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Ancient TL

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Thesis Abstracts

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Joseph Alexander Winzar

Spatially-resolved luminescence and chemistry of feldspars relevant for dating

September 2025

Aberystwyth University, Aberystwyth, UK

Degree: Ph.D.

Supervisors: Geoff Duller, Helen Roberts

Spatially-resolved luminescence and chemical measurement and analysis techniques present exciting opportunities for luminescence research and dating, such as the targeting of feldspars with favourable characteristics within polymineral aliquots and the ability to directly link luminescence behaviour to mineral chemistry at micron-scale resolution. However, the benefits of these techniques are not yet established, and several challenges must be addressed before they can be routinely applied. This thesis develops spatially-resolved luminescence and chemical methods for materials commonly used in luminescence dating (sediments and rock slices) and characterises Infrared Stimulated Luminescence (IRSL) and Infrared Photoluminescence (IRPL) in feldspars with differing chemistry and structure. These investigations inform the application of spatially-resolved techniques for fundamental luminescence research and dating, enabling their potential to be realised and critically assessed.

This thesis demonstrates that micro X-ray Fluorescence (μXRF) spectrometry can assess the concentrations of elements relevant to luminescence research in feldspars when presented in solid samples (e.g. rock slices). However, accurate measurement of these elements in sediment grains requires new approaches, which are developed here. Measurement and analysis of luminescence images acquired using Electron-Multiplying Charge Coupled Devices (EMCCDs) also require careful consideration due to spatially variable heating in the luminescence reader, EMCCD hotspots, and sample movement between measurements. Approaches are developed to address these challenges, including software for evaluating the accuracy of image registration in absolute terms and for correcting hotspots in EMCCD images in a quantitatively robust manner.

Investigation of IRSL and IRPL behaviour in a suite of 19 hand specimens of feldspar shows that IRSL signals generally grow to larger β-doses and optically reset more rapidly than IRPL signals, but are less intense and more susceptible to anomalous fading. Positive correlations between Fe content and fading rates, and the more beneficial IRSL and IRPL behaviour generally observed in K-rich feldspars, indicate that targeting K-rich, low-Fe feldspars is likely to produce the most favourable IRSL and IRPL characteristics for dating.

Applying these methodological developments and fundamental insights with bespoke software, combined EMCCD imaging and μXRF scanning reveal micron-scale variability in luminescence behaviour and chemistry across feldspar slices. When applied to single feldspar grains from sediments, ages derived from spatially-resolved luminescence and chemical data are more consistent with independent ^{14}C age control than those from non-spatially-resolved methods. This improvement largely arises from more accurate β-dosimetry, achieved by determining individual internal β-dose rates for each grain using μXRF rather than Geiger Müller counting of bulk-separated sediment. Ages obtained using IRPL were also consistent with fading-corrected IRSL ages and the independent age control, demonstrating its ability for dating. Overall, this thesis demonstrates the utility of spatially-resolved luminescence and chemical measurements for both fundamental luminescence research and dating, whilst highlighting areas requiring further development before routine and reproducible application across the wider field is possible.

A PDF of this thesis can be downloaded from: https://research.aber.ac.uk/en/studentTheses/spatially-resolved-luminescence-and-chemistry-of-feldspars-releva/

Leland Reisfield

Luminescence Dating of Sedimentary Deposits at Lobolo in the Turkana Basin (Kenya)

December 2025
Stony Brook University, Stony Brook, USA
Degree: Masters
Supervisor: Marine Frouin

