Abstracts

LED2023

17th International Conference on Luminescence and Electron Spin Resonance Dating

25-30 June 2023, Copenhagen, Denmark

International Scientific Committee

- Lee Arnold, University of Adelaide, Australia
- Andrzej Bluszcz, Silesian University of Technology, Poland
- Jan-Pieter Buylaert, Technical University of Denmark, Denmark
- Naveen Chauhan, Physical Research Laboratory, India
- Makaiko Chithambo, Rhodes University, South Africa
- Regina DeWitt, East Carolina University, USA
- Geoff Duller, Aberystwyth University, United Kingdom
- Mathieu Duval, CENIEH, Spain
- Xiao Fu, Zhejiang University, China
- Mayank Jain, Technical University of Denmark, Denmark
- Georgina King, University of Lausanne, Switzerland
- Naomi Porat, Geological Survey of Israel, Israel
- Tammy Rittenour, Utah State University, USA
- André Sawakuchi, University of São Paulo, Brazil
- Toru Tamura, Geological Survey of Japan, Japan
- Kristina Thomsen, Technical University of Denmark, Denmark
- Alida Timar-Gabor, Babes Bolyai University, Romania
- Sumiko Tsukamoto, LIAG, Germany
- Liping Zhou, Peking University, China

The international scientific committee evaluated the scientific quality for all submitted abstracts. Those abstracts submitted for poster presentation were reviewed by at least one member of the scientific committee whereas abstracts submitted for oral presentation were evaluated by at least two members of the scientific committee.

Local Organising Committee

Technical University of Denmark, Department of Physics

- Jan-Pieter Buylaert
- Pia Lone Elhauge
- Vicki Hansen
- Mayank Jain
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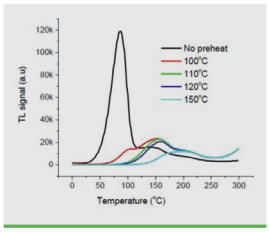
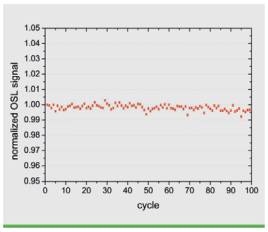


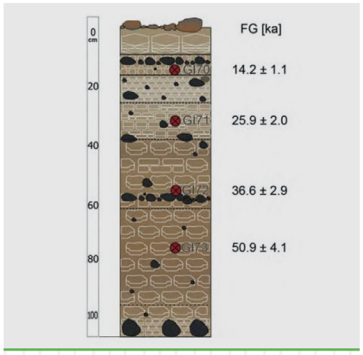
Preheat tests for thermoluminescence analysis (from Ademola et al., 2017).

Reproducibility

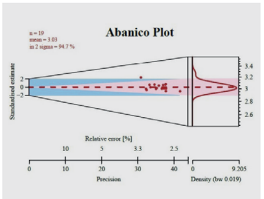


Normalized 1st second OSL response of Al_2O_3:C to 100 cycles of identical beta irradiations (Richter et al., 2015).

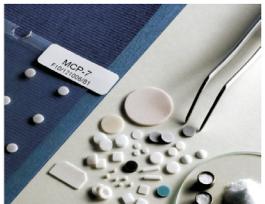
Luminescence dating



Sediment profile with sampling positions and results of fine grain quartz OSL dating (redrawn after Fuchs et al., 2015).



Analysis of equivalent doses of quartz OSL



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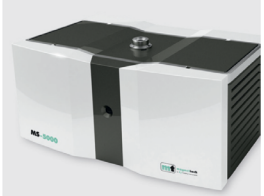
Authenticity testing of clay statues, pottery and ceramic objects



MS 5000 ESR spectrometer for ESR dating of tooth enamel, quartz and more

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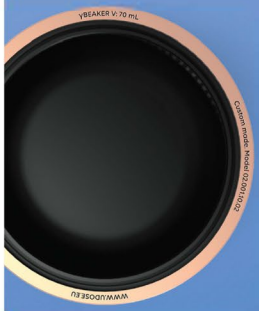

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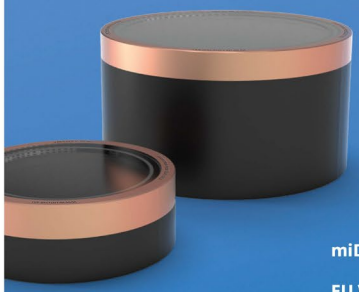

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Scientific Program

Titles of individual presentations in the program are hyper-linked to their corresponding abstracts.

Abstracts are sorted by
Surname (A-Z)

Monday, 26th June 2023

07:30 – 09:00: Registration

09:00 – 09:30: Inauguration

- Rasmus Larsen, Provost, DTU
- Jane Hvolbæk Nielsen, Head of Department, DTU Physics

09:30 – 10:30 Session 1, Fundamental investigations I

Chairs: Sumiko Tsukamoto & Nathan Brown

09:30 – 09:45	The evolution of post-isothermal feldspar luminescence in a Milankovitch time-scale glacigenic sedimentary basin	Michel Lamothe
09:45 – 10:00	Linking feldspar luminescence phenomena and mineralogy using spatially resolved techniques	Svenja Riedesel
10:00 – 10:15	Spectral characterization of the IRSL and TL emissions produced by xenolithic feldspars from the Chaîne des Puys, France	William McCreary
10:15 – 10:30	Effect of sample composition on the infrared-radiofluorescence (IR-RF) of polymineral and K-rich feldspar samples	Mariana Sontag-González

10:30 – 11:00: Coffee

11:00 – 12:30 Session 2, Fundamental investigations II

Chairs: Jakob Wallinga & Helen Roberts

11:00 – 11:15	What surface processes are encoded in the luminescence sensitivity of quartz sediment grains?	Andre Sawakuchi
11:15 – 11:30	Linking provenance and surface processes to quartz luminescence sensitivity of modern and Pleistocene alluvium in a small catchment	Natalie Tanski
11:30 – 11:45	Investigating luminescence and electron spin resonance characteristics of quartz derived from sandstones: An insight into provenance and sediment transport in ancient depositional environments	Aditi K. Dave
11:45 – 12:00	Testing the performance of an EMCCD camera in measuring single grain feldspar (thermo)luminescence	Anna-Maartje Boer
12:00 – 12:15	Revisiting a proof of concept in spatial and temporal bleaching processes by measuring residual doses in surficial sands	Magali Rizza
12:15 – 12:30	Single grain quartz OSL signal properties assessed using EMCCD imaging	Julie Durcan

12:30 – 14:00: Lunch

Monday, 26th June 2023 (continued)

14:00 – 15:45 Session 3, Applications in geoscience I

Chairs: Markus Fuchs & Abi Stone

14:00 – 14:15	OSL dating of Late Pleistocene raised shorelines in northwest Scotland	Regina DeWitt
14:15 – 14:30	Luminescence dating of paleo-shorelines reveals Holocene Lake shrinkage mainly modulated by the Indian summer monsoon on the northwestern Tibetan Plateau	Shuai Zhang
14:30 – 14:45	An optically-stimulated luminescence (OSL)-derived cryptostratigraphy from the Lake Suigetsu sedimentary profile, Japan: 30,000 – 50,000 cal BP	Richard Staff
14:45 – 15:00	From ice-dammed lake to aeolian dunes in the Store Mosse area, SW Sweden	Helena Alexanderson
15:00 – 15:15	Major dune construction during the Younger Dryas period along the Kankakee River Valley, Midwest USA: optically stimulated luminescence dating and ground penetrating radar	Xiaodong Miao
15:15 – 15:30	Luminescence dating of young glacial cobbles and sediments; implications for rock surface luminescence dating of glacial landforms	Yang Li
15:30 – 15:45	The single grain K-feldspar luminescence dating of paleolake shorelines of Manas Lake reveals the Late Quaternary glacial melting water forced high stand lake level in arid Central Asia	Xiaoyan Wang

15:45 – 16:15: Coffee

16:15 – 17:45 Session 4, Fundamental investigations III

Chairs: Makaiko Chithambo & Grzegorz Adamiec

16:15 – 16:30	An overview of infra-red photoluminescence: achievements and challenges	Mayank Jain
16:30 – 16:45	Spatially-resolved luminescence behaviour in museum specimens of feldspar: implications for dating rocks and sediments	Joe Winzar
16:45 – 17:00	Exploring TL signal saturation in quartz and feldspar using emission spectrometry	Pontien Niyonzima
17:00 – 17:15	ESR and OSL variability in quartz extracted from magmatic, metamorphic or sedimentary rock	Helene Tissoux
17:15 – 17:30	Are all luminescence thermal kinetic parameters the same?	Chloé Bouscary
17:30 – 17:45	Wavelength-resolved thermo- and radioluminescence of two quartz reference samples	Mauro Fasoli

17:45 – 18:00: Introducing the new LED society

Tuesday, 27th June 2023

08:30 – 10:00 Session 5, Applications in geoscience II

Chairs: Jintang Qin & Julie Durcan

08:30 – 08:45	Using rock surface luminescence and cosmogenic radionuclide measurements to demonstrate recent ice sheet thinning in the West Antarctic Ice Sheet	Nathan Brown
08:45 – 09:00	ESR thermochronometry of rock samples collected into the Tauern Window, Eastern Alps	Valentina Argante
09:00 – 09:15	ESR and OSL-thermochronometry in the Western European Alps	Xiaoxia Wen
09:15 – 09:30	Unravelling rock cooling histories of the Japanese Alps within the past 1 Ma using ESR and OSL thermochronometry	Melanie Bartz
09:30 – 09:45	Bleaching in river valley sediments from the eastern margin of the Last Scandinavian ice sheet	Anna Utkina
09:45 – 10:00	Exploring the multi-faceted potential of luminescence profiling via the portable reader in various fluvial landscapes and depositional environments (NE France)	Gilles Rixhon

10:00 – 10:30: Coffee

10:30 – 12:00 Session 6, Advances in dose determination

Chairs: Alida Timar-Gabor & Michael Meyer

10:30 – 10:45	A Bayesian hierarchical age model for single-grain dating of feldspars	Bo Li
10:45 – 11:00	Development of the pIt-IRSL protocol for dating polymineral fine grains from Chew Bahir, Ethiopia	Nina Ataee
11:00 – 11:15	Testing appropriate quartz OSL and K-feldspar pIR IRSL measurement protocols for dating fluvial sediments from Indonesia	Yuniarti Yuskar
11:15 – 11:30	Surface Exposure Dating Applications using OSL Laser Scanning Measures and Controlled Light Exposed Rock Sampling Techniques	Tristan Bench
11:30 – 11:45	Challenges in US-ESR dating: From irradiation sources to age modelling	Renaud Joannes-Boyau
11:45 – 12:00	Testing the accuracy of single-grain OSL dating on Eemian quartz samples	Frederik Baumgarten

12:00 – 13:30: Lunch

Tuesday, 27th June 2023 (continued)

13:30 – 15:00 Session 7, Instrumentation and Analysis

Chairs: Regina DeWitt & Ed Rhodes

13:30 – 13:45	Chasing snails: automating the processing of EMCCD images of luminescence from opercula	Geoff Duller
13:45 – 14:00	Radiation detection with a Si-based time-pixelated quantum counting/imaging detector: potential for trapped charge dating	Raju Kumar
14:00 – 14:15	Potential of luminescence imaging for screening sensitive or well-bleached rocks	Pavao Andričević
14:15 – 14:30	Calibration of buried NaI(Tl) scintillator detectors for 4π natural radionuclide measurement based on MCNP modelling	Amalia Chambon
14:30 – 14:45	μDOSE+: Dose rate measurement system with active shielding boosted by machine learning	Konrad Tudyka
14:45 – 15:00	Analysis of time-resolved optically stimulated signals in the presence of overlapping components or under the influence of shallow traps	Eduardo G. Yukihara

15:00 – 15:30: Coffee

15:30 – 18:00: **Poster Session I** starting with a rapid-fire round of 2-minute presentations by students

18:00 – 18:30: Remove posters from **Poster Session I** to make room for the posters in **Poster Session II**

Wednesday, 28th June 2023

08:30 – 10:00 Session 8, Fundamental investigations IV

Chairs: Geoff Duller & Mauro Fasoli

08:30 – 08:45	TL characteristics of calcite obtained from terrestrial and marine samples	Barbara Mauz
08:45 – 09:00	Luminescence and mineralogy characteristics of fault-associated carbonates features of Western Sichuan Plateau	Jintang Qin
09:00 – 09:15	Phototransferred thermoluminescence of calcite: Principles, analytical methods and mechanisms	Makaiko Chithambo
09:15 – 09:30	Towards rock surface OSL dating of flint	Lucas Ageby
09:30 – 09:45	Luminescence chronology and thermometry studies of plant opal phytoliths	Joel Spencer
09:45 – 10:00	Low temperature thermochronology using isothermal thermoluminescence signals from calcite	Chang Huang

10:00 – 10:30: Coffee

10:30 – 11:30 Session 9, Archaeology I

Chairs: Bo Li & Luke Gliganic

10:30 – 10:45	Dating the construction of a Late Prehistoric megalithic monument at Cruz de Cepos, NE Portugal	Ian Bailiff
10:45 – 11:00	Towards luminescence rock surface dating of rock engravings at Murujuga, Western Australia	Luke Gliganic
11:00 – 11:15	Rock surface luminescence dating of the burial mound at Saint-Bélec (Finistère) in Western France	Trine Freiesleben
11:15 – 11:30	Optically Stimulated Luminescence dating of the Xujiayao site reveals diversification of hominin lineages during the Penultimate Glacial Period in East Asia	Junyi Ge

11:30 – 12:00: Departure to Roskilde/Risø

12:00 – 18:00: Excursion in Roskilde/Risø

18:00 – 18:30: Bidding & voting for the LED2026 venue

18:30 – 22:45: Conference dinner at Risø Campus. The LED2026 venue will be announced

22:45 – 23:00: Departure to Copenhagen

Thursday, 29th June 2023

08:30 – 09:30 Session 10, Applications in geoscience III

Chairs: Helena Alexanderson & Simon Armitage

08:30 – 08:45	Using single-grain feldspar luminescence to decipher river landscape and sediment dynamics	Anne Guyez
08:45 – 09:00	Single-grain luminescence as a bioturbation tracer in chernozem	Aimin Zhang
09:00 – 09:15	Quantifying ancient bleaching and storage for feldspar single grains	Ed Rhodes
09:15 – 09:30	Isothermal thermoluminescence (ITL) dating of a speleothem from Bleßberg Cave	Junjie Zhang

