Thesis Abstracts

Index

Tarfah Sayer Albaqami

Late Quaternary Palaeoenvironmental Reconstruction of Wadi Trubah in Western Saudi Arabia

May 2025
University of Sheffield, Sheffield, UK
Degree: Ph.D.
Supervisors: Mark D. Bateman, Robert G. Bryantz

While research into Quaternary environmental changes has taken place in the Central, Eastern, and southern regions of the Arabian Peninsula (AP) within Saudi Arabia, little paleoenvironment research has yet to be carried out in the western part of the AP, this is, even though the western part of Arabia is uniquely different from the eastern and central areas regarding climate and geology. Western Arabia is also critical in understanding past human migrations from Africa and the archaeological record of Arabia. To address the project's aims in reconstructing Late Quaternary environmental changes in wadi activity in the western region of Saudi Arabia and their relationship to regional environmental changes on the AP, a multiple methods approach using luminescence dating of the Wadi sedimentary archive, particle size analysis, and remote sensing was applied to map, understand, and model the fluvial drainage network. This research revealed the occurrence of major wet phases in the western part of the AP, which are MIS 9, 7, 3, and 1, which align with wet periods in other areas of the AP. Interestingly, no wet phase during MIS 5 has been found in the selected study area, indicating a need for further research.

Remote sensing has assisted in delineating the extensive stream network, which used to be active during intense precipitation during pluvial periods due to the combined climate-wind systems of the Indian Ocean Monsoon and the North African Summer Monsoon. Regarding palaeolakes, the research mapped 231 ancient lakes in the Harrat region, 93 interdune palaeolakes, and 4806 archaeological sites, which themselves suggest that Wadi Trubah had a favourable climate condition for human settlements.

Access to this thesis will be via https://etheses.whiterose.ac.uk/id/eprint/37731/

Renan Cassimiro Brito

Paleogeographic reconstruction of the middle Negro River during the Quaternary: a geomorphological-geochronological approach

July 2025
University of São Paulo, São Paulo, Brasil
Degree: Masters
Supervisors: Fabiano do Nascimento Pupim

The Negro River, the main tributary of the Solimões, drains the largest tropical watershed and sustains one of the most biodiverse ecosystems on the planet. Despite the well-documented influence of fluvial dynamics on Amazonian landscape evolution, the scarcity of absolute dating of sedimentary deposits limits the understanding of Quaternary paleohydrological changes. This gap hinders the chronological reconstruction of the geomorphological processes that have shaped the region's fluvial systems over the past 250,000 years. This research project aims to reconstruct the geological evolution of the middle Negro River during the Late Quaternary (<250 ka) through geomorphological mapping (terrace levels and floodplains), luminescence dating (11 quartz and 4 feldspar samples), and sediment provenance analysis (%BOSL1s). Terraces yielded ages between 297 ka and 103 ka (quartz) and between 390 ka and 302 ka (feldspar), while floodplains showed younger ages (31 ka to 2 ka). Quartz OSL sensitivity (%BOSL1s) increased from terraces (20–24 %) to floodplains (36–46 %), supporting Andean sediment sources with progressive reworking in floodplains. Three knickzones in the longitudinal profile correlate with lithological transitions (Içá Formation/Jauaperi Metamorphic Suite) and Pleistocene megafans that forced southwestward channel migration. Tributaries (Jaú and Unini rivers) exhibited distinct patterns: meandering reaches in less resistant rocks (Içá Formation) alternated with confined valleys in crystalline units (Jauaperi Suite). Terrace ages in the Cuiuni (103–328 ka) suggest that the disconnection between the Japurá paleochannels and the Negro River occurred more than 100 ka ago, recalibrating previous Holocene models. This hydrological reorganization likely influenced biogeographic patterns, including the Jaú-Negro endemism zone. Our results demonstrate that landscape evolution reflects the interplay of lithological controls, orbital-scale climate changes, and tectonic factors, providing a new

chronological framework for understanding Amazonian fluvial dynamics and their impacts on biodiversity.