The western shoreline of Lake Turkana in northern Kenya holds significant geological records that are critical for understanding the timing of environmental change and human adaptations. Despite the region's global prominence in paleoanthropological research, the geochronology and sedimentary history of the Lake Turkana marginal deposits from the Late Pleistocene to the Holocene remain poorly constrained. This study focuses on the Lobolo area, on the western margin of Lake Turkana, a location of significance for paleoanthropological study. The objectives of this thesis are twofold: (1) to establish the timing of sediment accumulation through luminescence dating, (2) and to determine the depositional processes and provenance of sediments at Lobolo. In 2022, 14 sediment samples were collected from three exposures for luminescence dating as well as ... for radiogenic isotope analyses. While quartz-based OSL dating could not be applied due to signal saturation, equivalent doses (D_e) were measured on potassium-rich feldspar using three protocols: the IR_{50} protocol and two post-infrared infrared stimulated luminescence (pIRIR) dating protocols: $pIRIR_{225}$ and $pIRIR_{290}$. The dose rate estimates were determined via ICP-MS analysis. The fading-corrected IR_{50} ages are consistent with the $pIRIR_{225}$ ages at $1\,\sigma$, while the $pIRIR_{225}$ ages are consistent with the $pIRIR_{290}$ ages at either 1 or $2\,\sigma$. However, the IR_{50} signals are close to saturation, and the $pIRIR_{290}$ ages are likely affected by incomplete bleaching. We therefore consider the $pIRIR_{225}$ ages to provide the most reliable estimate of the burial age of the feldspar grains. Across the three sections, these ages range from 94.8 ± 7.3 ka to 83.1 ± 6.1 ka.

Sedimentological analyses, including grain-size distributions, petrographic microscopy, SEM imaging, and Sr-Nd isotopic compositions, indicate that the Lobolo deposits formed as part of an extensive deltaic complex, potentially constructed by the Turkwel River along the western margin of Lake Turkana during the Late Pleistocene. Following this period, we hypothesize that the Turkwel River likely underwent a major reorganization, shifting from a predominantly south-to-north flow direction to its modern west-to-east course toward Lake Turkana. This hydrological reorganization was accompanied by tectonic activity along the western margin of the basin, resulting in fault displacement and the preservation of contemporaneous deposits at different elevations. The three studied sections therefore do not represent separate depositional episodes but rather lateral facies variations within the same deltaic system.

These findings have important implications for understanding the Late Pleistocene history of the Turkana Basin. Deposits dating to this interval are rare and poorly constrained, leaving a significant gap in the geological and paleoenvironmental record. Beyond refining the evolution of the western Turkana margin, this work provides a chronological and environmental framework that will be essential for future efforts to place important paleoanthropological discoveries from the Lobolo region into their proper geological context.

A PDF of this thesis can be downloaded from: https://www.proquest.com/docview/3306661870?fromopenview=true&pq-origsite=gscholar&sourcetype=Dissertations%20&%20Theses

Alastair Goodship

Ice-sheet retreat and evolution of the postglacial landscape in northeast Finland and Norway – integrating portable optically stimulated luminescence and remote sensing

January 2026
University of Southeastern Norway, Bø, Norway
Degree: Ph.D.
Supervisors: Johanna Anjar, Helena Alexanderson, Endre Før Gjermundsen, Hans Renssen

The future of the Greenland Ice Sheet (GIS) and Antarctic ice sheets (AIS), and the land they cover, has been an increasing focus of climate research over the last 30 years. How these massive bodies of ice respond to global warming will have a profound impact on the prevailing climate and the planet's habitability. Large amounts of time and money are being invested in modelling and in trying to understand this response. However, these models and predictions need to be validated; otherwise, they remain purely speculative.

The last great period of ice-sheet retreat was more than 10,000 years ago. No direct observations or records exist of how this retreat occurred. To understand the pattern of retreat of extinct ice sheets and, in turn, to help validate models for future ice-sheet retreat, scientists must look to the landscape record in previously glaciated areas. These landscapes comprise some of the most complex landform assemblages on Earth. Within them are recorded the key events that occurred during and after ice-sheet retreat. Study of these landforms therefore allows us to better validate models of GIS and AIS retreat and to predict how the land they cover will respond once the ice has gone.

The last great ice sheets were vast. The Fennoscandian Ice Sheet (FIS) covered all of Scandinavia and extended into the North Sea and northern Germany at its peak. Many regions that once lay beneath the FIS are remote and difficult to access. Even after more than a century of detailed study, there are still areas in which we do not have a detailed understanding of how the ice sheet retreated and how the landscape developed afterwards.

In this thesis, we aimed to study in detail the retreat of the FIS across northern Finnish Lapland and north-east Finnmark, Norway. To achieve this, we used mapping and analysis of LiDAR data from the Norwegian and Finnish national

height models alongside targeted fieldwork and sample collection for OSL and ^{14}C dating. We also incorporated recent advances in remote-sensing technology, including UAVs and iPhone-based photogrammetry. Portable Optically Stimulated Luminescence (POSL) became a major focus of the thesis, and the strengths and potential of this method were assessed in greater detail.