09:30 – 10:00: Group photo

10:00 – 10:30: Coffee

10:30 – 12:00 Session 11, Archaeology II

Chairs: Mathieu Duval & Sahar al Khasawneh

10:30 – 10:45	Using luminescence dating to establish a window of extinction; the demise of the greatest ape - Gigantopithecus blacki	Kira Westaway
10:45 – 11:00	The first detailed luminescence chronology of the Middle Palaeolithic Khonako sites (Tajikistan)	Amélie Challier
11:00 – 11:15	OSL dating of the Xinmiaozhuang Locality 2 (XMZ2) site in the Nihewan Bansin, northern China	Yujie Guo
11:15 – 11:30	Geochronological advances in human first arrival date in the Philippines Archipelago (Cagayan valley, Luzon Island)	Jean-Baptiste Lambard
11:30 – 11:45	Violet stimulated luminescence based new ages of loess and hominin occupation in Lushi Basin, Eastern Qinling Mountains, central China	Jiang Wu
11:45 – 12:00	The Lower to Middle Paleolithic transition at Tabun Cave (Mount Carmel, Israel): some insights into diagenesis and dose rate variation using IRSL (pIRIR290) dating and infrared spectroscopy	Maïlys Richard

12:00 – 13:30: Lunch

Thursday, 29th June 2023 (Continued)

13:30 – 15:00 Session 12, Applications in geoscience IV

Chairs: Tony Reimann & Tammy Rittenour

13:30 – 13:45	Luminescence ages of offset and unfaulted alluvium along the San Andreas Fault in Southern California	Ayush Joshi
13:45 – 14:00	Luminescence dating of glacial sediments of penultimate glaciation in SE Tibetan Plateau using single grains of K-feldspar	Yantian Xu
14:00 – 14:15	The vertical and lateral erosion rates of Manas River, North Tianshan: insight from luminescence dating of terrace deposits	Jie Chen
14:15 – 14:30	Finding Quaternary Seismogenic Activity via Trapped Charge Dating Methods on Fault Gouges: A Case Study of the Periadriatic Fault System	Erick Prince
14:30 – 14:45	Pace of alluvial river incision constrained by luminescence dating	Kechang Li
14:45 – 15:00	Assessing the timing of the extent of the Laurentide Ice Sheet using optical dating of quartz, Hudson Bay Lowland, Manitoba, Canada	Maria Schaarschmidt

15:00 – 15:30: Coffee

15:30 – 18:00: Poster Session II starting with a rapid-fire round of 2-minute presentations by students

Friday, 30th June 2023

8:30 – 10:00 Session 13, Testing and Validation

Chairs: Christina Neudorf & Jeong-Heon Choi

8:30 – 8:45	Maximising reproducibility in luminescence measurements of rock slices	Helen M. Roberts
8:45 – 9:00	Luminescence vs Biotic dating methods in Late Quaternary stratigraphy	Stefano Andreucci
9:00 – 9:15	Cross-checking the results of radiocarbon dating and optically stimulated luminescence as a tool for the stratigraphic model of fluvio-aeolian succession in the central part of the European Sand Belt	Grzegorz Poręba
9:15 – 9:30	Extended range dating: how to choose the right signal?	Naomi Porat
9:30 – 9:45	Study of Holocene Soil Erosion on Agricultural Loess Slope using luminescence in conjunction with fallout radioisotopes Cs-137 and $Pb\text{-}210_{ex}$	Grzegorz Adamiec
9:45 – 10:00	Testing the timing of loess accumulation in western Greenland using joint radiocarbon and luminescence methods	Daniele Sechi

10:00 – 10:30: Coffee

10:30 – 11:15 Session 14, Fundamental investigations V

Chairs: Guillaume Guérin & Andre Sawakuchi

10:30 – 10:45	XLUM: an open data format for the exchange and long-term preservation of luminescence data	Sebastian Kreutzer
10:45 – 11:00	Radiological or nuclear emergency OSL dosimetry using commonplace salt	H. M. S. Alghamdi
11:00 – 11:15	Investigating the low temperature thermoluminescence peak from calcite for monitoring thermal lag	Debra Colarossi

11:15 – 12:00: Closing LED 2023 (presentation by next LED committee, Student awards)

12:00 – 13:30: Lunch

15:00 : Departure for field trip

Poster Session I, 27th June 2023

ID	Participant	Abstract title
1	Abi Stone	Exploring dryland dynamics with portable luminescence readers: the good, the bad and the ugly.
2	Agnieszka Szymak	Increasing the reliability of luminescence dating through the internal dose rate determination
3	Alicia Medialdea Utande	Polymineral fine grains as the alternative to date sedimentary material from New Zealand
4	Alicja Chruścińska	OSL signal components of quartz for the dose range close to saturation
5	Alida Timar-Gabor	Reconstructing dust provenance from quartz OSL and ESR signals: preliminary results on loess from around the world
6	Aline Zinelabedin	Testing the attenuation of light in evaporite-dominated sediments from the Atacama Desert
7	Ana Luísa Rodrigues	Uncovering the dynamics of construction, use and abandonment of Roman military camps in Northwest Iberia through luminescence dating and geochemistry
8	Andrew Murrray	A chronology for Holocene sedimentation and landscape dynamics in South-East Central Asia
9	Anna Yang	Application of OSL dating to trace the origin of the megaflood(s) of the Yarlung Tsangpo River
10	Annette Kadereit	Luminescence dating at the loess-palaeosol sections Baix and Collias in the Rhône Rift Valley, southern France, and chronostratigraphic implications
11	Antoine Zink	Luminescence dating of kilns pottery quarter at Paykend (Uzbekistan)
12	Anzhela Vasilieva	Dating the terraces of the Lena River using luminescence
13	Arindam Biswas	Understanding sediment transport using pIRIR signal from feldspar single grain supported by terrestrial cosmogenic radionuclides
14	Atul Kumar Singh	Climate and Neo-Tectonics Imprints on the Evolution of Late Quaternary Terraces in the Tista River Basin, Darjeeling Sikkim Himalaya
15	Belligraham Narzary	Luminescence chronology of neotectonic activity on foothills of the Assam-Bhutan Himalayas: An Insight into Climate-Tectonic Relationship
16	Caio Breda	OSL dating in Quaternary fluvial deposits in the Andes foothills: insights from environmental drivers.
17	Carlos Andrés Ortiz Barrios	OSL sensitivity of quartz as a provenance analysis tool: perspectives from the northern Andes uplift
18	Carlos Arce Chamorro	D_es comparisons of Late Pleistocene alluvial deposits on the Coast of Galicia (NW Spain) using BayLum or Analyst-based procedures.
19	Carolina Cruz	Luminescence characteristics of quartz to disentangle sediment provenance in low-contrasting source areas: the case of Eastern Andes of Colombia
20	Chantal Tribolo	Investigating the accuracy and relevance of the pIT protocol
21	Charlie Rex	Investigating the Utility of Optically Stimulated Luminescence to Access Residual Contamination of Pre-treated Diatom Silica
22	Christina Neudorf	The luminescence dating potential of pebbles from pluvial lake beach deposits: Preliminary results from the Great Basin, USA
23	Christoph Schmidt	Zircon luminescence as a geochronological tool for (sub-) recent sediments
24	Christophe Falgueres	ESR/U-series and IRSL dating of Middle Pleistocene site of Lunel Viel (LV I), Hérault, Southern France
25	Chuanyi Wei	Combined 14C, OSL and ESR dating of representative loess-paleosol sequence from Songnen Plain, Northeast China

Poster Session I, 27th June 2023

ID	Participant	Abstract title
26	Chun-Ru Liu	Geochronology of multiple dating methods on quaternary drilling hole: a case study from Shinaimiao core in the transition zone from the eastern foothills of the Taihang Mountain to the North China Plain
27	Chun-Xin Wang	The De underestimation caused by recuperation of heated quartz extracted from volcanically-baked clay and correction strategies
28	Daniel Richter	Recent developments from Freiberg Instruments
29	Daniela Constantin	Luminescence and ESR characterisation of granite source rocks and the derived sediments
30	Daniela Mueller	Luminescence dating of Pleistocene pro-glacial deposits from northern Switzerland
31	Dayane Melo	Precipitation changes over the last 30,000 years over La Plata basin based on quartz luminescence sensitivity
32	Dimitri Vandenberghe	The Brabant Member at Romont quarry (East Belgium): new luminescence ages based on quartz and feldspar
33	Dirk Mittelstraß	Signal component analysis of IR-RF decay curves of K-feldspars
34	Dominik Brill	Luminescence-based chronology and transport dynamics of tsunami backwash deposits from the shelf of Portugal
35	Emma Krolczyk	Using Single-Grain OSL of Anthropogenically Placed Rocks to Determine Headward Gully Migration in Wyoming, USA
36	Eslem Ben Arous	An extensive ESR-OSL dating comparison on coastal dune deposits from the Wilderness-Knysna area (South Africa)
37	Fabiano Pupim	Quartz luminescence sensitivity applied as a provenance tool of fluvial sediments from cratonic sources
38	Fayçal Kharfi	Algerian Islamic ceramics TL dating and origins identification
39	Fei Han	Dating the northernmost evidence of Gigantopithecus by combined ESR and U-series method
40	Furong Cui	Attenuation of daylight in different rocks and its influence on the detrapping rate
41	Galina Faershtein	A safe procedure for HF etching as part of sample preparation for luminescence dating
42	Gang Hu	Fluvial downcutting and its influence on human activities in the middle reach of the Lancang River during the late Holocene
43	Georgina King	Borehole calibration of ESR thermochronometry
44	Gillian Stephan	OSL and radiocarbon-based chronology of sand-drift events on Beniguet island (W France)
45	Gongming Yin	Preliminary ESR dating results for fault barite: Insights into the history of faulting recorded by barite in basalt bedrock of the Li-jiang–Xiaojinhe Fault, southeastern Tibetan Plateau
46	Guillaume Guérin	Looking at different time scales – the conflict between sampling resolution and stratigraphic constraints from a Bayesian perspective
47	Guiming Hu	The Optically Stimulated Luminescence dating of centennial-millennial paleoseismic events along the middle section of the Altyn Tagh fault, China
48	Guoshan Li	Luminescence chronology for the first terrace of the Pearl River in the Baise Basin, South China
49	Gustav Firla	Dating glacial sediments from drill-cores with single grain pIRIR luminescence methods.

Poster Session I, 27th June 2023

ID	Participant	Abstract title
50	Gwynlyn Buchanan	Investigating the characteristics of post-IR yellow stimulated luminescence
51	György Sipos	Spatial and temporal differences of quartz luminescence sensitivity in the fine grain fraction of loess and fluvial deposits in the Danube Basin
52	Hao Ji	Evaluating the signal bleaching degree of the Al and Ti-Li signals in quartz of fluvio-lacustrine sediments and the chronology of volcanic eruption in Datong, North China
53	Hao Long	Single-grain K-feldspar luminescence dating of late Quaternary lake expansion over the Tibetan Plateau
54	Hua Tu	Luminescence chronology of aeolian sands in east Guangdong of the coastal South China Sea
55	Huili Yang	OSL dating millennium volcanic eruption and baked sediments from Changbaishan, China
56	Hyo-Jeong Weon	Dating fault rocks using optically stimulated luminescence and ESR signals: Can OSL and ESR signals be reset by faulting?
57	Hyun Ho Yoon	A chronology of Holocene barriers in the East Sea of Korea: Luminescence dating of sandy sediments
58	Isabel Hernando-Alonso	ESR chronology of interior facies of Galería complex (Zarpazos-Galería-Tres simas)
59	Jakob Wallinga	Landscape dynamics enlightened by feldspar single-grain luminescence
60	Jan-Pieter Buylaert	A detailed luminescence dating study of the loess-palaeosol sequence at Kuldara, Khovaling Loess Plateau, Tajikistan
61	Jeong-Heon Choi	Luminescence exposure dating of a collapsed Buddha statue informs palaeoseismology
62	Jilei Yang	Single grain pIRIR dating of glacial sediments in the Yuzhu Peak area of Kunlun Mountains of Tibetan Plateau revealed the transgression and regression of glaciers during Holocene period
63	Jin Cheul Kim	Optically stimulated luminescence dating of coastal sediments from southwestern Korea: some discontinuities with concentrated organic layer
64	Jingran Zhang	Luminescence dating reveals glacial paced ancient dammed lakes formation and outburst along the Yarlung Tsangbo
65	Jitumani Kalita	Study of trap distribution in Sr4Al14O25:Eu2+,Dy3+ — a persistent luminescent phosphor
66	Jorge Sanjurjo Sánchez	OSL dating of very young aeolian sediments of NW Spain to assess dune erosion due to sea level changes
67	Jose Luis Antinao	Temporal and spatial variability of luminescence properties of MIS6 and MIS2 glacifluvial sediments derived from the Laurentide Ice Sheet, Indiana, USA
68	Jungyu Choi	How variable bleaching of single-grain low-temperature pIRIR signals impacts age estimation
69	Karissa Cordero	Cooling age estimates for hydrothermal explosions in Yellowstone National Park
70	Kartika Goswami	Applying luminescence signals to trace sedimentary provenance
71	Kathleen Rodrigues	New luminescence age estimates for the Soda Lake maar eruption (Nevada, USA)

Poster Session I, 27th June 2023

ID	Participant	Abstract title
72	Kiriha Tanaka	Potential for ESR Signal Zeroing of the E_1' center by Experimental Fault Slips
73	Kristina Thomsen	Preliminary optically stimulated luminescence ages for the archeological site of Gatzarria, France
74	Kunmei Yang	Luminescence dating of cobbles buried in moraine deposits from the source area of Litang River, eastern Tibetan Plateau
75	Laura Panzeri	Towards the determination of an absolute chronology by rock surface and sediment OSL dating of the pre-ceramic Tumshukaiko monumental site in the north-central Andes of Perù.
76	Lee Arnold	Single-grain OSL and U-series/ESR dating of the early Upper Palaeolithic sedimentary sequence at Lagar Velho Rock Shelter
77	Laura Kögler	Middle–Late Pleistocene fluvial landscape evolution in the Granada Geopark: Application of a challenging pIRIR dating approach