This study was financially supported by the São Paulo Research Foundation (FAPESP, Grants 2023/10430-4 and 2024/07848-0) and the Coordination for the Improvement of Higher Education Personnel (CAPES, PROEX Grant 88887.805016/2023-00).

A PDF of this thesis can be downloaded from: https://doi.org/10.11606/D.44.2025.tde-09102025-072755

Garrett Richard Leo Marietta

A Bayesian model of beach ridge OSL chronology for determining Holocene lake-level changes of ancestral Lake Michigan

July 2025

Indiana University, Bloomington, United States of America

Degree: Masters

Supervisors: Jose Luis Antinao-Rojas, Brian Yanites, Henry Loope

Over the past three decades, beach ridges adjacent to the Great Lakes have provided researchers with key sedimentological and geochronological data used to construct Holocene paleohydrographs, records that reconstruct past lake levels and show trends in century-to-millennia scale hydrologic variability. Such paleohydrographs are critical for understanding changes in regional climate and lake-level trends. The beach ridges are a well-suited setting for optically stimulated luminescence (OSL) dating, as they contain eolian sand over foreshore deposits, both of which are fully bleached of all luminescence signal prior to deposition. Previous studies have shown that the beach ridges form during decadal periods of lake-level rise and fall and that the elevation of basal foreshore deposits is a close approximation to the elevation of the lake level at the high stand. These interpretations rely on the model of beach ridge formation where beach ridges must either form sequentially lakeward or be eroded.

This study focuses on the record of lake-level fluctuation preserved in a strandplain of beach ridges at the Wentworth Woods Nature Preserve (WWW) along the southwestern margin of Lake Michigan. OSL ages of the basal foreshore deposits should provide an estimate of age for the lake-level highstand. The basal foreshores from seven beach ridges were dated via OSL and ranged from 2.6 ± 0.3 ka to 6.2 ± 0.4 ka. Due to inconsistencies between the model for beach ridge formation and the ages determined through OSL that break this pattern, statistical analysis was pursued. Using Bayesian modeling of OSL ages across the strandplain, this study recalculated age ranges for the entire strandplain to be between 4.9 ± 0.2 ka and 5.2 ± 0.1 ka and reduced reporting error from a median of 7 % (356 yrs) to 2 % (113 yrs). Beyond chronologic resolution refinement, this analysis allows for century-scale interpretations of lake-level change and suggests that the age of the highest premodern lake-level, the peak of the Nipissing phase in the Great Lakes, is revised from its previously reported age of 4.5 ± 0.5 ka to be 5.1 ± 0.1 ka. This analysis not only improves the understanding of paleohydrology in the Great Lakes basin but also provides insight into lake-level change as a result of glacial isostatic and climate change.

A PDF of this thesis can be downloaded from: https://www.proquest.com/openview/62c9e771c70b7b887faede7f60bd3337/1?pq-origsite=gscholar&cbl=18750&diss=y

Hamdan Mahmal Saad Alghamdi

New dosimetry methods for radiological and nuclear emergency management

September 2025

Scottish Universities Environmental Research Centre, University of Glasgow, Glasgow, UK

Degree: Ph.D.

Supervisors: Prof. David Sanderson and Dr. Alan Cresswell

During all phases following a nuclear or radiological incident analyses of doses received by members of the public and responders are required. Rapid and reliable dose assessment is critical for the effective management of radiological emergencies; for medical triage, understanding exposure levels, directing protective actions, and conducting subsequent analyses of the impact of the incident. Current practice has been reviewed, highlighting the potential for near real-time luminescence dosimetry to assist with such assessments, including low dose response that supports public reassurance below doses of medical significance, using common materials present at the time of the incident. A number of materials which might be found in the immediate vicinity of people have previously been investigated with regard to their potential to act as radiation dosimeters. The work in this thesis investigates the properties of common household salt and talc, using portable Optically Stimulated Luminescence (OSL) and Infra-Red Stimulated Luminescence (IRSL) instruments capable of rapid measurements in the field. The potential of these materials to measure radiation levels and provide rapid, cost-effective insights into exposure patterns using new methods is explored. This approach aims to support emergency response strategies by leveraging accessible materials to improve decision-making in radiological incidents, bridging a key gap in large-scale radiation measurements and initial triage support.