In the first part, we used remote mapping, field observations, OSL, ^{14}C, and POSL data to review the timing of deglaciation and post-glacial landscape development. Major periods of landscape instability recorded by aeolian sediments were identified through calibration of POSL values against full OSL dates. The second part then focused on the wider potential of POSL data and on how luminescence responses may vary according to the environments in which sediments are deposited and the bulk composition of the sediments themselves. pXRF analysis was incorporated to establish the compositions of POSL bulk samples.

Part three of the thesis used the detailed mapping and fieldwork to suggest a model for the formation of the most striking landform in the study area, the Gaccetávži ravine. This feature is more than 10 km long and is evident in aerial imagery and hillshade models derived from LiDAR data, but its origin had never previously been explained. A sequence involving the formation and drainage of ice-dammed lakes at the start of the final FIS retreat eroded this feature, demonstrating the extreme impacts that a retreating ice sheet can have on the landscape over a short period.

Overall, the thesis enhanced our understanding of the retreat of the FIS across the study area after the Younger Dryas. We demonstrated the potential of POSL analysis to improve the quality and quantity of data that can be captured in the field. The use of POSL was complemented by novel remote-sensing techniques for studying landforms and sedimentary deposits, and by pXRF analysis of bulk samples to improve our understanding of how sample composition influences luminescence response.

A PDF of this thesis can be downloaded from: https://nva.sikt.no/registration/019bb289032c-c3561d2b-b873-4811-a02c-2163f8c1c0a1

Madhurima Marik

Methodological advances in luminescence dating in the context of Quaternary climate and tectonics within Upper Rhine Graben

January 2026

University of Freiburg, Freiburg, Germany

Degree: Dr. rer. nat.
Supervisor: Prof. Frank Preusser

From the Late Pleistocene to the Holocene, river dynamics in central Europe were profoundly shaped by hydroclimatic variations and human-induced factors. The Rhine River, as one of Europe's largest and most dynamic fluvial systems, has been strongly influenced by these changes. Upper Rhine Graben (URG) is a part of the European Cenozoic Rift System and extends from Basel in the south to Frankfurt in the north. Acting as a long-term and large-scale sediment sink for the Rhine River, the URG, along with its subsidence dynamics, has preserved a rich sedimentary archive documenting the history of Rhine floodplain evolution. Therefore, in light of ongoing climate change and the increasing human pressure, a deeper understanding of the long- and short-term depositional history of the URG is essential. However, the palaeodynamics of the Upper Rhine system remain poorly understood until today, primarily due to the absence of a detailed geochronological framework from this region. In particular, the coarse-grained stratigraphy and the lack of sediment exposure make it difficult to establish reliable chronological constraints in the central and southern URG. The central aim of this study is, therefore, to establish reliable chronological constraints from fluvial and distal glaciofluvial deposits from this region, which can provide valuable insights in disentangling the complex depositional history of this Quaternary graben fill and to reconstruct the evolving river dynamics of the Rhine, its tributaries and subtributaires. Over the past few decades, luminescence dating has become an emerging geochronological tool to determine the depositional ages of sediments. Despite significant methodological advancements, unavoidable challenges still remain associated with this dating method, which prevents determining 'true' depositional ages of sediments. The current study addresses these limitations by applying luminescence dating to a range of stratigraphic contexts within the URG. Fine sand grains, gravel-rich matrix materials and clasts are collectively dated in this study and robust luminescence age constraints are established for distinct fluvial and distal glaciofluvial stratigraphic units in this region. In parallel, the study advances several methodological refinements, aiming to mitigate the effects of partial bleaching and anomalous fading, two critical challenges commonly associated with this dating method. Together, the findings of the study contribute to establish a reliable geochronological framework for the URG and address luminescence methodological limitations, enhancing the accuracy of depositional age estimation using this technique.

A PDF of this thesis can be downloaded from: https://freidok.uni-freiburg.de/data/276723

Anna Maartje de Boer

From light signals to sediment pathways – Developing luminescence as a sediment tracing tool

March 2026

Wageningen University & Research, Wageningen, The Netherlands

Degree: Ph.D.

