvironmental and palaeoecological reconstructions in the past decades. However, there are relatively few studies that focused on local, sub-annual palaeoclimatic variations, as they require archives of particularly high temporal resolution. In this paper, we explored the potential of mammoth tooth enamel in reconstructions of palaeoenvironmental and palaeoclimatic conditions at various temporal scales. Three molar teeth of woolly mammoth (*Mammuthus primigenius*) discovered in South-West Germany were analysed for oxygen (δ^{18}O) isotopic compositions. The samples were radiocarbon dated to fit into three different time windows during the Marine Isotope Stage 3 (MIS 3). Temporally successive enamel powder was drilled and analysed for time-series of δ^{18}O oscillations, and we effectively interpreted the sequential isotopic data into environmental parameters such as seasonality and season durations. Comparisons of these palaeoclimatic parameters at intra-enamel, intra-tooth and inter-individual levels enabled palaeoenvironmental reconstructions at sub-annual, decadal and millennial scales, respectively. These results consummated our understandings of MIS3 climatic conditions, as well as demonstrated the massive palaeoenvironmental information preserved in mammoth teeth, which have an abundant reserve and can be employed as the archive to construct a high-resolution Quaternary database.

Keywords: Palaeoenvironments; Palaeoclimates; Stable Isotopes; Quaternary; Germany; Woolly Mammoth

Presentation time: Friday, October 1, 2021 – 2.15 - 2.30 pm

*Speaker
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Session 3

Through time and space: new methods and concepts in Quaternary research

PICO

[P38]

Sandbox – Creating and Analysing Synthetic Sediment Sections with R

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Geoscientific concepts and hypotheses are usually formulated based on empirical data from the field or the laboratory (induction). After translation into models they can be applied to case study scenarios (deduction). However, the other way around – expressing hypotheses explicitly by models and test these by empiric data – is a rarely touched trail. There are several models tailored to investigate the boundary conditions and processes that generate, mobilise, route and eventually deposit sediment in a landscape. Thereby, the last part, sediment deposition, is usually omitted. Essentially, there is no model that explicitly focuses on mapping out the characteristics of sedimentary deposits – the material that is used by many disciplines to reconstruct landscape evolution. The R package sandbox is a model framework that allows creating and analysing virtual sediment sections for exploratory, explanatory, forecasting and inverse research questions. sandbox is a probabilistic and rule-based model framework for a wide range of possible applications. It has been advanced and linked to another model to allow the full work flow of modelling luminescence measurements. This contribution introduces news about recent developments and shows a set of applications.

Keywords: Modelling; Depositional System; Software; Chronology

Presentation time: Friday, October 1, 2021 – PICO: 2.30 - 2.31 pm, individual discussion: 3.10 - 4.45 pm

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[P39]

3D Architecture of the Critical Zone and Its Relationship to the Water Balance: Possible Inferences for Climate Change

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The surface of the Earth is modified chiefly by tectonics, water, and gravity. The forces in operation today are mostly responsible for the evolution of the Earth's surface to the condition we find it in, as well as its alterations through the Quaternary. Spatiotemporal scaling equations generate the integrated lengths of rivers subject to tectonic driving forces of disaggregation (shearing, rifting, and collisions), as well as the depth of the weathering zone, linking time scales for water to traverse a pore to such architecture on the time scale of a Wilson tectonic cycle. These same scaling equations can be used in combination with an optimisation of the Net Primary Productivity (NPP) to generate the water balance, as long as steady-state conditions apply. We will attempt to answer questions as to how this perspective can inform Quaternary studies and the understanding of how the water balance may change for predicted climate change scenarios. Since the organisation of drainage basins is relevant to flooding, water resources, landforms, sediment transport and isostatic adjustment to erosion and deposition, it is important to understand the general principles that affect this organisation over a wide range of time scales. What this theoretical development has to offer on its own, is the rough outlines of drainage basin dimensions and critical zone depth, but a compatible model, known as the Optimal Channel Model (Cieplak et al., 1998), yields a suite of Horton-Shreve scaling relationships in reasonable agreement with observation as well as the same Hack's law exponent and sinuosity as the present treatment. In any case, demonstrating a link between the immense time scales of the break-up of supercontinents and pore-scale flow rates may be interesting of its own accord.