Poster Session II, 29th June 2023

ID	Participant	Abstract title
78	Linda Maßon	Testing the applicability of standardised growth curves (SGC) for single-grain pIRIR measurements of chemically heterogenous feldspars from the Atacama Desert, Chile.
79	Liping Zhou	Towards an optimal protocol for dating lacustrine-aeolian sandy deposits at Jiufangtai Section in the Salawusu River Valley of the Mu Us Desert, China
80	Loïc Martin	Towards improving Luminescence Rock Surface Dating through imaging methods
81	Louise Karman-Besson	Alongstream single-grain luminescence signal along a pluvio-metric gradient in Chile: A preliminary dataset
82	Maciej Gosek	Dose rate measurements with correlated U, Th and K uncertainties using full NaI gamma spectrum analysis
83	Madhurima Marik	Luminescence dating of large clast rock surfaces buried in glaciofluvial sediments of the southern Upper Rhine Graben
84	Magdalena Biernacka	OSL medium component in quartz observed using the TM-OSL method
85	Manabu Ogata	Reconstructing the thermal structure of shallow crust using OSL-thermometry of K-feldspar from deep borehole core: case studies in the Japanese Islands
86	Manchen Huang	Combined ESR and U-series dating of a Paleolithic-Neolithic transition site - Naminan cave, China
87	Mariia Iakovleva	Luminescence dating the glacial history of the Pamir Mountains (Central Asia)
88	Marine Frouin	A synchrotron study of the defects associated with the principal trap in feldspar
89	Mariya Lukyanycheva	Luminescence dating of the Diring Yuriakh Early Palaeolithic site (North-Eastern Siberia)
90	Mark Bateman	Dating sediments from problematic glacial contexts
91	Martin Ntwaeaborwa	Optimization of the electron transport layer in quantum dots light emitting diodes by co-doping ZnO with gallium and magne-sium
92	Martina Demuro	Extended-range luminescence and ESR dating of Iberian fluvial terraces (Duero and Guadiana basins) associated with the Lower Palaeolithic sites of La Maya I, II, Burganes and Albalá (west-central Spain)
93	Mary Evans	Luminescence ages of the ceramics from the Urewe and Kalundu Traditions, Lydenburg Heads site, Mpumalanga, South Africa
94	Maryam Heydari	Employing luminescence dating to decipher the timing of past earthquakes through faulted colluvium and fault gouge at the North Tehran fault zone
95	Masashi Takada	Sensitivity changes and fading behaviors of luminescence signals from various geological materials
96	Mathieu Duval	Dating the earliest evidence of human presence in western Europe: New results from Pirro Nord (Italy)
97	Michael Meyer	The Python time machine – an open source software application for luminescence-based rock surface dating
98	Miren Del Val	Evaluating the impact of sediment sample size and heterogeneity on High Resolution Gamma Spectrometry
99	Miriam Saleh	A unique case of vitrified forts from Italy: TL dating with "Pre-bleach with blue LEDs" protocol.
100	Myungho Kook	Optical bleaching in the luminescence reader using an LED based solar simulator

Poster Session II, 29th June 2023

ID	Participant	Abstract title
101	Naoya Obata	Thermal stabilities and sensitivities to dose of the low and high temperature components of ESR signals in quartz.
102	Nasrin Karimi Moayed	Optical dating of post-1930 CE charcoal kilns remains: a test of accuracy
103	Natalia Taratunina	Chronology of Late Quaternary permafrost events in the Lower Volga region (Northern Caspian Lowland)
104	Neda Rahimzadeh	Dating the Neanderthal environment: Detailed luminescence chronology of a palaeochannel sediment core at the palaeolithic site of Lichtenberg in the Lower Saxony, northern Germany
105	Nicolas Brot	When the sediment can't be correctly dated: the case study of the archeological site Toca dos Coqueiros (Piauí, Brazil).
106	Olivier Tombret	ESR/U-series dating of palaeontological remains from the Neandertalian site of Mutzig-Rain (Alsace, France)
107	Paul Hanson	Luminescence Dating and Alluvial History of the Platte River Valley Fill, Nebraska, USA
108	Penghui Lin	OSL and radiocarbon dating of core SXG06 from Dongguan in the Pearl River Delta
109	Pierre Voinchet	Middle Loire Valley settlement: first chronology using ESR on quartz grains
110	Priscila Emerich Souza	Investigating the quartz relative fast OSL component sensitivity from test- and regenerative-dose signals over SAR cycles
111	Qinjin Shen	Late Quaternary sedimentation history of the alpine Damqu Wetland in the Yangtze River headwater in Tibetan Plateau by luminescence dating
112	Qiuyue Zhao	Multi-step post-IR IRSL dating and paleoclimate implications since penultimate interglacial palaeosol in the Central Shandong Mountains, eastern Chinese Loess Plateau
113	Rabiul H. Biswas	Towards accurate modelling of OSL rock surface exposure dating
114	Rachel Haupt	How old are the coastal dune deposits and shell middens on the West Coast near Yzerfontein, Western Cape, South Africa?
115	Redzhep Kurbanov	Dating the Middle and Late Quaternary Caspian Sea-level fluctuations: first luminescence data from the coast of Turkmenistan
116	Ruonan Tian	Holocene lake formation, Yellow River migration and neolithic human activity revealed by OSL and radiocarbon ages of cores from the North China Plain
117	Sahar al Khasawneh	Investigating Luminescence-depth profiles of rocks with different lithologies
118	Salome Oehler	Approaching Last Glacial Maximum to Holocene continental surface air temperature reconstruction using thermoluminescence paleothermometry
119	Sarah Schaffer	Constraining extreme fluvial discharge events using a combination of classical and EMCCD-based rock surface dating-techniques.
120	Sebastien Huot	Measurements of uranium, thorium, and potassium as an inter-laboratory comparison: it takes two to tango!
121	Seok-Jin Kim	Quartz OSL and K-feldspar IRSL dating of terrestrial sediments in Quaternary movement sections along the Yangsan and Ulsan faults, southeastern part of the Korean peninsula
122	Shannon Mahan	Age Reassignment Using Luminescence Dating for The Mammoth Site, Black Hills, South Dakota, USA
123	Sheng-Hua Li	Photoluminescence study of different types of single crystal feldspars and the implications to PL dating using a Raman system
124	Shengli Yang	Luminescence chronology of the Jinchuan loess-paleosol sequence at the Western Sichuan Plateau, China

Poster Session II, 29th June 2023

ID	Participant	Abstract title
125	Shuangwen Yi	New chronological results of Paleolithic in the Chaohu Lake Region and its implications for the early Hominin occupation in south China
126	Shugang Kang	Luminescence dating of sandy loess along the middle Yellow River and its implications for the interactions between aeolian and fluvial processes
127	Simon Armitage	Environmental dose rate calculation for deep ocean sediments: Measure, model or guess?
128	Sumiko Tsukamoto	Resetting of quartz OSL signal from fault gouges by the 1891 Nobi Earthquake
129	Tammy Rittenour	Wildfire exposure recorded in quartz luminescence sensitivity
130	Thais Silva	OSL and TL sensitivity measured in marine and fluvial sediments from the São Francisco River basin, eastern Brazil
131	Thays Desiree Mineli	Quartz standardized growth curve for optically stimulated luminescence dating: case study from Amazonian fluvial deposits, Brazil
132	Thomas Kolb	Feldspar, fading and correction: A systematic investigation of parameters influencing the performance of fading correction techniques
133	Toru Tamura	Sediment transport revealed by residual doses of modern K-feldspar sands in the Kujukuri coast, central Japan
134	Virginia Martínez-Pillado	New Electron Spin Resonance, Luminescence and Aspartic Acid Racemization dating results for the Pleistocene sedimentary infill of Cueva Mayor (Atapuerca, N Spain)
135	Warren Thompson	Direct dating of an ancient stone causeway at Bjæverskov, Sjælland, Denmark: A combined approach using rock surface burial luminescence dating of granitic cobbles and coarse grains from disaggregated heated rocks.
136	Weitao Yuan	Luminescence Chronology for DZK01 Core from Shandong peninsula of the coastal Bohai Sea in China
137	Xianjiao Ou	What is the true age? Complicated transport history revealed by luminescence dating of multiple buried cobbles
138	Xiao Fu	High-resolution OSL dating of loess in the Gonghe Basin, north-eastern Tibetan Plateau
139	Xiaomei Nian	Transgressive-regressive cycles in the Yangtze River Delta since the penultimate glaciation
140	Xue Rui	Testing the upper limit of luminescence dating based on single-grain (SG) standardised growth curve (SGC) for pIRIR signals of K-feldspar grains from Nihewan Basin, northern China
141	Yali Zhou	OSL dating for the oldest aeolian sand in the Otindag sandland, China
142	Yan Li	Timing of fluvial-lacustrine sedimentation in the North China Plain since the late Pleistocene by multiple luminescence dating approaches
143	Yang Ou	Late Quaternary stratigraphic reconstrution based on OSL and radiocarbon dating of core sediments in the North Yellow Sea
144	Yeong-Min Hong	Formation history of marine terraces in the southeastern coast of Korea during the late Quaternary revealed by quartz OSL dating of marine and colluvial sediments in Nulchado island
145	Ying Wang	Quartz OSL and K-feldspar pIRIR dating of young nebkhas from semi-arid dune fields in northern China
146	Yinjun Zhou	OSL chronology of fluvial aggradation and incision in the source area of the Mekong River in Tibetan Plateau since Late Pleistocene
147	Yiwei Chen	OSL dating of fluvial and lacustrine sediment in Ranwu Lake, Southeastern Tibet
148	Yougui Song	Ages of Central Asian loess and their implications for dust sedimentation

Poster Session II, 29th June 2023

ID	Participant	Abstract title
149	Yuexin Liu	Comparison of OSL and radiocarbon dating on core LFZK06 from Lufeng of the coastal South China Sea
150	Yuxuan Du	Luminescent chronology of coastal sedimentary strata in Northern Jiangsu Basin over the last 350,000 years
151	Yuye Feng	Application of single-grain pIRIR dating to beach ridges deposition from the inner Tibetan Plateau
152	Zhaojing Ding	Luminescence dating of playa sediments from the Qaidam Basin in the Tibetan Plateau using both Quartz and K-feldspar
153	Zhixiong Shen	Quartz OSL of a Category 5 hurricane washover deposits sufficiently bleached
154	Zhongbo Wang	OSL and radiocarbon dating of a borehole from the East China Sea shelf and implications for regional stratigraphic correlation
155	Zhongping Lai	Luminescence chronology of core JNZK1 from Jinan in the middle Yellow River Plain
156	Zuzanna Kabacińska	The effects of transport on ESR and OSL properties of quartz: a case study in an area with a simple granitic lithology

Towards rock surface OSL dating of flint

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A significant part of the pre-historic record consists of lithic artefacts made from flint. Thermoluminescence dating can be used to date heated flints from archaeological sites but is not applicable to unheated samples, making such samples challenging to date. But it's not always possible to find heated flint; thus, there is a need for flint dating techniques that can date flint samples that were likely reset by exposure to daylight. Optically stimulated luminescence (OSL) dating - especially if applied to flint surfaces (rock surface luminescence dating) - could determine the degree of pre-burial bleaching and subsequently date the burial of flint from previously hard-to-date sites. The OSL characteristics of flint are often considered unsuitable for dating, but previous work has demonstrated that some heated cherts are sensitive to optical stimulation [1]. We here investigate whether samples of Danish flint from various locations are suitable for dating using light-sensitive luminescence signals and use this knowledge to date a previously dated interstadial site in Zealand, Denmark.

Initially, flint samples were collected from four sites in Denmark. On average, blue-stimulated luminescence (blue OSL) is brighter than green or infrared-stimulated luminescence, with nearly all samples providing a clearly detectable dose-dependent blue OSL stimulation curve (>100 cts s^{-1} above background). Laboratory-administered doses are recoverable (dose recovery ratios range between 0.94 ± 0.04 and 0.98 ± 0.02) using a single aliquot regenerative protocol for one sample per site using blue stimulation and a 100 s preheat at 240 °C. Dose-response curves from the same four samples and sites provided D_0 values ranging between 380-450 Gy. Unfortunately, fading measurements yield high g- values (2 to 9 % per decade); at least the largest of these values are inconsistent with the presence of the measured natural OSL, and the reason for these results is currently not understood.

OSL-depth profiles from flint samples excavated from primary flint deposits demonstrate no bleaching at the buried surfaces; this is in contrast to exposed flint beach cobbles in which the OSL signal was bleached to ˜10 mm before reaching field saturation at larger depths. The presence of bleaching fronts in flints demonstrates that a previously bleached surface could be identified in buried flints with unknown exposure histories. The OSL-depth profiles from one such sample from a palaeobeach deposit in Zealand show that pre-burial bleaching was substantial on several surfaces: bleaching fronts (inflection point)) reach depths of 11 mm. The burial plateaus are easily distinguished in some cores; in others, the plateaus are poorly defined due to large scatter, which is also true for the OSL plateau at the centre of the flint (taken as field-saturation).

While questions remain regarding signal stability and variations in signal intensity from different geological sources, our study into flint OSL dating shows that the method has promise. We will now test this further at chronologically well-constrained archaeological and geological sites.

Keywords (max. 5): flint, OSL, rock surface luminescence**,** depth profiles**,** bleaching

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Investigating Luminescence-depth profiles of rocks with different lithologies

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Luminescence rock surface dating has an enormous potential in the radiometric dating of geo/archaeological features. There have been a rapid advances to improve the accuracy and precision of the technique [1,2]. These studies included the development of models to describe the penetration of light into rock surfaces, and the effect of subsequent burial [1,2,3]. Experiments have been undertaken to investigate the dependence on the model parameters controlling the bleaching/ accumulating of the luminescence signal in rock surfaces; these include light attenuation, effective dose rate and surface erosion rate [1,2,3,4]. Some attempts have also been made to connect the light attenuation coefficients to the rock lithology [2]. In this project, we investigate the luminescence signals from three different types of rock (sandstone, granite and basalt). We use a controlled bleaching experiment where rock samples are artificially irradiated (~3.25 kGy) to saturate the latent luminescence signals, before experiencing controlled light exposures. We determine the penetration of daylight into the surfaces of the 3 different lithologies, and analyze the luminescence depth profiles developed in these materials. Finally, our data are compared with those derived from archaeological buried rocks, and the implications of our work for dating are considered.

Keywords: Basalt, Granite, Sandstone

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From ice-dammed lake to aeolian dunes in the Store Mosse area, SW Sweden

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Aeolian deposits surround and stretch across the Store Mosse (*Great Bog*) bog complex in southwestern Sweden. Both peat and aeolian sand are underlain by lacustrine sediment and the deposits record the area's transition from an initially ice-dammed lake to Ancient Lake Bolmen, which gradually drained, exposing sediments to wind erosion and allowing peat to start forming in basins.

Here, we present 25 luminescence ages from lacustrine/fluvial and aeolian deposits that range from the time of deglaciation (~14.5 ka) to the late Holocene (~3.5 ka). Most of the waterlain sediments are dated to 12-10 ka while the bulk of the dunes formed 10.5-6.5 ka ago, possibly during two phases in the early and early-mid Holocene, respectively. Single younger ages likely record limited re-activation of dunes during the mid-late Holocene.

The optically stimulated luminescence (OSL) dating was done on 180-250 µm quartz grains, which showed generally good but variable luminescence characteristics. OSL profiling (portable OSL) was carried out for initial assessments and the correlation between those data and final ages will be discussed, as well as the relationship of the dune record to a regional peat-based palaeostorm record [1].