Supervisors: Prof. Dr. Jakob Wallinga, Dr. Ir. Bram van Prooijen

Luminescence signals stored in mineral grains record the transport and depositional history of sediment, making them a promising sediment tracer (in coastal systems). However, both instrumental and methodological challenges have so far limited the routine application of luminescence as a sediment tracer. This study developed and applied a luminescence-based sediment tracing approach to improve insight into sediment redistribution in the Ameland tidal inlet in the Dutch Wadden Sea. The broader motivation is a concrete coastal management problem. In the Netherlands, sand nourishments are increasingly used as a nature-based strategy to maintain coastal safety under rising sea levels, but tracking where nourished sand goes after placement remains a key open question.

A central technical contribution is the development and optimization of an EMCCD-based single-grain imaging system. Tested against a conventional XY laser setup, the EMCCD proved faster and particularly advantageous for measuring feldspar luminescence. An optimal Region of Interest size of 450 µm was identified, balancing net signal strength against detection crosstalk between neighbouring grains. To support systematic crosstalk evaluation, Moran's I was introduced as a spatial autocorrelation statistic applied to luminescence images. Simulations showed that crosstalk effects are negligible for well-bleached samples but can distort distributions that are bimodal or heterogeneously bleached, which is especially relevant for feldspar-based measurements where partial bleaching is often observed. A further advance was the first demonstration of automated single-grain thermoluminescence (TL) measurements, making a signal recognized as a promising tracer accessible at the single-grain scale. It potentially also enables mineral identification in polymineral samples within a single measurement sequence.

Effective sediment tracing requires understanding how luminescence signals reset under water. Two field bleaching experiments were conducted to quantify this process. A pilot experiment at the NIOZ jetty on Texel confirmed that laboratory derived bleaching hierarchies hold under natural conditions: IRSL signals bleach fastest, while higher-temperature post-IR IRSL signals are more stable. The main experiment in the Ameland inlet quantified bleaching as a function of water depth, exposure time, light spectrum, and suspended sediment concentration. Clear bleaching fronts were identified below which no resetting occurs. Hydrodynamics strongly modulate bleaching efficiency: suspended sediment concentration controls spectral filtering with depth, and combined with mineral-specific photo-ionisation cross-sections, this produces depth-dependent bleaching hierarchies and resetting durations. The time required for quartz and feldspar signals to reach 50 % of their initial value was calculated as a function of depth and time, providing empirical input directly applicable to luminescence-based sediment transport models.

The tracer potential was then evaluated by examining whether luminescence signals could distinguish nourished from native sands, or reveal transport histories across the inlet. Spatial patterns in single-grain dose distributions revealed sediment pathways, but nourished and native sands could not be separated because the nourishment material was sourced from local Holocene deposits sharing near-identical luminescence fingerprints with native sediment.

A PDF of this thesis can be downloaded from: https://doi.org/10.18174/681304

Isabel Hernando-Alonso

Geochronology of the Evolution of the Sierra de Atapuerca Karst System using Electron Paramagnetic Resonance

April 2026

University of Burgos, Burgos, Spain

Degree: Ph.D.

Supervisors: Dr. Alfonso Benito Calvo, Dra. Davinia Moreno García, Dra. Ana Isabel Ortega

The archaeological sites of the Sierra de Atapuerca are located within a multi-level karst system, whose formation and sedimentary infill are closely linked to the evolution of the northeasternmost sector of the Duero Basin drainage network. Nevertheless, this geomorphological model still carries chronological uncertainties. This doctoral thesis therefore seeks to refine the temporal reconstruction and establish more precise correlations between the development of these karst cavities and the main drainage system of the Sierra de Atapuerca.

To achieve this objective, the primary method employed was Electron Spin Resonance (ESR), as it enables dating the moment when sediments were introduced into the caves or deposited on fluvial terraces. This technique was applied using the recently developed multi-center approach, which provides more robust age estimates. Complementary methods, including Paleomagnetism and Uranium-series dating, were also applied to refine the reconstruction of the fluvio-karstic dynamics responsible for the formation of these sites. In total, 30 ESR samples were collected from the Galería Complex, Cueva del Silo, Cueva Peluda, the Arlanzón Valley, and the Arlanza Valley, along with two speleothem samples analyzed using Uranium-series dating and 65 samples for Paleomagnetic analysis.