References

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Keywords: Critical Zone; Water Balance; Climate Change

Presentation time: Friday, October 1, 2021 – PICO: 2.32 - 2.33 pm, individual discussion: 3.10 - 4.45 pm

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★Poster award★

[P40]

Tailor-Made Multivariate Geochemical Applications Tested at the new Schwalbenberg Key Loess-Palaeosol-Sequence (Middle Rhine Valley, Germany)

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Loess-Palaeosol-Sequences (LPS) are valuable climatic and environmental archives, well-known to reflect cold conditions in favour for loess formation and milder climates associated with pedogenesis in the terrestrial realms. Although this rationale holds true in most cases, Gelic Gleysols reflecting embryonic soils have been correlated to contrasting conditions including the coldest stages of stadials and milder conditions, e.g. prevailing during interstadials. From a geochemical perspective, each environment should leave traces in LPS. It is, however, challenging to quantify environmental signals from loess-geochemistry due to a plethora of processes that operate on different temporal and spatial scales, and which affect several mineral components. To account for this, we applied a multivariate geochemical approach on the 30 m long new key-LPS REM 3 from the Schwalbenberg site (Remagen, Middle Rhine valley, Germany). The Schwalbenberg LPS records millennial to sub-millennial scale climatic and environmental changes during

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the Upper Pleistocene. We integrate element ratios indicative of provenance shifts, sediment reworking dynamics and weathering into multivariate analysis. Principal Component Analyses (PCA) and Linear Discriminant Analysis (LDA) are applied to sub-datasets, comprising similar diagnostic sediment units. Combined PCA and LDA and the existing age model facilitate differentiation of provenance shifts, sediment relocation, decalcification, brunification and formation of clay minerals and their temporal succession. To address initial pedogenesis, we designed the Ca/Dithionite soluble Al = Ca/AlDith ratio, promising to be susceptible, e.g., for brunification intensities and feldspar weathering. Our results confirm that Gelic Gleysols may develop during contrasting environmental conditions, and we show that it is possible to distinguish between Gelic Gleysols formed during interstadials and stadial periods. Our systematic approach can be fitted to specific research questions and serves as a key for studying the timing and intensity of terrestrial processes under changing climatic and environmental conditions.

Keywords: Loess; Geochemistry; Climate; Multivariate Statistics

Presentation time: Friday, October 1, 2021 – PICO: 2.34 - 2.35 pm, individual discussion: 3.10 - 4.45 pm

[P41]

Luminescence Profiling and Sedimentological Investigations on (Paleo-)lacustrine Landforms at Schweriner See, NE-Germany

Marie-Luise Adolph*† [1], Reinhard Lampe[1], Sebastian Lorenz[1], Torsten Haberzettl[1]

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We investigated four subaerial (paleo)lacustrine landforms to reconstruct lake-level changes at Schweriner See, NE-Germany. Landforms included two beach ridges, one subaerial nearshore bar and a silting up sequence located close to a fossil cliff, which marks the former maximum extent of the Schweriner See.

We used luminescence profiling with a SUERC Portable OSL device (POSL) on all sediment sequences, and combined it with sedimentological methods (grain size, loss-on-ignition and magnetic susceptibility) to provide information on various formation mechanisms in the lacustrine depositional environment. The POSL reader was used on pre-treated polymineral samples to gain an insight into luminescence distribution within the individual sediment sequences. It was also used to compare the four sequences with each other. POSL proved valuable to understand depositional processes, which were not visible in lithology or sedimentological parameters. With somewhat larger uncertainty this method provides relative age chronologies of the sediment sequences. Additionally, we carried out radiocarbon dating and full optical stimulated luminescence (OSL) dating to establish a chronological framework for lake-level changes at Schweriner See.

OSL ages proved to be more reliable to date the lacustrine landforms in this setting than radiocarbon samples, which were severely influenced by sediment reworking. The combined approach of sedimentological analyses, luminescence profiling and absolute age determination revealed details in depositional processes at Schweriner See which otherwise would have remained undetected.