Keywords: OSL, portable luminescence, quartz, Holocene, Scandinavia

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Radiological or nuclear emergency OSL dosimetry using commonplace salt

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During recovery phases following a nuclear or radiological incident analyses of doses received by members of the public and responders are required, both to guide countermeasure decisions, and for retrospective impact analysis. Several methods have been used at different timescales after the incident, including assessments based on measurements of materials present at the time of the incident. Common salt has previously been shown to have potential for dosimetry in the sub-mGy dose range, and portable OSL instruments have been appraised in dose ranges below 100μGy, demonstrating detection limitsdown to 7μGy and a linear response in the 0-500μGy range [1].

This study aims to explore the effects of sample storage under light and dark conditions on OSL signals. Reverse fading, with signals increasing during short term storage, has been observed. Light exposure (simulated daylight) results in a very rapid loss of OSL signals. Results are discussed with reference to TL measurements of associated trapping systems which provide insight into potential zeroing mechanisms and the observed fading behaviour. The results are sufficiently favourable to conclude that these characteristics, together with the widespread availability and low cost of household salt, support its use for prompt emergency assessment, and as a retrospective dosemeter, below 100μGy. Considerations for deployment for individual and community dose assessment and area mapping are discussed.

Keywords (max. 5): Optically stimulated luminescence (OSL), NaCl, Emergency dosimetry, Retrospective dosimetry, Fading.

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Luminescence vs Biotic dating methods in Late Quaternary stratigraphy

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Since the late '40 radiocarbon and U/Th methods have been widely used to provide precise ages of Pleistocene/Holocene, continental to marine, sedimentary successions worldwide. The major stratigraph- ic assumption is that the time elapsed since the death of organisms such as corals, shells, plants and (in some cases) bones found in sedimentary bodies correspond to the age of the strata depositions. The lu- minescence method, instead, provides the age since quartz and/or feldpsar grains were hidden by the sunligth and buried in a sedimentary strata. Thus, this method should directly calculate the age of a de- positional events. Despite their enourmous influences on stratigraphy both abiotic and biotic methods aren't silver bullets and when combined for dating marine or continental successions, results are not so straight forward building up, frequently different geochronological frameworks.

We present two case studies where luminescence and biotic methos (radiocarbon and/or U/Th) have been applied on Late Quaternary marine and continental successions producing "apparent"geological mismatchings.

The first case study is represented by the Marine Isotopic Stage (MIS) 5e (ca. 125 ka)relict beach deposits of Sardinia island (MediterraneanSea) . The succession filling marine terraces, is characterized by two superimposed units with abbundant corals toward the top. Traditional U/Th dating have been performed on corals for more than 30 years dating all the successions to the MIS5e (ca. 125 ka). Newly performed luminescence analysis instead, dated the lower unit to the MIS 5e (ca. 130ka) and the upper unit containing the U/T dated coral fragments to the following MIS 5c (ca. 100 ka) substage. Despite the methods provide a different chornological framework both are accurate and relailable. Thus the resultant interpretation is that the luminescence method is dating the age of the strata deposition (MIS5c) whereas U/Th provide the age of the death of corals (MIS5e) that were reduced in fragments and reworked from the underlain unit toward the top.

The second case study is represented by the distal alluvial fan deposits developed along the flank of the Famara cliff (Lanzarote island, CanaryArchipelago). The succession from the bottom up is domina- ted by a ritmitic alternation of sand-sheet and muddy pond-like strata cut at the top by a relatively thick- gravelly channel body. The succession is luminescence dated at the MIS3 (40-25 ka) wherease radiocar- bon on shell-snails found in the muddy strata point to the early-middle Holocene (10-4 ka). The resultant chornological framework clearly appear as a geological nonsense and the age reversal cannot be explai- ned considering a post-death reworking of the snails. Despite these both methods are accurate and the ages fully relailable. The site evolution is thought to be the following; during the MIS3 several high frequency climatic oscillations allow the deposition of the sandy-muddy succession and at the beginning of the last glaciation (MIS2) a strong fluvial incision occurred leaveing the succession partially exposed. Finally, terrestrial gastropods during the extremely dry phases occurred along the early-middle Holocene (possibly cold Bond events) borrowed into the muddy strata trying to find a humid nest and there died.

Keywords: pIRIR, U/Th, Radiocarbon,marine terraces, alluvial fans

Potential of luminescence imaging for screening sensitive or well-bleached rocks

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Rock surface luminescence dating (RSLD) is being increasingly applied to constrain the chronologies of geological and archaeological deposits. However, often a majority of sampled rocks do not show desirable characterises, e.g., luminescence sensitivity, transparency or sufficient daylight exposure prior to burial. We have recently introduced the Risø imager, an instrument based on Infra-Red Photoluminescence (IRPL) [1] and Infra-Red Stimulated Luminescence (IRSL) signals, for rapid imaging of luminescence-depth profiles in rocks [2]. This system is highly attractive for *in-situ* measurements in the field for screening samples with desirable luminescence characteristics.

Although luminescence-depth profile imaging is fast, this technique is expected to have lower detection sensitivity compared to the conventional coring-slicing technique; this is because of larger detector noise and measurement areas in case of imaging compared to the PMT measurements. Imaging sensitivity can be especially poor if luminescence is distributed homogeneously rather than concentrated in a few bright spots. Thus, based on imaging measurements, one may discard a rock in the field, while it may in fact have produced acceptable luminescence signals using the conventional PMT measurements. It becomes therefore important to inter-compare the sensitivity of imaging vs. the PMT measurement techniques. We investigate this aspect using various rock types with different patterns of the luminescent minerals.

In contrast to sensitivity, a clear advantage of the imager is its unprecedented spatial resolution compared to the conventional coring-slicing technique. A poor resolution of > 1 mm in the latter case may lead us to discard samples where the bleaching front is very close to the surface. The imager can potentially detect a fully bleached rock surface even when luminescence-depth profile is very close to the surface. The potential of such fine detection of bleaching front will be tested by designing a controlled experiment using different durations of light exposure of rocks in a solar simulator.

Here we will present and discuss the results of these two sets of investigations.

Keywords (max. 5): rock surface luminescence dating, IRPL, Risø imager, sensitivity, spatial resolution

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Temporal and spatial variability of luminescence properties of MIS6 and MIS2 glacifluvial sediments derived from the Laurentide Ice Sheet, Indiana, USA

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Since late 2017, the Luminescence Laboratory at the Indiana Geological and Water Survey has measured about 110 samples from Middle and Late Pleistocene (MIS6 to MIS2) glaciofluvial sediments in Indiana. The extensive dataset has allowed documentation of changes in luminescence properties across time and space in this ice-marginal setting, and to hypothesize sources for this variability.

Exposed sections and cored sequences were sampled along margins of the Laurentide Ice Sheet (LIS) in Indiana. For MIS2 sediments, we differentiated between samples from the Lake Michigan Lobe (LML) sourced from the north, and the Huron-Erie Lobe (HEL), from the northeast. Small aliquots of 180-225 micron quartz and feldspar were used, each with 10-20 grains (maximum of 60), mounted on discs.

Most of the quartz from MIS2 HEL sediment sequences displays low sensitivity. This is consistent with the relatively high (50%) proportion of aliquots displaying near-background signal and supports the idea that data from small aliquots is a proxy for single-grain measurement data. MIS2 LML samples display higher sensitivity. Dose recovery and preheat plateau tests for all MIS2 samples indicate that relatively lower preheat temperatures adequately recover given and unknown doses. A slow component detected in many of the aliquots analyzed did not affect SAR analysis performed with late-light background subtraction. High overdispersion was observed in both glaciofluvial and aeolian samples. Partial bleaching obscured data analysis in the proximal glaciofluvial samples. Minimum age models (MAM) were able to recover known ages within the range established by other dating methods with ~30-40 accepted aliquots in most cases. In some samples, however, even when the MAM was used in larger datasets, ages consistent with the stratigraphy were not resolved.

MIS6 samples display higher sensitivity than MIS2 samples, and quartz ages range from 150 to 130 ka. A key factor in obtaining these ages is the relatively high level at which dose saturation appears for quartz in some subsurface samples in central Indiana. $2D_0$ values between 200 and 600 Gy help constrain the age of MIS6 sediments given the relatively low (1-2 Gy/ka) dose rates in most sediment packages. The $2D_0$ values are higher than values observed on MIS2 sediments from the same region. The difference in sensitivity and $2D_0$ values are hypothesized to be linked to different provenance lithologies , which is consistent with the geomorphological and geological data available. The similarity between high sensitivity quartz in MIS6 deposits and quartz derived from local Carboniferous sandstones in south-central Indiana suggests that a substantial region glaciated during MIS6 was never glaciated before, which is consistent with up to 60 m thick MIS6 glacifluvial sediment packages directly over the Carboniferous bedrock. This has implications in landscape evolution, paleoclimate and ice sheet modeling.

When tested against quartz ages, post-IR IRSL protocols in feldspar appear to recover burial doses well, and potentially could extend the reach of the technique to ~250 ka. We conclude that both quartz and feldspar luminescence techniques can be applied successfully to sediments in this environment and age range, with the caveats discussed above.

Keywords: quartz OSL, feldspar PIRIR, MIS2, MIS6, glacifluvial

D_es comparisons of Late Pleistocene alluvial deposits on the Coast of Galicia (NW Spain) using BayLum or Analyst-based procedures.

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The coastal sedimentary record of Galicia (NW Spain) is important to study sea-level oscillations during the Late Quaternary. Alluvial deposits preserved in the Ria de Coruña and Ria de Arousa are the remnants of fluvial valleys flooded by the sea during Pleistocene transgressions. This explains why most of these deposits of continental origin are preserved in areas where today a marine environment is developing. Knowing theirs age would greatly expand our knowledge of coastal evolution in this Atlantic region since the Eemian or earlier.

A first chronological study recently carried out by Arce-Chamorro [1] using OSL from large multi-grain aliquots of quartz grains revealed a fast-component dominated, but dim OSL signal. Various analyses (interpolation, various curve fitting options, early or late background estimation) and models (CAM: [2]) were conducted to investigate the sensitivity of absorbed dose estimation to analytical choices. In all cases, De distributions determined with the Analyst software [3] are highly scattered, i.e. they exhibit large overdispersion values. Part of this overdispersion may be linked with the concentration in potassium, suggesting beta dose rate heterogeneities [4]. Nevertheless, for most samples the number of aliquots in saturation (~0-60% of the total) is a significant issue.

In this work, we investigate an alternative to Analyst (used in combination with statistical models) to calculate OSL ages. BayLum [5] indeed allows working with aliquots for which the natural L/T signal, or the sum of this signal and its uncertainty, does not intersect the dose response curve. Heydari and Guérin showed on single-grain experiments [6] that the range of OSL could be extended using this software to analyse artificial laboratory distributions. In this paper, we discuss the comparison between ages calculated with BayLum and those estimated from Analyst De estimations.

Keywords: OSL, BayLum, Analyst, equivalent dose, Late-Pleistocene coastal deposits.

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ESR thermochronometry of rock samples collected into the Tauern Window, Eastern Alps

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Thermochronometry using luminescence and Electron Spin Resonance (ESR) dating has been proven to be a useful tool to detect changes of rock temperature close to the surface (<100°C) and therefore it is able to reconstruct tectonic processes of the upper crust. The high saturation dose of the quartz ESR signals allows the investigation of sample ages back to ~2 million years [1].

In this study, we show the results of ESR thermochronometry on quartz to investigate deformation associated with cooling processes and exhumation in orogenic settings. We applied ESR dating on rock collected from alpine faults that were active in the recent extensional phases, i.e. Brenner and Salzachtal faults in the Eastern Alps, where thermal history of the rocks are already defined by several thermochronological data up to the Pliocene. The faults allowed the exhumation of metamorphic rocks in the so-called Tauern Window (TW). Fifteen samples were collected into the TW. The Al and Ti centres from quartz were investigated using the application of Single Aliquote Regenerative dose (SAR) and Single Aliquot Additive Dose (SAAD) protocols to calculate the equivalent dose. The Ti centre in quartz samples from shear zones is mostly absent. Ages between 200 and 800 ka were obtained from all of the samples, whereas samples characterized by high dose rates (~10 Gy/ka) have a saturated natural Al centre and minimum ages were calculated. We compare the ESR ages on quartz obtained with new thermoluminescence ages of calcite thermoluminescence and (U-Th)/He data on apatite and zircon from literature [2; 3]. Our results are in accordance with the tectonic history of the Eastern Alps, following the same trend of other thermochronological data, and confirm the ESR ultra-low thermochronometry as a powerful tool to investigate the Quaternary activity of the Alpine Orogeny.

Keywords: ESR, quartz, Alps, thermochronometry

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Environmental dose rate calculation for deep ocean sediments: Measure, model or guess?

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Luminescence dating of deep ocean sediments is complicated by disequilibrium in the ^{238}U and ^{235}U decay series, which cause the environmental dose rate to vary as the sediment ages. Production of insoluble isotopes (^{230}Th and ^{231}Pa) in the water column overlying the sample site causes the incorporation of these isotopes in excess. This excess activity decays over time, leading to a progressive decrease in dose rate due to excess isotopes. In anoxic sediments, uranium can be incorporated into sediment without its decay products, leading to an increase in dose rate as the sediment ages and this "authigenic" uranium tends towards secular equilibrium. Direct measurement of excess and authigenic isotopes is possible via mass spectrometry, but this is time-consuming. Furthermore, accurate differentiation of authigenic and minerogenic uranium is challenging. However, while direct measurement of disequilibrium is usually preferable, it may be possible to derive good approximations of the excess and authigenic isotope concentrations via modelling. The primary controls on excess isotope concentrations are water depth (production) and sedimentation rate (dilution). Where these quantities are known, burial activities of excess ^{230}Th and ^{231}Pa may be estimated. Authigenic uranium concentration may be estimated as total uranium minus minerogenic uranium. The latter quantity can be calculated assuming a fixed abundance/activity ratio of minerogenic $U/^{232}Th$, since the latter can be assumed to be invariably minerogenic. This poster presents methods for calculating dose rates for deep ocean sediments, using either direct measurements or modelling of excess and authigenic contributions, and identifies situations where the latter approach may be inappropriate.

Keywords (max. 5): dose rate, disequilibrium, ocean cores, sapropel

Single-grain OSL and U-series/ESR dating of the early Upper Palaeolithic sedimentary sequence at Lagar Velho Rock Shelter

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Lagar Velho Rock Shelter (Leiria, Portugal) is a key locality for understanding the early Upper Palaeolithic history of Southwest Europe as it preserves the near-complete skeleton of a 5 year-old buried child originally reported as exhibiting a mosaic of early modern human and Neanderthal features, and a ~5m infill sequence containing successive Gravettian to Middle Solutrean occupations. The existing site chronology is based on ^{14}C dating of charcoal and bone, suggesting the archaeological sequence spans 24.8–23.8 to 43.1–29.9 ka cal. BP. While the ^{14}C dataset is stratigraphically consistent, several geoarchaeological complexes are undated or imprecisely constrained, and all of the ^{14}C ages are based on standard (acid-base-acid) pre-treatment procedures, which may not necessarily ensure complete removal of organic contaminants compared to more rigorous (e.g., ultrafiltration, ABOx-SC) ^{14}C extraction procedures. Stratigraphic correlations between the eastern and western sectors of the site, including the child burial complex, also remain tentative owing to lateral variations in the sedimentary succession and partial truncation of the longitudinal profile by pre-discovery terracing activities. There is thus a need to expand and complement the existing chronological framework at Lagar Velho Rock Shelter using a broader suite of dating methods.