The chronological results of this study support the previously proposed geomorphological model linking cavity formation to fluvial incision. Our data indicate that the upper level would have begun to form at least 1722 ± 248 ka,

while the intermediate and lower levels developed around 1215 ± 82 ka and 844–773 ka, respectively. Moreover, the chronological evidence confirms the synchronous evolution of the northeastern valleys of the Duero Basin, although they display incision patterns that diverge from those of the other rivers in the basin. These findings reflect a high degree of immaturity in the northeastern drainage network, which could imply a future shift in dominance from the Duero system to the Ebro system. Ultimately, this research not only consolidates the chrono-geomorphological framework of the Sierra de Atapuerca but also establishes a robust foundation for future regional correlations, thereby paving the way for a deeper understanding of the Pleistocene geomorphological and paleoenvironmental evolution of the Duero Basin.

Nehal Khan

Prediction of Meteoroid Orbit using Natural Thermoluminescence of Meteorite Interior

May 2026

Indian Institute of Technology Kanpur, Kanpur, India

Degree: Masters (MTech)
Supervisors: Prof. Rabiul H. Biswas

Meteorites are fragments of asteroids that travel along elliptical heliocentric orbits for millions of years before reaching the Earth's surface. During this journey, the feldspar minerals within the meteorite interior continuously accumulate thermoluminescence (TL) signal through galactic cosmic ray (GCR) induced trap filling, while simultaneously losing signal through thermally activated charge release near perihelion and through quantum-mechanical tunnelling (athermal fading). The dynamic equilibrium between these competing processes encodes information about the meteoroid's orbital thermal history – and in particular, about the shape and size of its heliocentric orbit. The present study develops a complete kinetic modelling framework to exploit this dependence and reconstruct the pre-atmospheric heliocentric orbital parameters of ordinary chondrite meteorites from laboratory TL measurements.

Four Indian ordinary chondrite meteorites were studied: Dhajala (H3.8, fell Gujarat 1976, CRE age 6.2 ± 0.8 Ma), Kendrapara (H5, fell Odisha 2003, CRE age 4.5 ± 0.45 Ma), Ararki (L5, find Rajasthan 2001, CRE age 7.2 ± 0.45 Ma), and Bansur (L6, fell Rajasthan 1892, CRE age 9.5 ± 0.3 Ma). TL measurements were performed on feldspar-rich non-magnetic fractions using a Risø TL/OSL DA-20 reader with a violet-blue emission filter combination (BG3 + BG39). All kinetic parameters governing TL behaviour – the thermal decay parameters (activation energy E, frequency factor s, and detrapping order b) obtained from the T_{m}–T_{stop} fractional glow curve method, the growth parameters (saturation dose D_0 and trapping order a) from the single-aliquot regenerative-dose (SAR) protocol, and the athermal fading parameter (dimensionless recombination centre density ρ') from post-irradiation delay experiments – were constrained independently for each sample. This sample-specific parameterisation represents a significant improvement over earlier TL-based orbital studies, which assumed identical kinetic parameters for all meteorites.

The TL signal sensitivity to orbital temperature variations was assessed for three temperature windows: 250–260 °C, 260–270 °C, and 270–280 °C. Forward modelling demonstrated that these low-temperature peaks experience approximately 20 % signal loss within the equilibrium surface temperature range of 250–330 K corresponding to inner solar system orbits (a = 1.0–2.5 AU), making them sensitive and appropriate thermometers for orbital reconstruction. Higher temperature windows (370–380 °C) were found to be insensitive to this temperature range and were excluded.

The forward modelling framework numerically integrates the complete General Order Kinetic (GOK) rate equation of Biswas et al. (2018) over a simulation duration of 0.5 Ma for each orbit. The rate equation simultaneously accounts for GCR-induced trap filling ($\dot{D} = 61\,\mathrm{Gy\,kyr^{-1}}$), thermally activated charge loss governed by Arrhenius kinetics, and athermal charge loss by quantum tunnelling following the formulation of Huntley (2006). The heliocentric distance at each time step is computed by solving Kepler's equation numerically using the Newton-Raphson method, and the meteoroid surface temperature is derived from the radiative equilibrium model of Melcher (1981). A Monte Carlo strategy was adopted in which approximately 10,000 orbital configurations were randomly generated within the ranges $a \in [1.0, 2.5]$ AU and $e \in [0.2, 0.6]$, producing a comprehensive library of synthetic TL predictions for each combination of semi-major axis and eccentricity.