Common salt has previously been shown to have the potential for retrospective dosimetry in the mGy dose range using laboratory instrumentation. This thesis investigates the use of portable instruments, with unprepared commercially sourced salt, in dose ranges below mGy. Responses from pulsed IRSL laboratory systems and portable OSL instruments were compared. For OSL measurements, detection limits of 7 µGy have been demonstrated, with detec-

tion limits of 30–340 µGy for the other instruments investigated. This work examines the effects of signal stability and sample storage conditions. The OSL signals initially show a brief decrease in luminescence during the first few days after irradiation, followed by a gradual increase with longer storage periods. Between days 8 and 64, the results remain relatively stable, which is crucial for dose estimation during both the early and later stages of responding to radiological emergencies, and methods for correcting for these signal variations at shorter and longer periods have been developed and demonstrated. However, exposure to light and moisture leads to a rapid loss of OSL signals. Three practical experiments were conducted using salt to simulate real accident scenarios, measure radiation, estimate dose, and compare the results with gamma systems (backpack). The first experiment was conducted under controlled laboratory conditions. The second mapped natural and artificial radiation fields in an outside environment. The final experiment mapped complex radiation fields within an accelerator laboratory. The results demonstrate that salt has considerable potential for use in dosimetry below mGy and that measurements can be conducted with portable OSL instruments. Furthermore, the results of the first two experiments compared well to theoretical doses and measurements with different systems. The results confirmed that this approach can provide reliable dose estimates for radiological accidents. The salt system has demonstrated its ability to map the spatial boundaries of radiation fields, serving as a low cost radiation mapping tool. Protocols must be instituted for testing and assessment during exercises, taking into account variables such as zeroing, ambient conditions, and the necessity for fading adjustments. The studies of talc focused on the optimal conditions for measuring the radiation-induced OSL signal using the SUERC Portable OSL Reader. It also addressed the inherent complexities associated with geological residual signals observed in talc sourced from Luzenac Pharma's packing line. This residual signal can be removed through thermal treatment, specifically at 400 °C for 1 h, after which the talc exhibits sufficient sensitivity to detect doses in the mGy range through to the radiologically significant range of 0.5 to 3 Gy, making it a promising candidate for field-deployable radiation assessment.

The fading data exhibit a complex decay pattern, suggesting the presence of multiple trap depths, with an initial signal loss of approximately 6 % within 24 h post-irradiation, escalating to a substantial 65 % reduction of the original OSL signal within 128 d at ambient temperature.

The work presented here has demonstrated that the novel approach of using salt or talc with portable OSL systems is capable of delivering dose estimates in the range from a few µGy to several Gy in near real-time, complementing existing techniques. To optimize this approach, comprehensive protocols should be developed for both testing exercises and evaluations, which could lead to wider acceptance of these approaches offering a robust, low-cost solution for rapid dose assessment for both emergency response and environmental dosimetry.

A PDF of this thesis can be downloaded from: https://theses.gla.ac.uk/85442/

Malika Singhal

High Radiation Dosimetry: Methodology Development

October 2025

Physical Research Laboratory, Ahmedabad, India

Degree: Ph.D.

Supervisors: Dr. Naveen Chauhan

Radiation dosimetry is the measurement of absorbed radiation dose (Gy = J kg^{-1}). Estimation of dose in natural minerals using luminescence emissions is an integral part of luminescence dating. The upper limit of luminescence dating is limited to ∼0.5 Ma. This limit is because of saturation of luminescence intensity with dose and depends on the capacity of the traps (defect sites) inside the crystal to accumulate charges produced during irradiation. The saturation is mineral-dependent and found to differ for different minerals. Quartz and feldspar are two ubiquitous minerals that are widely used in luminescence dating. The quest to increase the datable range of luminescence dating has been long, and many new traps (and their corresponding luminescence signals) in quartz and feldspar have been identified and probed to increase the datable range. However, the probed signals still face challenges in bridging the gap between laboratory calibrations and naturally acquired doses.