In this paper we present results of a new optical dating programme at the site, which aims to obtain depositional ages on all major geoarchaeological complexes, independently evaluate the reliability of the existing ^{14}C chronological framework, and combine all reliable dating evidence within OxCal Bayesian models to examine the chronological viability of stratigraphic correlations across different sectors of the site. Single-grain OSL analysis of twelve samples spanning the full sedimentary sequence reveals generally low D_e scatter indicative of suitable daylight exposure, and yields ages in broad agreement with the published ^{14}C dataset. However, a few OSL samples from the lower and intermediate slope deposits exhibit minor age offsets (up to several ka older) compared to associated ^{14}C estimates. The suitability of the OSL ages is examined via replicate extended-range luminescence measurements (single-grain TT-OSL) and combined U-series/ESR dating of a red deer tooth from the basal alluvial complex. These semi-independent dating comparisons, plus insights from available ^{14}C sample quality indicators (organic preservation and contamination proxies), are used to examine if there is any merit in cross-checking some of the bone and charcoal ^{14}C ages using more rigorous pre-treatment procedures in the future.

Bayesian modelling of the combined chronological dataset provides improved temporal constraint on the basal fluviatile and slope geoarchaeological complexes, new insights into temporal correlations of the transitional fluviatile–slope, slope, and breccia deposits found across different sectors of the site, and helps place the entire occupation sequence in a firmer regional climatic context. Our results confirm the chronological significance of Lagar Velho Rock Shelter for assessing Late Pleistocene anthropogenic histories and early Upper Palaeolithic cultural transitions on the Iberian Peninsula, with the site spanning at least 12 ka and recording at least three periods of human activity between late MIS 3 and early-mid MIS 2. The study highlights the significant role that OSL and ESR dating can play in refining early Upper Palaeolithic histories of the region, particularly when undertaken as part of multi-technique comparisons that target complementary dating materials.

Keywords: single-grain OSL, combined U-series/ESR, Gravettian, Solutrean, Iberian Peninsula

Development of the pIt-IRSL protocol for dating polymineral fine grains from Chew Bahir, Ethiopia

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Rift lakes are perfect places for sediment accumulation and hence potentially contain continous paleoclimate records. Located in the eastern African rift valley, in southern Ethiopia, Lake Chew Bahir preserves a record of environmental change which is pertinent to the story of hominin evolution and dispersal. Independent chronology from various dating techniques is available throughout this 293 m composite core record, from which a coherent Bayesian age-depth model was generated spanning the last 620 ka and providing one of the longest directly-dated lacustrine sediment sequences in eastern Africa [1]. However, there are regions of the core where the age depth model could be improved if further datable materials were available. For instance, beyond ~50 m depth, the quartz OSL signal appears to be saturated and there is a large gap to the first $^{40}Ar/^{39}Ar$ age. The luminescence signal from feldspars saturates at a greater D_e value than that from quartz and therefore offers the potential to extend the maximum age range of the luminescence-derived chronology in the core, and to fill in gaps within the quartz-derived chronology where quartz is not available.

The luminescence chronology for the Lake Chew Bahir core was refined and extended using the fading corrected post-IR $IRSL_{225}$ signal from polymineral fine grains. However, there are challenges and complications regarding both assessment of fading and the subsequent application of the fading rates. The duration of the delay times used to assess fading, and the given laboratory dose (two critical factors in measurement of fading rates), were the same for all samples, but because of variability in lithology in the core, it is not clear whether sample specific fading rates should be used or if the mean fading rate of all samples is appropriate. Moreover, selection of the most appropriate fading correction model is critical.

To circumvent the complications of fading rate measurement and its application, the recently developed post-Isothermal (pIt) IRSL protocol [2] was therefore also explored. Application of a modified $pIt\text{-}IRSL_{225}$ protocol to polymineral fine grains from this core, demonstrates that this signal is successful in providing accurate ages for this material without any fading correction. Additionally, uncertainty on the derived ages were reduced in comparison with the fading corrected post-IR $IRSL_{225}$ ages. However, since the calculated D_e from this protocol relies on the $IR_{50}/pIRIR_{225}$ D_e ratio, it seems to be limited to the saturation limit of the IR_{50} signal. This may be the reason that the $pIt\text{-}IRSL_{225}$ age for one of the older samples in the core (~300 ka) does not agree with its fading corrected post-IR $IRSL_{225}$ age. Possible modifications to the $pIt\text{-}IRSL_{225}$ protocol to overcome this limitation will be discussed. Furthermore, the suitability of the isothermal annealing step in this protocol to account for the athermal process of signal loss (i.e. fading) was investigated. The data suggest there is a correlation between the isothermal annealing time (for which the D_e in the pIt- $IRSL_{225}$ protocol is reached) and the g-values determined using IR_{50} and $pIRIR_{225}$ signals.

Keywords (max. 5): $pIt\text{-}IRSL_{225}$, post-IR $IRSL_{225}$, polymineral fine grains, Chew Bahir

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ESR/U-series dating of palaeontological remains from the Neandertalian site of Mutzig-Rain (Alsace, France)

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The Middle Palaeolithic site of Mutzig, discovered in 1992, has been the focus of several pits and excavations since 2010, delivering numerous well preserved palaeontological remains and more than 4500 lithic artifacts. The site is made by several rock shelters now collapsed (called "M1" to "M12"), each of them containing several Middle Palaeolithic occupation levels. The faunal assemblage of the main archaeological levels (7a to 7f) from the current excavation (M2) includes woolly mammoth, reindeer, horse, bison and woolly rhinoceros, reflecting a cold steppe context, while microfauna from the lower levels (7D and 10) indicate the presence of forests and suggest a more temperate climate. An OSL dating study places the archaeological sequence as coeval of the onset of the last glacial stage, the Weichselian, during MIS 5, between 105 and 80 ka. The good state of preservation of the abundant faunal remains at Mutzig provided good supports for ESR and U-series dating method. The first results obtained by U-series in 1995 on bones were not encouraging. A first set of teeth (from "M2" site), considered today as more appropriate dating material was therefore analyzed by combined ESR/U-series, using alpha spectrometry in 2013-2015, and yielded ages around 96-100 ka for levels 5-7, in agreement with the OSL data [1]. These analyses showed a quite systematic U-leaching from the dental tissues and the ages were calculated by the "Accelerated Uptake (AU) model" [2]. A second set of teeth from "M2" and "M8" sites was recently analyzed by combined ESR with U-series using quadripolar mass spectrometry (ICP-Q-MS) in MNHN laboratory. The whole set of ESR/U-series data obtained on Mutzig teeth is presented and discussed versus OSL dates allowing a better resolution of the chronology of the site.

Keywords: Mutzig-Rain, Eastern France, Middle Palaeolithic, ESR/U-series, OSL

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Dating the construction of a Late Prehistoric megalithic monument at Cruz de Cepos, NE Portugal

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The presence of many 'standing stone' monuments within the European Late Prehistoric landscape is considered to be associated with a pivotal human cultural transition from hunting and gathering to agriculture and settlement, currently dated by radiocarbon to the 5th millennium BCE [1]. However, many standing stones were first erected, subsequently collapsed, and then re-erected during the following three millennia [2]. A major difficulty encountered in attempting to apply radiocarbon in previous field investigation to understand these events is identifying samples that are securely related to the construction process. The site of Cruz de Cepos in NW Portugal has been excavated with the aim of learning more of the method of construction of the megalithic monument and, in particular, to explore the potential for application of radiocarbon and luminescence techniques to obtain a reliable chronological framework for its erection. Fortunately, samples suitable for both methods were available and obtained during a programme of excavation of the Cruz de Cepos monument. This paper discusses the luminescence and dosimetry characteristics of quartz extracted from sediment samples taken from locations associated with the socket and surrounding original backfilling deposits, and the OSL single-grain dates produced. The latter are compared with the radiocarbon dates and the prospects for wider application to megalithic monuments of this type is assessed.

Keywords: Late Prehistory, megalith, chronology, quartz, OSL

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Unravelling rock cooling histories of the Japanese Alps within the past 1 Ma using ESR and OSL thermochronometry

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Understanding the interactions between Earth surface processes, tectonics and climate in mountain regions is challenging, partly due to the difficulties of measuring changes in the rates of Earth surface processes at the timescale of glacial-interglacial cycles. The Japanese Alps uplifted throughout the Quaternary and now reach elevations of up to 3,000 m. In particular, the young age of the Japanese Alps has made measurement of their exhumation histories complicated. To help resolve this issue, we investigate the potential of ultra-low temperature thermochronometers based on the luminescence of feldspar minerals and electron spin resonance (ESR) of quartz minerals, in combination with inverse modelling to derive rock cooling rates and exhumation rates histories at 10^4-10^6 years timescales.

We focus on the Tateyama region in the Hida range of the Japanese Alps. In total, 19 new samples were analyzed by luminescence and ESR thermochronometry. While most luminescence signals (IR_{50}, IR_{100}, IR_{150}, IR_{225}) have already reached saturation, ESR signals (Al and Ti centres) still grow with dose and are suitable for determining finite exhumation rates in the Tateyama region. We used the ESR single aliquot regenerative additive (SARA) dose protocol for dose evaluation including protocol optimization (i.e., preheat-plateau test). We checked for sensitivity changes due to the high-temperature annealing step within the SARA procedure using SARA *vs*. single aliquot additive dose response, repeated dose points (i.e., recycling ratio) and dose recovery of an artificially zeroed sample. Thermal stabilities of the ESR signals were analysed by using isothermal decay experiments and simulations of the isothermal decay using the experimentally constrained kinetic parameters.

Our experiments showed insignificant sensitivity changes during measurements, resulting in Al and Ti ages of between 0.3-0.9 Ma and 0.5-1.1 Ma, respectively. In general, thermal stability is lower for the Al centre compared to that of the Ti centre but simulations yielded sufficient thermal stability over Quaternary timescales for both ESR centres. Inversions of the ESR data reveal rock cooling rates on the order of 30-80 °C/Ma, allowing us to resolve erosion rates on the order of few mm/a. Thus, preliminary erosion rates of <1 mm/a within the past 1 Ma could be inferred.

Keywords: electron spin resonance, IRSL, quartz, thermal stability, exhumation

Dating sediments from problematic glacial contexts.

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This paper presents data from UK glacial sediments which are thought to have had limited sediment movement (possibly subglacially) prior to burial. For glacial sediments, generally quartz single grain OSL is better placed to find bleached grains. Here however, statistical models struggle to pick out the few 'bleached grains' from those with feldspar inclusions which have faded D_e values, dim quartz with low D_e values as well as older/poorly bleached grains. The youngest grains date to ~15 ka and appear to under-estimate true burial age given the clear glacial context of these samples. MET IRSL on feldspars clearly suffers from fading and poor bleaching, the relative proportion of which varies according to measurement temperature. Using Minimum Age or Finite Mixture Models to extract D_e point to a small proportion of sand which was fully bleached and buried between 20-30 ka. However, this requires being selective as to which model and which component is used for the age calculations which is sub-optimal and hard to justify.

Looking at individual"super" MET grains which provided D_e values for 3-5 of the MET data temperatures measured and isolating plateau D_e values allows a robust way independant of statistical analsyis for D_e values least affected by fading and poor bleaching to be selected for age calculation. Using this approach ages for glacial sediments fall within the expected glacial window.

Keywords (max. 5): MET, coarse-grain, IRSL, feldspar

Testing the accuracy of single-grain OSL dating on Eemian quartz samples

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The main purpose of this study is to investigate the accuracy of single-grain quartz OSL SAR dating for samples with known absorbed natural doses in the 150-200 Gy range. There exists some evidence that at least multi-grain quartz OSL ages tend to underestimate the true burial age in this dose interval by ~10-15% (e.g. [1,2]). It has been hypothesized that single-grain data are superior to multi-grain data, because the latter must contain signals from 'aberrant' grains (e.g. grains failing SAR procedural tests and/or grains in saturation), which can be excluded in single-grain analysis.

Here we test this hypothesis using five known-age Eemian (MIS 5e, ~125-130 ka) sediment samples collected in northern Russia (Sula [1]) and in Denmark (Gammelmark [2]); conventional multi-grain methods using quartz gave results consistent with expectations for both sites, although there appeared to have been a small systematic age underestimate. Preliminary single-grain measurements show that ages are in poor agreement with the age control when using the conventional frequentist approach; the expected dose is underestimated by ~50%. Applying commonly used rejection criteria (e.g. recycling, OSL IR depletion and recuperation) does not improve this significant underestimation. However, a significant fraction (~40-50%) of the detectable grains have natural sensitivity corrected OSL signals which cannot be interpolated on to the individually constructed laboratory dose response curves to give finite dose values, i.e. the grains are said to be in saturation. Previously, it has been argued that discarding such grains has the potential to significantly bias the resulting dose distributions towards low doses. In an attempt to circumvent this bias, it has been suggested that all grains with dose response curves with low characteristic doses (D_c values) compared to the natural dose ought to be rejected. Here we test if the so-called D_c criterion suggested by [3] in combination with Bayesian modelling using the specifically designed software tool BayLum [4] can help overcome this bias.

Keywords (max. 5): single-grain quartz OSL, independent age control, saturated OSL signals, dose distributions

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An extensive ESR-OSL dating comparison on coastal dune deposits from the Wilderness-Knysna area (South Africa)

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Electron spin resonance (ESR) dating of optically bleached quartz grains in many situations can determine reliable numerical age results, i.e. consistent with the existing independent age control [1]. However, some methodological issues still need to be better understood, especially around the behaviour of the ESR signals. One easy way to fill this knowledge gap is to test the accuracy of the ESR equivalent dose (D_e) determination on quartz samples independently dated with luminescence.

Our work follows up on our previous methodological study [2] of five quartz samples from the Plio-Pleistocene to Holocene aeolian coastal dune deposits of the Wilderness-Knysna area (South Africa) that were dated previously by optically stimulated luminescence (OSL) [3]. Here, we extended this initial ESR-OSL comparison by analysing with ESR seven additional optically-bleached quartz samples following the Multiple Centre approach [4] and using the Multiple Aliquot Additive dose method [5]. The Aluminium (Al) and Titanium (Ti) signals (Ti-Li, Ti-H and a mixture of Ti centres with the Ti-Li-H) were systematically measured in all samples, and resulting D_e values and age estimates were compared with the OSL data. As expected, some samples show an overestimation of the expected D_e values. This outcome may be due to incomplete resetting of the ESR signals during sediment transport. However, our work also investigated a potential methodological bias by evaluating the impact of the following sources of overestimation and uncertainty on the dose and age determinations: (i) the spectrum noise for the Ti signal, (ii) the magnitude of the gamma irradiation dose steps for both signals and (iii) Al ESR signal extraction method.