Inverse modelling was performed by comparing the synthetic TL predictions against the measured natural TL levels ($\bar{n}_{\mathrm{obs}}$) across all three temperature windows simultaneously using a combined misfit function following Biswas et al. (2018). The probability of each simulated orbit was determined from the likelihood function, and the orbital configuration with maximum probability was identified as the best-fit solution for each meteorite.

The recovered best-fit orbital parameters are: Dhajala (a = 1.404 AU, e = 0.41, q = 0.828 AU), Kendrapara (a = 1.410 AU, e = 0.46, q = 0.761 AU), Ararki (a = 1.208 AU, e = 0.39, q = 0.737 AU), and Bansur (a = 1.522 AU, e = 0.46, q = 0.822 AU). All recovered orbits are consistent with delivery from the inner main asteroid belt through Earth-crossing trajectories. The perihelion distances are broadly consistent with first-order estimates obtained using the simplified Melcher (1981) method, while the present approach additionally constrains the semi-major axis and eccentricity independently – information that the Melcher method cannot provide.

This study demonstrates that TL of meteorite feldspar, when combined with accurate kinetic modelling and systematic Monte Carlo orbital search, is a viable quantitative tool for reconstructing the pre-atmospheric heliocentric orbital history of meteorites from standard laboratory measurements alone.

A PDF of this thesis can be obtained by contacting the author: Nehalkhanamu@gmail.com

Edda Sól Ólafsdóttir Arnholtz

Constraining Weichselian high relative sea-level events in Basissletta, northeastern Spitsbergen

June 2026

Lund University, Lund, Sweden

Degree: Masters

Supervisors: Helena Alexanderson, Zoran Perić, Mark Furze

The fluctuation of the Svalbard Barents Sea Ice Sheet is relatively well constrained during the Late Weichselian, yet its behaviour before the Last Glacial Maximum (LGM) remains elusive. Inter-fjord areas, largely covered by cold-based, non-erosive ice, have a higher preservation potential for older terrestrial records than fjord areas that were dominated by active ice streams during the Last Glacial Maximum. Basissletta, located on the northeast coast of Spitsbergen, represents one such inter-fjord setting and therefore offers the potential to recover stratigraphic records of the ice sheet fluctuation through the Weichselian.

The area is an undulating coastal area characterized by Quaternary deposits, which consist predominantly of raised marine sediments, glacial deposits, fluvial and glacifluvial deposits and periglacially altered surfaces. In order to reconstruct the paleoenvironment in Basissletta, and in particular identify high relative sea level stands, glacifluvial and littoral sedimentary sections above the proposed marine limit (ML) of 68 m a.s.l. were described and chronologically constrained using Optically Stimulated Luminescence (OSL) dating and Radiocarbon (^{14}C) dating. Geomorphological mapping was conducted through the identification of landforms using digital ortho-imagery and drone imagery obtained during a field excursion to Basissletta, complemented by field observations.

Chronology and stratigraphical analysis of a delta deposit reveal a composite landform comprising of two deltaic formations separated by an unconformity. The lower unit was deposited during early Marine Isotope Stage (MIS) 3 whereas the upper unit yielded post-LGM ages, indicating a renewed delta formation following deglaciation. The activation of an outwash plain in the foothills, constrains the ice margins retreat during deglaciation to 14 $\pm$ 2 ka. Prominent beach ridges are observed up until 78 m a.s.l, which have been constrained to the Late Weichselian deglaciation by OSL and radiocarbon chronologies, and is defined as the post glacial ML, making it about 10 m higher than previously thought. Two high relative sea level events were thus recorded in Basissletta, the former during MIS 3 following an extensive glaciation during MIS 4 and the latter during a post-LGM high stand in the Late glacial – early Holocene transition.