Keywords: Lake Level Variations; SAR; OSL Dating; POSL; Portable OSL; Beach Ridge Stratigraphy; Beach Ridge

Presentation time: Friday, October 1, 2021 – PICO: 2.36 - 2.37 pm, individual discussion: 3.10 - 4.45 pm

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[P42]

Half Precession Signals in Lake Ohrid (Balkan) and their Spatio-temporal Relations to Climate Records from the European Realm

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Lake Ohrid (North Macedonia/Albania) is Europe's oldest lake and thus is a valuable archive for changes of local (hydro)climate during the last 1.36 Ma (e.g., Wagner et al., 2019). During an International Continental Scientific Drilling Program campaign in 2013, geophysical downhole logging by the Leibniz Institute for Applied Geophysics acquired continuous datasets of physical properties. Additionally, sediment cores from four sites were obtained, the deepest with a length of 570 m (Wagner et al., 2014). Investigations of half-precession (HP) cycles (∼ 9,000–12,000 a) have been given a subordinate role in previous cyclostratographic studies.

Here we focus on HP signals in Lake Ohrid and investigate the temporal variability of this signal over the last one Ma. Next to a connection of HP cycles to interglacials, we see a more pronounced HP signal in the younger part of several proxy records. We relate the results from Lake Ohrid to a variety of proxy records from the European mainland and marine records. The HP signal is to some extent present in all of the investigated sites but we observe a more pronounced HP signal in the southeast compared to records from high latitudes. HP cycles are a relevant part of natural climate variability - also in Europe - and allow a more detailed investigation of sedimentary systems.

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Keywords: Cyclotratigraphy; Half Precession; Time Series Analysis; Europe; Lacustrine Sediments

Presentation time: Friday, October 1, 2021 – PICO: 2.38 - 2.39 pm, individual discussion: 3.10 - 4.45 pm

[P43]

Mapping Buried Palaeogeographical Features of the Nile Delta (Egypt) Using the Landsat Archive

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The contribution highlights the use of Landsat spectral-temporal metrics (STMs) to detect surface anomalies that are potentially related to buried near-surface palaeogeomorphological deposits in the Nile Delta (Egypt), in particular for a buried river branch close to Buto. The processing was completed in the Google Earth Engine (GEE) for the entire Nile Delta and selected seasons (summer/winter) using Landsat data from 1985 to 2019. We derived the STMs of the tasselled cap transformation (TC), the Normalised Difference Wetness Index (NDWI), and the Normalised Difference Vegetation Index (NDVI). These features were compared to historical topographic maps of the Survey of Egypt, CORONA imagery, the digital elevation model of the TanDEM-X mission, and modern high-resolution satellite imagery. The results suggest that the extent of channels is best revealed when differencing the median NDWI between summer (July/August) and winter (January/February) seasons (ΔNDWI). The observed difference is likely due to lower soil/plant moisture during summer, which is potentially caused by coarser-grained deposits and the morphology of the former level. Similar anomalies were found in the immediate surroundings of several Pleistocene sandhills ("geziras") and settlement mounds ("tells") of the eastern delta, which allowed some mapping of the potential near-surface continuation.

Keywords: Remote Sensing; Nile Delta; Time Series; Landscape; Google Earth Engine

Presentation time: Friday, October 1, 2021 – PICO: 2.40 - 2.41 pm, individual discussion: 3.10 - 4.45 pm

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[P44]

The Middle Pleistocene Site of Bilzingsleben – New Insights into Chronology and Site Formation