The present thesis attempts to develop a method to estimate high radiation doses (HRDs $\gtrsim$1 kGy) by exploring new minerals for high dose estimates and developing a better understanding of the luminescence mechanism in conventional minerals (quartz and feldspar) in the high dose regime. This thesis, for the first time, explores the luminescence characteristics of jarosite, a hydroxyl sulphate of metal and iron, because of its importance as a direct indicator of paleo-aridity (hence climate change) and its abundance and occurrence on Mars. Essential dosimetry properties like identification of traps, their thermal stability, bleaching, dose saturation, and athermal fading are studied. Thermoluminescence (TL) glow peaks appear around 100 °C, 150 °C, 300 °C, and 350 °C, with emissions recorded in the spectral range of 325–700 nm. Heating to 450 °C alters luminescence sensitivity without affecting the shape of glow curves, a finding supported by FTIR and CL-EDXS analyses. The 300 °C TL peak is thermally stable over geological time periods, with a lifetime of ∼0.3 million years (Ma) at 30 °C and ∼3 Ma at 10 °C ambient temperature, indicating suitability for dating older events in colder environments. Dose-response curves (DRCs) show saturation dose ranges from 590 to 1600 Gy for various traps probed by BSL, IRSL, pIRIR$_{225}$ and TL. Based on a terrestrial dose rate of ∼2 mGy a^{-1} and fading considerations, jarosite has the potential to date events up to ∼800 ka (constrained by the thermal stability to colder areas), while on Mars, where the dose rate is ∼65 mGy a^{-1}, the dating limit is approximately 25 ka.

The multi-spectral studies are conducted to understand the trapping, storage and recombination of charges in conventional minerals (quartz and feldspar) at HRDs. Experiments are conducted in the broad spectral window from 325–700 nm and are consequently narrowed down. Results show that quartz TL saturates in 10–18 kGy range, whereas feldspar TL saturates around 1–5 kGy, the range being sample-dependent. Since quartz provides a significant scope for estimating HRD, it is studied in detail in this thesis. The dose-response and saturation characteristics in quartz are found to be primarily controlled by the trapping centres rather than the recombination centres, with saturation doses showing minimal spectral dependence. Bleachability is found to be wavelength-dependent; longer-wavelength emissions exhibit reduced bleaching efficiency. Standard normalisation protocols, such as the zero or second glow normalisation, become unreliable beyond $\sim$1 kGy, leading to inconsistent sensitivity correction. Instead, normalisation approaches based on sample mass/weight should be used. These findings highlight the need for revised protocols at HRDs. The thesis further re-investigates the Blue Stimulated luminescence (BSL) from quartz at HRDs, which is known to saturate at $\sim$250 Gy, which is approximately 40 times less than the observed TL saturation. Results show that BSL measured on multiple aliquots of the same sample and compared by mass normalisation does not saturate as early as seen in Single Aliquot Regeneration (SAR) protocols. HRDs are better measured using Multiple Aliquot Additive Dose (MAAD) protocols in combination with alternative normalisation. Signals like zero-glow peak, annealed BSL, and annealed TL (blue emission) show reduced/negligible dependence on regeneration dose for the test signal, making them more suitable for constructing DRCs in the high-dose regime. Dose response curves generated using these normalisation methods show saturation around 5.8 kGy.

The thesis further uses the proposed methodology for two natural old geological settings: the Upper Shivaliks ($\sim$0.5–5 Ma) and the Charavathur formation ($>$2.5 Ma). In natural high-dose contexts, such as Shivalik sediments, where SAR-based curves show early saturation, the MAAD method proves particularly effective and could estimate higher radiation doses. In samples like those from Charavathur, where a low dose rate was estimated, the samples acquired an equilibrium between the trapping and detrapping due to thermal effects. MAAD accounts more appropriately for natural dose equilibrium, which cannot be explained by SAR. These findings highlight the limitations of SAR at high doses and suggests the use of MAAD protocols appropriately normalised for accurate dose estimation in old geological settings. However, the estimated doses are accompanied by large errors which need further investigation in the future.

A PDF of this thesis can be obtained by contacting the author: malikasinghal97@gmail.com.