A PDF of this thesis can be downloaded from: https://lup.lub.lu.se/student-papers/search/publication/9232359

Shengliang Dong

Establishment, history and internal architecture of Kolabacken, the former beacon at Falsterbo, southern Sweden

June 2026

Lund University, Lund, Sweden

Degree: Masters

Supervisors: Dan Hammarlund, Helena Alexanderson, Mats Rundgren

Kolabacken is a small grass-covered mound near the southern tip of the Falsterbo Peninsula in southern Sweden. The site is known as the former beacon at Falsterbo, where a so-called tilting beacon helped ships navigate along the shallow and dangerous coast before the present lighthouse was built in 1795. Although Falsterbo's importance for maritime traffic and trade during Medieval times is well known, the internal structure and historical development of Kolabacken have not previously been studied in detail. The study is based on hand-auger sampling to depths of 1–6 m at twenty points along two crossing transects through Kolabacken. The sediments were described in the field and later analysed using grain-size analysis, microscopic analysis, portable OSL profiling, quartz OSL dating and radiocarbon dating. Historical maps and written sources were also used to compare the sediment record with the known history. The results show that Kolabacken is a complex structure situated on a former beach ridge close to the early Medieval coastline. The natural beach sand is overlain by a succession of mainly wind-deposited fine- to medium-grained sand, with varying amounts of residues from beacon operation and other human activities. Six sedimentary units were identified: from bottom to top, brown beach sand with gravel, grey sand with charred wood remains and brick fragments, black sand with incompletely burnt coal, yellowish-white aeolian sand, grey sand with coal slag, and greyish-white sand with coal residues and a soil horizon.

Four radiocarbon dates on charred wood from the lower unit with wood remains yielded ages in the range of 1025–1260 CE. Considering the inherent age of the trees used as fuel, these dates broadly confirm historical records stating that King Valdemar II allowed the construction of a beacon site at Falsterbo sometime during 1225–1241 CE. A peat fragment from the underlying beach sand was radiocarbon dated to 645–775 CE, showing that the shoreline was located close to the present site of Kolabacken several hundred years before the beacon site was established. The grey sand with charred wood remains represents Medieval beacon activity, when wood, probably from local woodlands, was used as fuel, while the brick fragments may derive from some form of foundation or building at the site. The overlying black sand represents a subsequent early phase of coal

burning when large fragments of unburnt or partly burnt coal were left in the deposits. According to historical sources, coal burning probably began during the 1620s. Higher in the stratigraphic sequence, the grey sand with coal slag suggests a later phase of more complete burning, regular cleaning, maintenance, and more efficient beacon operation. Between these coal-rich units is a layer of aeolian sand from the late 1600s. It is unclear whether this layer resulted from a longer period of sand drift or a single storm event, but in combination with war-related interruptions in coal deliveries it probably affected beacon operation.

Complementary luminescence dating results provide general chronological support, although dating of this type of mixed coastal and anthropogenic deposits is challenging. Cleaner units of aeolian sand give more reliable results, while the mixed lower units were affected by reworking, partial bleaching and later disturbance. Optimal chronological control is therefore obtained by combining the dating results with sedimentology, microscopic observations and historical records.

Potential future studies of the origin and history of Kolabacken could include wood-anatomical analysis of charred wood remains in order to clarify the age and origin of the fuel. Refined luminescence dating of selected sediment layers, combined with comparisons with similar studies from other parts of the Falsterbo Peninsula, could improve the chronology. In addition, possible remains of the tilting beacon and surrounding structures could be mapped using ground-penetrating radar.

A PDF of this thesis can be downloaded from: https://lup.lub.lu.se/student-papers/search/publication/9243490

Junqi Xie

Isotopic chronological study of the Xianrendong hominin site in Xichou County, Yunnan Province, Southwest China