In addition to the methodological aspects discussed in this paper, this ESR dating study also provides new and finite numerical age constraints for a series of Middle Pleistocene coastal dune deposits in the Wilderness-Knysna area Southern Cape.

Keywords: Electron Spin Resonance (ESR) Dating; Quartz grains; Multiple centre approach; Dunes; South Africa

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Surface Exposure Dating Applications using OSL Laser Scanning Measures and Controlled Light Exposed Rock Sampling Techniques

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With the aim of improving the accuracy and applicability of OSL surface exposure dating, modified sampling and measuring procedures incorporating controlled exposure experiments (CEE) and OSL scanning methods were performed in a trial study on 11-year exposed quartzite rocks in Washington, USA, as well as millennial to decamillennial exposed quartzite surfaces a part of the Foothills Erratics Train in Alberta, Canada. CEE sampling approaches attempt to reliably determine exposure dating model parameters directly from the rock surface of interest using OSL saturated core samples subjected to controlled light exposures. OSL laser scanning measures are used in tandem to record sub-millimeter resolution OSL depth profiles from transverse slices of core surface samples. Scanning electron microscopy with energy dispersive spectroscopy analyses (SEM-EDS) is used additionally to identify and filter non-quartz OSL anomalies in scans to generate less scattered depth profile data which more closely follows depth profile forms of the first-order kinetic exposure dating model. The 11-year exposure study showcases that such measuring and sampling techniques can assist in acquiring precise depth profiles and accurate exposure ages, yet may face resolution issues in OSL data collection depending on rock sample composition. The trial exposure dating study on the Foothills Erratics Train, a site hosting millennial to decamillennial exposed quartzite erratic surfaces, aims to provide an enhanced timeline of glacial retreat for the Erratics Train, offering an interpretable timeline to when humans could have accessed an ice-free corridor to migrate into North America.

Keywords (max. 5): Exposure Dating, quartz, OSL, Imaging, Glaciers

OSL medium component in quartz observed using the TM-OSL method

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The fast component of the OSL signal in quartz, commonly used so far in dating, sometimes is problematic because of its low sensitivity in comparison with slower components. Therefore, the determination of the thermal stability of traps responsible for the medium OSL component in quartz is important for its application in dating. Such studies have been undertaken several times. Some results proved that the medium component is more stable than the fast component [1], while others claim it is not stable enough for dating [2]. On the other hand, Peng et al. [3] state that the medium OSL component is related to the emission of charges from the 170 °C TL trap after their phototransfer from traps responsible for the fast component. However, recently, it was demonstrated that the fast component can be bleached using red light (620 nm) whereas depleting the medium component requires a much shorter wavelength (530 nm) [4]. That is consistent with early findings [1] and confirms the different origins of the fast and medium components. The latter signal's origin and thermal stability have not yet been unequivocally determined, most probably due to problems with its separation from the rest of the OSL signal. So, finding a way to separate the medium component analytically can solve the problem of its thermal stability and utility for dating.

In this study, the analytical separation of the medium OSL component was to be improved using the thermally modulated OSL (TM-OSL) method. The medium component was measured using 530 nm after the fast OSL component zeroing with the wavelength of 620 nm. The proper selection of the TM-OSL measurement parameters allowed for minimizing the participation of the slower components. Based on that, the thermal stability of the medium component was investigated using the OSL isothermal depletion curve method and the laboratory-generated dose-response curves were constructed for a wide dose range. The research was carried out for quartz samples of various origins from sediments and rocks. For experiments, one used a Risø TL/OSL-DA-20 reader with EMI 9235QB PMT and a 7.5 mm Hoya U-340 filter. Optical stimulation was accomplished using dedicated LED modules with wavelengths 620 nm and 530 nm.

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Keywords (max. 5): OSL, quartz, medium component, trap stability

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Towards accurate modelling of OSL rock surface exposure dating

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Dating of rock surface using optically stimulated luminescence (OSL) is emerging as new tool to estimate exposure age and post exposure erosion rates. Since last ten years several research, both on methodology developments and applications, demonstrate the novelty and potential of this method [1,2]. OSL in light-shielded rock (primary luminescent mineral is feldspar), exposed to natural irradiation for >Myr, is in equilibriums, decided by radiation-induced growth and decay via the athermal pathway. When the rock is exposed to sunlight, the equilibrium level decreases. The rate decrease of OSL (proportional to trapped electrons) depends on the decay constant, a product of solar flux (ϕ) and radiation matter interaction cross-section (σ). The solar flux attenuates with depth inside rock, decided by the attenuation coefficient of the material (μ). Thus, the OSL profile along depth shows a curvy trend (resembling a sigmoidal shape) which propagate forward with time. Erosion of the surface (constant rate of stochastic nature) will show the opposite effect; the OSL-depth profile will move backwards because of the continuous reduction of saturating depth.

The mathematical formulation for these combined effects is established [3]. An appropriate inverse modelling of the OSL-depth profile thus provides information on exposure age and/ or erosion rate, provided the kinetic parameter ($\sigma\phi$ and μ) are well constrained. The knowledge gap is, all the existing model, except one study [4], so far, assume the light-dependent decay rate of OSL of feldspar follow first-order kinetics, a simple linear model. However, the OSL of feldspar never decay exponentially with time (according to first order kinectics), instead the decay is much slower (non-linear decay), either follow stretched exponential or general order kinetics. The non-exponential decay of OSL signal, more precisely infrared stimulated luminescence (IRSL) of feldspar, can be better explained by general order kinetics (GOK). Thus, we propose a new GOK model for OSL surface exposure dating. Theoretical study shows, for FOK model the OSL (IRSL) depth profile propagate faster with time of light exposure than actual. Consequently, the FOK model predicts lower exposure age. This age underestimation is often explained by higher erosion rates. The propagation of OSL profile with time depends on order of kinetics of the GOK model. The order of kinetics is sample dependent. We demonstrate how the order of kinetics can be constrained through laboratory bleaching experiment. The impact of GOK model on exposure age, upper age limit and post exposure erosion rate, for different order of kinetics will be presented.

Further, we apply this newly developed model to experimental data of samples having some independent control to validate the applicability of this model.

Keywords: OSL rock surface dating; General order kinetics; IRSL of feldspar; Bleaching of IRSL

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Understanding sediment transport using pIRIR signal from feldspar single grain supported by terrestrial cosmogenic radionuclides

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Understanding sediment movement over time and space requires quantitative tools. The trapped charge phenomenon or luminescence properties of sand grains are one of the potential techniques in sediment tracing [4]. Luminescence of sand grains builds up during burial in sedimentary deposits and resets at the Earth's surface when exposed to sunlight. This sensitivity to daylight exposure can be utilized to quantify Earth's surface processes such as sediment transport and or soil mixing. Thus, the variations in the magnitude of the luminescence signal, raise the possibility of quantifying rates of Earth surface processes via measurements of the luminescence signal.

In this study, we aim to investigate the luminescence signature of hillslope denudation by measuring the percentage of bleached versus non-bleached (saturated) grains in associated modern fluvial deposits for a large variety of source catchments (in Chile and New Zealand) with contrasting morphometric properties. We will utilize feldspar single-grain pIRIR measurement protocols to measure the luminescence signature and perform the data analyses previously described in [5]. Our research will offer innovative constraints on weathering intensity and hillslope denudation and how they are related to the denudation rates of the selected catchments. We will thus use paired in situ ^{14}C and ^{10}Be terrestrial cosmogenic nuclides (TCN) measurements for some selected catchments in the Southern Alps of New Zealand and Chile (both with pronounced climatic gradients), to complement and compare our luminescence data. Numerous studies have already proven the dependency of denudation rates on landscape characteristics such as the mean slope of the catchments or mean hillslope gradients and to external forces such as tectonic uplift and climate [1,2,3].

Keywords: Sediment transport, TCN, luminescence signal, catchment-wide denudation rate, saturated grains.

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Are all luminescence thermal kinetic parameters the same?

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In luminescence thermochronometry, the thermal stability of feldspar minerals is conventionally constrained from isothermal decay experiments. However, despite recent refinement of the measurement protocol [1], measurements take several days and must be done for each individual sample.

Following that most other thermochronometric methods usually use only a single reference set of thermal kinetic parameters, and that recent studies on direct physical probing of feldspar sample properties have shown that trap depth and band-tail width are broadly similar despite large variations in chemical composition [2], we sought to optimise luminescence thermochronometry measurements by exploring whether a single set of thermal kinetic parameters can describe luminescence thermal decay in feldspar.

We explored the effect of using averaged thermal kinetic parameters rather than sample-specific thermal kinetic parameters to model luminescence signal accumulation under different thermal conditions. A set of K- and Na-feldspar minerals extracted from different regions of the world were analysed after being measured with a multi-elevated temperature protocol [3], comprising four different IRSL signals at 50, 100, 150, and 225 °C. For each sample, two forward models were run and compared for given cooling histories: the first using the natural sample-specific thermal kinetic parameters and the second using the average thermal kinetic parameters.

Results show that even though it is not possible to generalise the thermal kinetic parameters between IRSL signals measured at different temperatures, similarities exist between the same temperature IRSL measurements of samples from the same locality. Comparisons were done between the kinetic parameters of each IRSL signal depending on different variables such as region of the world, transect, crystal type, or lithology of the rock. Despite slight differences between the Na-feldspar and K-feldspar thermal kinetic parameters, the deviation between the thermal kinetic parameters of different samples from the same site is within the range of measurement error (i.e., <2-10 %), suggesting that regional, rather than sample-specific values may be appropriate.

The impact of taking average thermal kinetic parameters instead of sample-specific thermal kinetic parameters on geological and geomorphological applications (derivation of cooling histories, exhumation/erosion rates, temperatures) will be further evaluated with forward and inverse modelling, and the results discussed. If successful, this approach would allow rapid investigation of luminescence thermochronometry samples, reducing measurement times by c.50% (i.e., 3-4 days), allowing higher resolution sampling and measurement.

Keywords: luminescence thermochronometry, thermal kinetic parameters, feldspar

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OSL dating in Quaternary fluvial deposits in the Andes foothills: insights from environmental drivers.

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Mountain regions and their foreland basins sustain a set of landforms (e.g., floodplains, fluvial terraces, and alluvial fans) that are sensitive to climatic and tectonic changes. The varia- tion of these factors can change the rates of incision and aggradation in river valleys and trigger the propagation of the imbalance signal along with the river profile, transforming the local re- lief. Thus, information about tectonic activity and climate change in a defined area can be ob- tained through landscape analysis. The main aim of this research is to investigate the evolution of the alluvial deposits in in the Eastern Andean Cordillera, in the upper Guaviare river basins in southern Colombia, at the surroundings of Florencia. We mapped landforms by visually in- terpreting the Landsat images and Copernicus digital elevation model (DEM; GLO-30) and used optically stimulated luminescence (OSL) dating in quartz grains to estimate burial ages. Our results show that alluvial and fluvial fans with distinct lobes formed most of the landforms. In the region, we mapped two levels of alluvial fans – positioned 20 to 30 m above de current floodplain – and three levels of fluvial terraces – from 2 to 15 m above de channel level. OSL ages obtained so far indicate that between at least 150 to 70 thousand years the formation of alluvial fans dominated the sedimentation of the landscape. Between at least 150 to 70 ka the formation of alluvial fans dominated the sedimentation of the landscape. The data also suggest that after a valley incision period, there were changes in the hydrodynamic conditions of the system. The highest level of the terrace is not more than 30 ka, suggesting very high rates of incision during the late Pleistocene and Holocene. New OSL ages (in progress) will allow us to estimate the burial ages of the mapped landforms and provide new insights into the time and drivers related to changes in fluvial dynamics and landscape evolution in the tropical Andean foothills. (FAPESP Grants #2020/11047-1 and 2021/14947-6).

Keywords: Luminescence Dating, Geomorphological Mapping, Fluvial Systems, Eastern Andes; Northwest Amazon

Luminescence-based chronology and transport dynamics of tsunami backwash deposits from the shelf of Portugal

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Since the catastrophic impact of the 1755 Lisbon tsunami, tsunami exposure of the Portuguese coast is well known. However, due to the limited accuracy of historical records and poor preservation of geological onshore archives, significant uncertainties remain regarding the recurrence patterns of large tsunamis [1]. Offshore tsunami deposits, which as yet have been poorly investigated, may help to fill existing knowledge gaps in the regional tsunami history. New evidence from the Algarve shelf, which includes sediments of a potential predecessor of the 1755 tsunami, has been identified during METEOR cruise M152 [2]. In this study, quartz and feldspar luminescence dating was applied to the silt- and sand fraction of tsunami backwash and shelf deposits recovered during this cruise, with the aim to improve understanding of magnitude-frequency patterns by providing new information on chronology and transport dynamics.

Since this is a seminal application of luminescence dating to offshore tsunami deposits, dating accuracy for different minerals, signals, aliquot sizes and grain-size factions was evaluated against a correlative radiocarbon chronology. Linear regression yielded smallest residuals for single-grain quartz and feldspar IRSL ages, while those of multi-grain ages were significantly larger. The associated quartz and feldspar single-grain chronologies show overall good agreement with radiocarbon ages for the same cores and, when combined with Bayesian deposition models [3], support evidence of tsunami backwash associated with the 1755 tsunami and a prehistoric event that, according to the radiocarbon-based age-depth model, took place 3600±600 years BP.

Luminescence-based tracers for signal resetting in different minerals and grain-size fractions, offer new insights into sediment transport during tsunami backwash on the investigated shelf sections: (i) offshore sediment transport during the 1755 tsunami was characterised by significant spatial variability between sediments derived from local sources that were transported as gravity currents, and sediments derived from a mixture of sediment sources that were partly transported in suspension over larger distances; (ii) when comparing sediments of the 1755 tsunami and the prehistoric event in the same sediment core, incomplete signal resetting of most sand and silt grains in the palaeo-event indicates a mixture of more local sediment sources mainly transported as bedload; and (iii) varying degrees of signal resetting within the sand layer of the palaeo-event point to a successive shift towards sediment sources with better prebleaching.