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The Middle Pleistocene site of Bilzingsleben, located in Thuringia (Germany), was discovered at the beginning of the 20th century when geologists and palaeontologists reported the exposure of Pleistocene animals bones and Nordic flints at the site. After the unearthing of the first human fossils in the 1970s, the site was recognised as one of the most important Central European sites for the study of early humans. Since then, multi-disciplinary investigations have been carried out in order to gain insights into the site formation, the lithic artefact assemblage as well as the faunal remains and the palaeoenvironment. One of the critical issues, highly debated, is the radiometric age of the site, as well as the deposition and formation of the travertine sands containing the flints, animal and human bones. Lithostratigraphically, the sediments clearly post-date the Elsterian glacial cycle and should correspond biostratigraphically to a Middle Pleistocene interglacial, likely either MIS 11 or MIS 9. However, the exact chronological position remained unclear. We, therefore, conducted further radiometric dating at Bilzingsleben using luminescence- and infrared-radiofluorescence dating on K-feldspar from the travertine sands, in combination with amino acid analysis on four individual *Bithynia tentaculata* opercula. To clarify the depositional context, we performed micromorphological analyses and studied fabrics as well as vertical distribution patterns of bones and rocks. The latter analyses indicate that the find-bearing layer was created by natural processes, which is also supported by the former. The results obtained from the optical dating (around 350 ka and 400 ka) point to deposition of the find-bearing sands prior to MIS 9. We regard these ages as minimum ages due to the reworking of the dated sediments. In combination with the amino acid geochronology, our investigation lends further support to an MIS 11 age for Bilzingsleben.

Keywords: Middle Pleistocene; Luminescence Dating; IR-RF; Micromorphology; Amino Acid Analysis

Presentation time: Friday, October 1, 2021 – PICO: 2.42 - 2.43 pm, individual discussion: 3.10 - 4.45 pm

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★Poster award★

[P45]

On the Potential of Infrared-radiofluorescence (IR-RF) for Dating Quaternary Sediments

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Few techniques are appropriate for dating deposits of Middle Pleistocene age or older. Within the suite of routinely used luminescence dating methods, the only one which ranges that far is infra-red stimulated luminescence (IRSL) of potassium feldspar, which determines the last time the mineral grains were exposed to sunlight. However, a part of the IRSL signal is unstable due to a phenomenon termed anomalous fading, which leads to severe age underestimations if not accounted for. Whereas it is possible to isolate signal components with reduced anomalous fading, correction procedures are often still necessary and reduce the precision of resulting ages, especially for old samples. An alternative dating method currently in development is the radiofluorescence (RF) of potassium feldspar, in particular the infra-red (IR) RF emission, which reportedly requires no correction for anomalous fading. This technique holds much promise for the dating of Quaternary sediment deposits, as initial results suggest an upper dating limit of ∼ 2–3 million years. Significant methodological advances have been achieved since the technique's first introduction in the late 90's, such as automated instrumentation, the determination of appropriate measurement parameters and open-source data analysis tools. However, several aspects still require further investigation before the technique can be routinely applied, such as more thorough studies on anomalous fading, including possible sample-dependence; better understanding of the efficacy of signal zeroing prior to burial; and the spectrometric composite nature of the signal. This contribution will detail the advantages of IR-RF dating and address the challenges that still need to be overcome.

Keywords: Luminescence Dating; Infrared Radiofluorescence; Geochronology; Middle Pleistocene

Presentation time: Friday, October 1, 2021 – PICO: 2.44 - 2.45 pm, individual discussion: 3.10 - 4.45 pm

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[P46]

Quantifying Human Impact on $^{14}C/^{12}C$ Ratios by Comparing Suess Effect and Human Development Index

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Decreasing levels of the radioactive isotope ^{14}C in the atmosphere are known as the Suess Effect, and are widely used as a proxy for human interference with the atmosphere by combusting fossil fuels, in which all ^{14}C has already decayed. The Human Development Index (HDI) describes a country's prosperity by calculating a geometric mean of the life expectancy index, the education index, and the Gross National Income. It is widely accepted that there is a connection between industrial developments and global warming. I aim to test this hypothesis by comparing countries' atmospheric $^{14}C/^{12}C$ ratios with their corresponding HDI's. I expect countries with high HDI's and great export commodities to combust most fossil fuels and therefore to have lower ^{14}C levels. Atmospheric ^{14}C levels will be determined by measuring $^{14}C/^{12}C$ ratios of soil organic carbon (SOC) and soil inorganic carbon (SIC) - e.g., in rhizoliths - using AMS. Soil samples will be acquired from ten places of a single country each, which are differently exposed to fossil fuel combustion. This ensures a more precise statistical interpretation. The median of these ten $^{14}C/^{12}C$ ratios will be compared with the HDI of the respective country by linear regression. Due to climatic changes in the past century and its concomitant weather extremes, it is important to establish a quantified data set that demonstrates an interaction between economic and climatic developments, and which is comparable worldwide.