June 2026

Yunnan University, Kunming, China

Degree: Masters

Supervisor: Fei Han

In Southwest China, karst caves preserve exceptionally rich paleoanthropological records that are pivotal for evaluating hypothesized southern dispersal routes of anatomically modern humans (AMH). The Xianrendong site in Xichou County has yielded six *Homo sapiens* teeth fossils – the earliest identified AMH remains in eastern Yunnan – yet its chronological framework remains poorly resolved. Previous U-series ages derived from mammalian tooth dentine (105–47 ka) are probably underestimated due to post-depositional uranium mobility in open-system conditions. To address this limitation, we applied combined electron spin resonance and uranium-series (ESR/U-series) dating method to ten mammalian tooth fossils and cross-validated the results against U-series ages obtained from stratigraphically associated flowstone layers. The ESR/U-series ages for the teeth range from 135 ka to 51 ka, and a flowstone layer interbedded within the same sequence yielded a U-series age of 95.7 ± 16.9 ka – fully consistent with the bracketing tooth fossil ages. Collectively, these data establish the first robust, multi-proxy chronological framework for Xianrendong, constraining the hominin-bearing deposits to the late Middle Pleistocene through the middle Late Pleistocene. This chronology predates the majority of early AMH sites in northern China and provides empirical support for recurrent southward dispersal events during Marine Isotope Stage 5 (MIS 5).

In parallel, we conducted a methodological study to overcome practical constraints inherent in conventional ESR dating of fossil teeth – specifically, the requirement for extensive, high-dose irradiation experiments. Drawing on dental fossils from eleven archaeological sites spanning the late Miocene to the late Pleistocene, we developed a standardized growth curve (SGC) for equivalent dose (D_e) estimation and refined fitting functions to substantially reduce reliance on high-dose irradiation protocols. Dose-response data from old fossil teeth ($D_e > 2$ kGy) demonstrate that period-specific SGCs yield D_e estimates within 12–20 % of those obtained via the conventional additive dose method (ADM). Validation at Xianrendong – using a site-specific SGC derived from five specimens – successfully predicted D_e values for the remaining five teeth, with deviations from ADM-derived values all < 20 %, and three predictions fell within ± 5 %, a level of agreement deemed acceptable for preliminary chronological screening. These results confirm the SGC approach as an irradiation-free alternative for rapid D_e estimation. Although the SGC approach currently yields lower precision than ADM, its use of empirically optimized fitting functions – and application to an expanding set of fossil tooth ESR datasets – enables faster, more standardized D_e determination in fossil tooth ESR dating.

A PDF of this thesis can be obtained by contacting the author: xiejq1216@163.com

Bibliography

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Various geological applications

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Conference Announcements: DLED 2026

German Luminescence and Electron Spin Resonance Dating (DLED) Meeting 2026

20-22 November 2026

We are pleased to announce that the German Luminescence and Electron Spin Resonance Dating (DLED) Meeting 2026 will be held at the University of Tübingen.

Dates: 20–22 November 2026

(Friday afternoon to Sunday morning, with an optional guided tour of the archaeological exhibition at the University Museum in Hohentübingen Castle on Friday morning: https://www.unimuseum.uni-tuebingen.de/en/museum-at-hohentuebingen-castle)

Venue: Geo- und Umweltforschungszentrum (GUZ)
Schnarrenbergstraße 94–96
72076 Tübingen, Germany

The DLED meetings have a long-standing tradition of a Saturday afternoon walk. This year, participants will have the opportunity to enjoy the beautiful Ammer Valley and the historic old town of Tübingen.

If you are interested in receiving further information, please send an email to tobias.lauer@uni-tuebingen.de.

We look forward to welcoming many of you to Tübingen in November 2026.

The DLED2026 organising team
(Tobias Lauer, Sumiko Tsukamoto and Mika Meyer-Oehme)

Ancient TL

ISSN 2693-0935

Aims and Scope

Ancient TL (electronic ISSN 2693-0935) is a community-based, not-for-profit, peer-reviewed, diamond open access journal devoted to theoretical and experimental luminescence and electron spin resonance (ESR) research. This includes research on environmental dose rate, rock thermal histories (e.g., low-temperature thermochronometry) and mineral provenance and characterisation. Manuscripts on luminescence and ESR dating, on software codes, numerical models and on instrumentation are also welcome. Ancient TL also publishes interlaboratory comparisons, standardisation procedures, failed experiments, as well as observations difficult to explain. Following Ancient TL's tradition, manuscripts about practical aspects of laboratory and field work are explicitly welcome. Periodically, Ancient TL publishes an up-to-date bibliography, thesis abstracts, and miscellaneous information for the community.

Frequency

Two issues per annum in June and December

Submission of articles to Ancient TL

For instructions to authors and information on how to submit to Ancient TL, please visit the website at:
http://ancienttl.org/TOC1.htm

Journal Enquiries

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