Keywords (max. 5): Quartz, feldspar, single grain, tsunami, process tracer

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When the sediment can't be correctly dated: the case of study of the archeological site Toca dos Coqueiros (Piauí, Brazil)

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The Toca dos Coqueiros archaeological site is located in the Serra da Capivara region in northeastern Brazil, which has been designated a UNESCO World Heritage site since 1991. The excavations conducted by a Franco-Brazilian team since 2018, have led to the discovery of numerous lithic remains typical of the late Pleistocene and early Holocene. Some of these have features of the Itaparica phenomenon (dated between ~12,000 and 7,000 BP uncalibrated [1]) with unifacial pieces of the "lesmas" type. Some of the characteristics that define these lesmas are also found in lower levels of Toca dos Coqueiros, but are made on different blanks and raw materials than those traditionally observed. From a techno-cultural point of view, this could be interpreted as a local antecedent of Itaparica.

To establish the chronological framework of the stratigraphic succession, several ^{14}C dates and luminescence (OSL and IRSL) dates on sediment were performed. However, the geochronological analysis shows stratigraphic inversions and strong overdispersions on the quartz and feldspars, making only the use of the Minimum Age Model (MAM) possible, providing low resolution dates. This logically hinders the chronological location of a probable techno-cultural antecedent of the Itaparica phenomenon.

Our latest chronological research on Toca dos Coqueiros aims to understand these inversions and overdispersions by characterizing the quartz in the sediment, and potentially provide a clearer explanation of the site's deposit. This presents challenges for precisely dating the site and understanding its place in South American prehistory.

Keywords: OSL, IRSL, overdispersion, radiocarbon, Prehistory

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Using rock surface luminescence and cosmogenic radionuclide measurements to demonstrate recent ice sheet thinning in the West Antarctic Ice Sheet

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The Thwaites Glacier is a rapidly melting region, roughly the size of Florida, within the West Antarctic Ice Sheet. The amount of ice flowing from Thwaites into the Amundsen Sea has nearly doubled in the past 30 years and some have speculated that the future collapse of this and neighboring glaciers is inevitable. The resulting meltwater from this collapse would contribute up to 3.4 m of global sea level rise in coming centuries.

As part of part of the International Thwaites Glacier Collaboration between the US National Science Foundation and UK National Environmental Research Council, we collected subglacial bedrock samples from the Mount Murphy massif, a volcanic ridge that separates the Thwaites and Pope Glaciers [1]. Samples were collected by drilling 30-40 m beneath the ice sheet surface. We measured the concentration of cosmogenic ^{10}Be and ^{14}C within quartz separates from three cores as well as ^{26}Al in quartz from one core to constrain the ice burial and surface exposure history. We also measured the infrared stimulated luminescence (IRSL) and post-infrared IRSL (pIRIR) signal from K-feldspars within two subglacial cores to constrain the same history. The pIRIR signal was also measured from one known-age boulder that was exposed four years earlier to estimate the solar bleaching characteristics of this lithology at this site.

We measured above-background and depth-dependent concentrations for all three radionuclides that require thinner-than-present ice levels during the Holocene. Luminescence results show no direct light exposure since at least 200 – 280 ka, implying that this region was never completely ice free during the Holocene or even the last interglacial. Together, these datasets require the ice to have been 30-35 m thinner than present for at least 3 ka (and up to 8 ka) during the mid-to-late Holocene, with no ice-free period.

This ice thickness history, combined with existing studies that link nearby isostatic rebound with grounding line retreat, suggests that a period of Holocene ice loss at Thwaites Glacier was reversed due to the stabilizing feedback of isostatic rebound. Whether modern ice loss is reversable is unclear.

Keywords (max. 5): pIRIR, K-feldspar, rock surface dating, Antarctica, cosmogenic radionuclide dating

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Investigating the characteristics of post-IR yellow stimulated luminescence

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The use of the infrared stimulated luminescence signal (IRSL) from potassium feldspar as a dosimeter is associated with two disadvantages: anomalous fading [1] and slow resetting of the signal by light. A plethora of work has explored how to overcome the fading problem with both time-consuming post measurement fading corrections [2] and the quest for a more stable signal through post-infrared infrared luminescence (pIRIR) [3]. However, these more stable pIRIR signals frequently exhibit incomplete bleaching or residual signals, resulting in age over-estimations.

Due to its higher energy, yellow (590 nm) optically stimulated luminescence has the potential to exploit a more stable signal, in which electrons are guided via a sub-conduction band [4]. In this study we investigate the characteristics of yellow stimulated luminescence (Y-OSL) and its potential in the dating of Quaternary sediments. Initial work, in which Y-OSL is measured at 260 °C following an IR stimulation at 50 °C (pIR-YOSL), has shown promising results with regards to dating Quaternary sediments [4]. We intend to carry out a systematic study of signal stability, emission-spectra, saturation and bleachability on a set of samples that have robust independent age control ranging from the Middle-Pleistocene to recent age.

Keywords (max. 5): YOSL, feldspar, luminescence characteristics

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A detailed luminescence dating study of the loess-palaeosol sequence at Kuldara, Khovaling Loess Plateau, Tajikistan

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In this study we present the first luminescence ages for the upper part of the Kuldara loess-palaeosol sequence, in the Khovaling Loess Plateau in Southeast Tajikistan. This study is part of the THOCA project ("Timing and Ecology of the Human Occupation in Central Asia", www.thoca.org) in which we aim to reconstructthe timing of hominin arrival in Central Asia, and the environmental and palaeoclimatic conditions under which they lived and evolved. The Kuldara site is located ~15 km from the famous Khonako site complex (see Challier et al., these proceedings) and is close to the Obi-Mazar/Lakhuti palaeolithic site [1,2].

The upper ~20 m of the stratigraphy at Kuldara is made up of a Holocene soil (~1.4 m thick), a thick (~10 m) L1 loess and two pedocomplexes (PC1 and PC2) separated by only ~2 m of (L2?) loess; the latter suggests that part or most of the presumed MIS6 loess was eroded at this site. In general, Tajik loess sequences consist of more than 40 pedocomplexes and cover a sedimentary history of the last 2 Ma; they are presumed to be complete. Even though previous studies noted that most parts of the sequences have no distinguished hiatuses, many sections have shortened loess layers between PC1 and PC2, and in some cases these two PC's are sitting immediately on top of eachother. This phenomenon suggests a regional erosional event, which could be activated by wind/water/ slope processes or tectonic uplift. For understanding this important event we need to identify the chronological range of this regional hiatus. In order to provide an independent timescale for palaeoclimatic studies using grain size, magnetic mineral assemblages, etc., and to check the completeness of the sedimentary record, 70 luminescence samples were collected using stainless steel tubes down to below the PC2 complex. A higher spatial sampling density was used in S0 and L1 (~15 cm) compared to the lower part of the sequence where it was ~50 cm.

Quartz and feldspar in the coarse-silt and/or fine sand (40-63/63-90 µm) range were extracted using conventional sample preparation techniques. Quartz was purified using HF only, no heavy liquid separation was attempted and so the feldspar fraction must have contained significant quartz. Dose rates were determined using high resolution gamma spectrometry and are typical for loess in Tajikistan (~3-3.5 Gy/ka to silt-size d quartz grains). Quartz OSL dating is used to constrain the timing of loess deposition for the upper part of the sequence ($D_e \leq 150$ Gy) and to determine a residual dose for the $pIRIR_{200,290}$ signal. We apply $pIRIR_{200,290}$ dating to the bottom part of the sequence using a relatively large test dose as suggested by the results of dose recovery tests. It appears that we can obtain reliable $pIRIR_{200,290}$ D_e estimates up to ~800 Gy allowing us to provide a detailed luminescence chronology for the Kuldara site back to ~250 ka.

Keywords: loess, Tajikistan, $pIRIR_{200,290}$, polymineral, coarse silt

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The first detailed luminescence chronology of the Middle Palaeolithic Khonako sites (Tajikistan)

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Central Asia is a key migratory route for the peopling of Asia during the Palaeolithic. Unfortunately, chronological information is limited, leaving a geographical and temporal gap in our knowledge of human migrations. One of the aims of the transdisciplinary project THOCA ("Timing and Ecology of the Human Occupation in Central Asia") is to determine the chronology of the first settlements in Central Asia over time through the study of three major archaeological sites (Khonako, Obi Mazar and Kuldara) located in the Khovaling Loess Plateau of Tajikistan [1]. Luminescence dating is being used to date the upper part of the sections, providing a chronological framework for palaeoenvironmental, palaeoecological, and palaeoclimatic studies over the past ~250 ka.

Here we present the first detailed luminescence chronology of the Khonako sites. These sections consist of an alternation of thick loess units and up to 16 well-developed pedocomplexes (PC), providing a sedimentary record presumably back to MIS 31. Lithic assemblages excavated in the upper PC 1 and PC 2 are among the best representatives of the regional Middle Palaeolithic industries. About 320 samples were taken to establish a chronological model down to at least PC 2.

Because of the high dose rates (~ 3 Gy/ka), the OSL signal from quartz can only be used to date the last ~30 ka, and so only the upper part of the section (~ top of L1). Quartz OSL and feldspar $pIRIR_{200,290}$ ages are compared to evaluate the completeness of bleaching of the $pIRIR_{200,290}$ signal and evaluate the size of the presumed residual dose that was present at deposition. First IR stimulation temperature tests are used to confirm the suitability of our pIRIR protocol. Because of the fine-grained nature of the sediment, only very small amounts of 63-90 µm K-rich feldspar grains could be extracted. Therefore, measurements using a $pIRIR_{200,290}$ protocol were also carried out on the polymineral 63-90 µm fractions (i.e. no HF treatment or heavy liquid separation). All these measurements were made using a test dose approximately equal to the measured D_e. Dose recovery ratios (of between 0.91 ± 0.09 and 1.07 ± 0.02) are satisfactory for 6 samples ranging from ~ 20 ka (given dose of ~ 90 Gy) to ~ 250 ka (given dose of ~ 770 Gy) after the subtraction of residual doses (from 16 Gy to 54 Gy). Our preliminary test results also show that the polymineral 63-90 µm fraction yields the same D_e values as purified K-rich feldspar extracts.

The new chronology for the Khonako sites confirms that PC 2 and PC 1 can be associated with MIS 7 and 5, respectively. The sedimentary record appears to be almost continuous through the last 250 ka, although there may be a hiatus in sedimentation at the bottom of PC 1 (end of MIS 6/beginning MIS 5).

Keywords: Middle Palaeolithic, loess, Tajikistan, pIRIR200,290, polymineral coarse grains

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Calibration of buried NaI(Tl) scintillator detectors for 4π natural radionuclide measurement based on MCNP modelling

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NaI(Tl) scintillation detectors are widely used for field measurements of gamma rays due to their robustness and low cost; at least in case of high activity concentrations or large samples, they can provide accurate measurements. Measurements of naturally occurring activity concentrations of ^{40}K, and of the decay series of ^{238}U and ^{232}Th, are of interest in the earth sciences in general, and in particular, NaI(Tl) scintillator-based gamma spectrometers can be used for the low cost determination of burial dose rates in natural geological samples [1]. We are currently developing a robust, portable, and wireless detector specifically intended for field measurement of natural radionuclide concentrations and dose rates.

One of the challenges in developing such an instrument is reliable calibration. Currently most calibrations of field instruments depend on non-finite matrices of known K, U, Th activity concentrations, in either a 4π or 2π geometry [2]. There are only a limited number of these facilities available in the world, and for most laboratories repeated access for regular calibration is clearly difficult. We are investigating an alternative approach, based on the measurement of small samples (~300 g) containing well-known activity concentrations of only K or U or Th, and MCNP modelling to convert the observed spectra to those expected from specific activity concentrations in an non-finite 4π geometry.

The determination of the non-finite matrix calibration spectra is based on three main steps:

- MCNP simulations of NaI spectra for individual K, U and Th wax impregnated calibration cups of known activity and major element composition, validated against observed spectra.
- MCNP simulations of individual K, U, Th spectra expected from field measurement (non-finite matrix) for a chosen activity and major element composition [3].
- The resulting spectra ratios $\frac{Infinite\ modelling}{Cup\ modelling}$ are used to multiply the observed calibration cup spectra to give predicted non-finite matrix calibration spectra.

These modelled calibration spectra are validated by (i) combining in appropriate proportions, and comparing with measured spectra from non-finite matrices of known mixed K, U, Th composition, and (ii) by deriving these (known) K, U, Th concentrations using least squares fitting of the calibration spectra to the measured spectra (after subtraction of instrument background) [4].

This modelling approach to calibration also allows us to investigate the sensitivity of our analytical results to variations in measurement geometry, water content and major element composition.

Keywords: NaI(Tl) detector, field measurement, calibration, MCNP

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High-resolution OSL dating of loess in the Gonghe Basin, north-eastern Tibetan Plateau

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The north-eastern Tibetan Plateau is climatically influenced by the Asian summer monsoon and the westerlies, thus is a key region for studying the interplay of the two climatic systems in the Quaternary. The Gonghe Basin is the largest intramontane basin on the northeastern Tibetan Plateau. The basin is located near the margin of the East Asian summer monsoon and near the transitional zone between semi-arid and arid areas in northern China, therefore, is an ideal area for studying climate change in the north-eastern Tibetan Plateau. Aeolian sediments are widespread in the Gonghe Basin and were shown to document climatic changes of the basin since the last deglaciation. Particularly, loess-palaeosol sequences widely distributed at the edge of the basin as well as in the areas with elevation over 3000 m are important archives for the reconstruction of aeolian activity and late Quaternary environmental change of the basin. Previous studies on the loess-bearing profiles in the Gonghe Basin concluded that loess in the Gonghe Basin is mainly deposited in the late Pleistocene and early Holocene, whilst palaeosols are mainly developed in the Middle Holocene and Late Holocene [1,2]. Discontinuity for individual loess sections was shown to be common, and joint analysis of a number of sections in the entire basin was suggested to be necessary for the reconstruction of palaeoenvironmental changes. Establishing high-resolution chronostratigraphic framework is important for identifying depositional hiatuses in individual sections and for correlating different sections. Previous studies, however, were mostly based on low-resolution sampling for individual sections, which is insufficient for identifying periods of depositional hiatuses and for accurate intersection comparison. In this study, we applied high-resolution optically stimulated luminescence (OSL) dating to four loess sections from the Gonghe Basin, in order to improve our understanding of the timing of deposition and hiatus of loess in the Gonghe Basin, and unravel palaeoenvironmental changes documented by these records. Single-aliquot quartz OSL dating was applied to date all samples, and in order to improve the dating efficiency, we tested using a group of standardised growth curves (SGCs) derived from individual quartz grains [3] for equivalent dose (D_e) estimation. Our results show that the quartz D_e values derived from the SGCs are statistically consistent with those derived from the conventional single-aliquot regenerative (SAR) procedure. Combining the high-resolution OSL chronological frameworks with grain size and magnetic susceptibility analysis, the palaeoenvironmental implications of the investigated sections are discussed.