Keywords: ^{14}C; Suess Effect; HDI; SOC; SIC

Presentation time: Friday, October 1, 2021 – PICO: 2.46 - 2.47 pm, individual discussion: 3.10 - 4.45 pm

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[P47]

The Last 30,000 to 600,000 Years Ago: Unravelling the Timing of Human Settlement for the Palaeolithic Site of Kozarnika

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Kozarnika cave is a renowned prehistoric site in the Balkans. It contributes significantly to our understanding of the human past due to its rich assemblages associated with the Lower to Upper Palaeolithic periods. The cave was first mentioned in the prehistoric survey carried out before 1933. Years after, in 1996, the site was excavated systematically by Bulgarian-French researchers (Guadelli et al., 2005).

Notably, various chronological dating methods have been employed alongside the excavation to unravel the timing of human occupation in Kozarnika. Radiocarbon dating was applied to unfold the timeframe for the Kozarnikian tradition uncovered in the Upper Palaeolithic sequence of the cave, and palaeomagnetic dating assigned the Brunhes-Matuyama reversal to the layer beneath the Lower Palaeolithic assemblages with the age of 780 ka (Muttoni et al., 2017)

This study presents our contribution of employing luminescence-dating methods (OSL, IRSL, pIRIR, VSL, IR-RF) to unravel reliable timeframes for several geological units and archaeological

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assemblages. A vast body of techniques has been put together, enabling us to date sediment samples containing the assemblages attributed earlier to the Upper, Middle, and Lower Palaeolithic periods (Guadelli et al., 2005; Sirakov et al., 2010). Our results unravelled that the inhabitants of Kozarnika occupied that region from ca 30 ka to ca 600 ka, showing general accordance with the previous dating.

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Keywords: Luminescence Dating; Kozarnika; Palaeolithic; VSL; IR-RF

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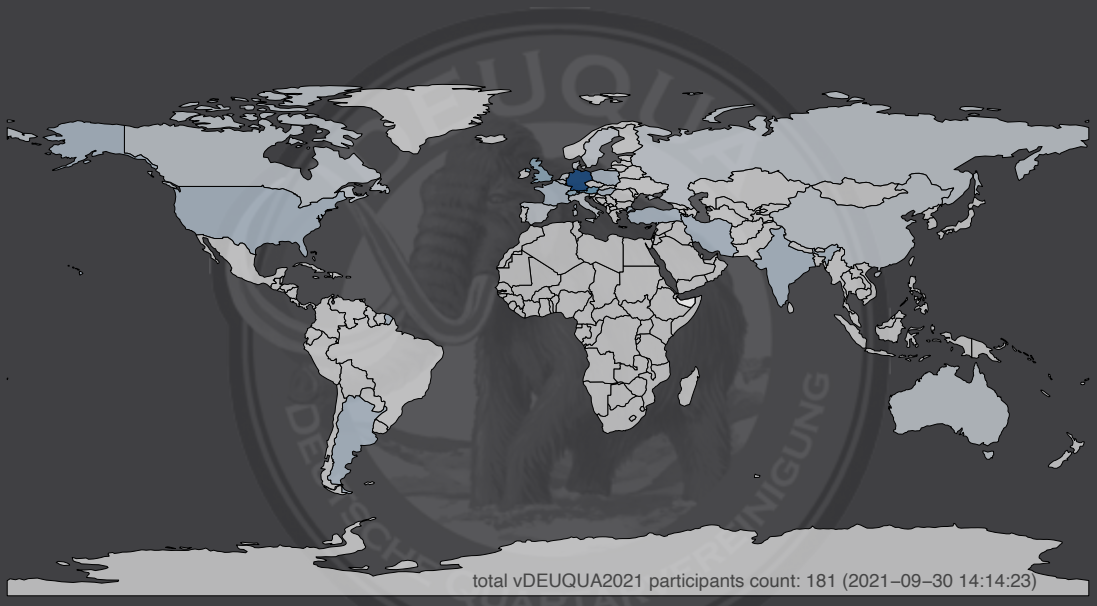

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