Keywords: northeastern Tibetan Plateau, loess, East Asian monsoon, quartz, standardised growth curve,

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Phototransferred thermoluminescence of calcite: Principles, analytical methods and mechanisms

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Calcite, as do all carbonates, derives from the $(CO3)^{2-}$ anion. Calcite produces intense thermoluminescence (TL) which is mostly attributed to presence of Mn^{2+} anions. The emission spectra of calcite [1] and carbonatite [2] consist of broadband features at lower temperatures and line structures at high temperatures. These wavelength multiplexed differences are attributed to the solubility of Mn within calcite [1]. Although there has been considerable progress in understanding mechanisms of TL in calcite, corresponding advance related to optical stimulation has been halting. In this study we combine the utility of optical stimulation with the facility of thermal stimulation to study the phototransferred thermoluminescence (PTTL) of calcite induced by 470 nm blue-, 525 nm green- and 405 nm illumination.

The conventional glow curve measured during heating to 600ºC has an indeterminate number of glow peaks only three of which stand out and are regenerated under phototransfer. These are the ones studied. PTTL time-response profiles, that is, the dependence of PTTL intensity on the duration of illumination, are analysed using three methods, namely, a matrix- based analytical model, by use of vector fields and by theoretical modelling. We also address attendant effects such as backscattering to donor traps and competition effects, where supposed donor electron traps suppress electron trapping at acceptor electron traps.

The time-response profiles corresponding to blue and UV light illumination displays the archetype increase through a maximum whereas that induced by green light is drawn out and, in some cases, tends to saturation. Surprisingly, the PTTL induced from deep electron traps by 405 nm illumination counterintuitively increases monotonically. We consider the extent to which this behaviour reflects the influence of slow bleaching components at the higher end of the corresponding PTTL peak or the effect of emission over a range of excited states as predicted by the modified Orgel (1955) diagram rather than the principle $^4P(^4T1g)$ relevant here. The intensity of PTTL induced from deep electron traps increases with temperature of illumination with an activation energy of thermal assistance of 0.052 ± 0.002 eV and decreases at elevated temperatures with an activation energy of thermal quenching of 0.75 ± 0.06 eV. The long term behaviour of the PTTL as studied by stability theory shows unstable critical points. The dosimetric characteristics of the latter including pre-dose effects are described.

Keywords: Phototransferred thermoluminescence; Calcite; time-response profiles; mechanisms; stability

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How variable bleaching of single-grain low-temperature pIRIR signals impacts age estimation

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Low-temperature pIRIR signals of K-rich feldspar can be a useful tool to date young sediments (<1 ka). The low-temperature pIRIR signals bleach rapidly compared to their high-temperature equivalent, and anomalous fading effects for young samples are minor. However, despite their bleachability, resulting ages may still be affected by remnant doses. Moreover, previous research demonstrated that bleachability varies between individual grains. Yet, only few attempts [1] have been made to select grains for palaeodose estimation based on bleachability.

In this research, we aim to estimate the effects of variability of remnant doses of low-temperature pIRIR signals, caused by the difference in bleachability between individual grains. The research is conducted using samples collected from a plaggic anthrosol, which is located in Braakmankamp, eastern Netherlands. To analyse the difference in bleachability, we compare the residual doses of individual grains through measurements after bleaching conditions: 1) during the SAR measurement (recuperation point); 2) after light exposure in a solar simulator; and 3) after natural sunlight exposure.

The results of these experiments allow us to test whether bleachability during the measurement reflects bleachability in nature. This would allow us to examine the way to use the residual dose as measured in the recuperation point to identify grains with the highest bleachability and provide input to clean up equivalent dose distributions. In addition, we combine our dataset of bleachability with information on the difference between the $IRSL_{50}$ and $pIRIR_{175}$ equivalent doses determined on the same grain (D_e ratio). The latter allows us to identify well-bleached grains in an environment influenced heavily by pedoturbation. Combining both datasets (bleachability and D_e ratio) will allow us to identify whether poor bleaching of grain is caused by poor bleachability or highly-limited light exposure. This, in turn, will allow inferences about soil mixing intensity.

Keywords (max. 5): low-temperature pIRIR, K-feldspar, single grain, bleachability, residual dose

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Luminescence exposure dating of a collapsed Buddha statue informs palaeoseismology

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In 2007, a Buddha statue, originally carved on a rock cliff, was found collapsed at an ancient temple site in the middle of mountain (Mt. Namsan) slope in Gyeongju city, South Korea. The statue has drawn much attention because of its potential palaeoseismic importance, since it is considered to have collapsed by a past earthquake shock. In previous work, a quartz OSL age of the sediments underneath the collapsed rocks around the statue has been reported to be 0.8 ± 0.1 ka; however, the relative chronology of the collapse of these rocks and that of the Buddha statue is still unknown [1].

Recent advances in luminescence dating allow an estimation of the time elapsed since the exposure of rock surfaces to daylight. Field observations suggest that the bottom part of the Buddha statue became exposed to sunlight for the first time after the collapse of the statue. Thus, potentially, the luminescence exposure dating of the bottom part of the statue can indirectly provide us with an age of the earthquake.

In this paper, we examine the pIRIR luminescence depth profiles of rock (granite) cores (> ~ 5 cm in length, ~ 3 cm in diameter) collected from the bottom part of the Buddha statue with a view to obtaining its exposure age. In order to constrain the effective detrapping rate and the daylight attenuation coefficient, we sampled several granitic rocks from Mt. Namsan and put them around the statue for ~ 4 months. The orientation of the freshly exposed surface of the calibration samples, and any shadowing effects, were kept similar to the daylight exposure conditions for the bottom part of the statue.

For an independent quality control of our results, we measured the single grain quartz OSL ages of the sediments immediately beneath the statue, and the quartz OSL ages of two pottery samples that correspond to the building of the ancient temple. These ages likely represent the time when the statue was carved, hence they constrain the maximum age limit for the timing of the collapse.

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Keywords: rock surface exposure dating, pIRIR, luminescence depth profile, collapsed Buddha statue

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OSL signal components of quartz for the dose range close to saturation

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The diversity of dose response curves (DRC) shapes observed in OSL results during the dating protocols execution reflects the OSL complexity in quartz. Sometimes the saturating exponential function fits the DRCs. Most often, however, the sum of two such functions is necessary, in particular when one constructs the DRC shape to high doses. Both the amplitude ratios of the two exponential components and their dose constants vary from sample to sample.

It has been known for a decade that the DRC determined for laboratory doses does not follow the natural DRC in the whole dose range [1, 2]. The apparent discrepancy of the curves appears for higher doses in the range close to the OSL saturation. The natural DRC mostly follows the single saturation exponential (SSE) and the laboratory DRCs for the same samples require the sum of two saturation exponential functions to be reproduced correctly. Wang et al. [3] demonstrated that, when using the multiple-aliquot regenerative-dose (MAR) protocol, although the DRCs obtained due to this protocol do not follow the SSE function, one can significantly extend the range of doses where natural and laboratory DRCs overlap. It indicates that the inconsistency between the two DRCs is at least partly due to the processes occurring in the sample during the equivalent dose determination.

On other hand, it is characteristic that the DRCs for individual components obtained by decomposing the laboratory OSL curves were properly fitted with the SSE curves like the natural DRC. On this ground, one can suppose that both DRCs, natural and laboratory agree better when they are measured for a single OSL component. This work aims to check whether the selective measurement of the OSL components by thermally modulated - OSL (TM-OSL) method allows obtaining the laboratory DRC of this signal in the form of the SSE function. The TM-OSL method uses simultaneous optical stimulation with photons of low energy and heating of the sample to enhance the stimulation [4].

The measurement results show that the TM-OSL curves for doses from the range close to saturation differ from those observed for low doses. Sources of the discrepancy are both the admixture of additional OSL and TL signals. These observations prompt a closer look at the components of the OSL signal in DRC measurements carried out for higher doses using various protocols.

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Keywords (max. 5): OSL, dose response curve, quartz, thermally modulated OSL

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Investigating the low temperature thermoluminescence peak from calcite for monitoring thermal lag

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Calcitic snail opercula are a promising new material for thermoluminescence (TL) dating with the potential to cover the last ~3 Ma [1]. The ERC-funded *Bridging Europe: a Quaternary Timescale for the Expansion and Evolution of Humans (EQuaTe)* project aims to produce a secure dating framework for the earliest human occupation and expansion across Europe using this TL signal.

Thermal lag is a key consideration for TL measurements and assessing the reproducibility of heating samples during TL measurement is an important but challenging issue. The potential magnitude of the problem is illustrated by Schmidt et al. [2] who reported a variation of ~60°C in the temperature of the "110 °C" TL peak from quartz grains when heating at 5 °C/s. It is unclear what proportion of this variability is due to thermal lag or incorrect calibration of hotplates. Duller et al. [3] showed that across eight different readers it was possible to reduce the variability in the "110 °C" TL peak from quartz to 2°C, and they suggested the temperature at which the TL peak was observed could be used to routinely assess the reproducibility of sample heating during measurement protocols. This relatively simple procedure involves measuring the TL glow curve and fitting the 110 °C TL peak with a Weibull function [see 4] thereby monitoring the peak position during a measurement sequence.

The TL signal from calcitic opercula displays one low temperature peak (~100 °C, peak I) and two high temperature peaks (~275 °C and 350 °C, peak II and peak III respectively). Lifetimes of 7.4×10^7 and 1.4×10^{11} years have been reported for peaks II and III [1], and these are the signals that are of value for dating [e.g. 5, 6]. Little work has been published for peak I (~100°C). Here we present our investigation of the low temperature TL peak produced by *Bithynia tentaculata* opercula, and whether it can be used to investigate thermal lag and monitor temperature during TL measurements. The approach is used to assess the reproducibility of heating between different TL measurements during a single aliquot regenerative dose (SAR) procedure, and also to examine variability in heating between different opercula from a single sample.

Keywords (max. 5): TL, biogenic calcite, snail opercula, thermal lag

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Luminescence and ESR characterisation of granite source rocks and the derived sediments

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Quartz luminescence sensitivity as well as some ESR signals have been proposed as potential indicators for the provenance of sediments. While luminescence sensitivity is largely believed to be acquired by Earth surface processes [1], recent studies bring empirical evidence that sensitisation processes are a function of source geology [2,3]. Most of the provenance studies using luminescence and ESR methods target minerals grains deposited in sinks and focus only on observing the characteristics of signals displayed by different samples, followed by clustering. As such, there is a gap in the knowledge regarding quartz luminescence and ESR signals in rocks. Without directly examining the signals of the potential rock sources, these studies are not proving a cause-effect relationship.

Here we investigate the luminescence (OSL and TL) and ESR properties of quartz extracted from granite rocks of varied crystallisation ages and their related sediments in the Basin and Range geology in the vicinity of Tucson, southeast Arizona, USA. We observe that the oldest granite sample, Oracle granite (1.4 Ga) displays the highest OSL sensitivity being 10 times brighter than the youngest sample, Catalina granite (26 Ma), and has a larger contribution of the fast component to the OSL signal, as firstly reported by [4]. The OSL dose response curves are generally similar for the granite samples of various ages and slightly change upon heating to 500 °C. Moreover, the mass normalized E' and peroxy intensities increase with the age of the granite. The OSL sensitivity and mass normalized E' intensity of quartz extracted from the sediments is higher compared to the parent granite rocks. The change in the OSL dose response curve after heating is more important in the sediment compared to the Catalina granite source rock, whereas in Oracle granite and its sediments does not vary significantly.

Our findings indicate that the luminescence and ESR signals in quartz have the capacity to distinguish between granite rocks of different crystallisation ages. Further analyses on their capacity to carry genetic information from the granite parent to the sediment are required. These investigations will contribute to the development of a quartz fingerprint method that can have a significant impact on quantitative provenance studies.

Keywords: OSL, TL, E', peroxy, quartz, granites, sediments

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Cooling Age Estimates for Hydrothermal Explosions in Yellowstone National Park

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The Yellowstone Plateau volcanic field hosts an active hydrothermal system that has produced some of the largest hydrothermal explosions in the world. Hydrothermal explosions occur when boiling water contained in shallow hydrothermal systems flashes to steam causing a violent release of water, steam, and rock. These hydrothermal explosions can be triggered by events such as seismic activity, pressure release due to deglaciation or draining of a subglacial lake. Hydrothermal explosions are not classified as volcanic eruptions due to the absence of direct magma involvement. The energy required to trigger these explosions comes from the circulation of heated meteoric water. Yellowstone's hydrothermal activity has been continuous through recent glaciations and has created a variety of phreatic craters throughout the volcanic field. These craters range in diameter from <2m to >2km.

The ages of these craters are poorly constrained, especially from direct dating methods. We use luminescence dating as a part of a larger geochronological study to date two of these explosion craters located in the largest hydrothermal basin in Yellowstone National Park, Lower Geyser Basin. Here we focus on two large explosion craters, Pocket Basin and Twin Buttes, that are both surrounded by associated explosion breccias and debris. The Twin Buttes crater is approximately 645 meters in circumference and encompasses several smaller craters. The Pocket Basin crater is a 365-by-800 meter asymmetric crater rim that has been breached by the Firehole River. We present cooling ages for sediments that were at elevated temperatures in hydrothermal reservoirs prior to explosions events. We use single aliquot regenerative post- infrared infrared-stimulated luminescence (post-IR IRSL) on K-feldspar and single aliquot regenerative optically stimulated luminescence (OSL) on quartz to date the explosion events that formed both craters. The luminescence dating results are compared to several other geochronometers including in situ, cosmogenic ^{10}Be, ^{14}C, and ^{36}Cl exposure dating of explosion-thrown boulders; radiocarbon dating from fossilized wood embedded within hydrothermal breccia; and tephrochronology of lake cores withing the explosion craters. Dating these hydrothermal explosions will provide insights into their triggering mechanisms and associated hazards.

Keywords: OSL, post-IR IRSL, hydrothermal explosions

Luminescence characteristics of quartz to disentangle sediment provenance in low-contrasting source areas: the case of Eastern Andes of Colombia

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The paleogeographic history of rivers plays an important role in the evolution of the Amazon landscape and its biota, but the timing and mechanisms that control changes in the Amazonian fluvial system over time are poorly known. This is the case of the northwestern Amazonian low- lands in the Putumayo basin, Colombia. Part of this knowledge gap results from the absence of adequate sediment provenance proxies for comparison between ancient and modern river sys- tems. This study explores variations in optically stimulated luminescence (OSL) and thermolu- minescence (TL) signals of quartz grains from modern (active drainages), buried (sedimentary deposits) sediments, and cretaceous rocks to reconstruct changes in paleodrainagens of the north- western Amazon during the Cenozoic. Preliminary results show distinct characteristics in the OSL sensitivity of quartz along the foothills of the Andes. In the region of Florencia, for example, there is variability in the sensitivity of quartz within the hydrographic basins of the Pescado River and the Ortegueza River, even with a low sensitivity it is possible to distinguish different sedi- mentary units with possible different source areas. The new information generated will contribute to discriminating target sedimentary units, determining the origin of sediments, and reconstruct- ing changes in provenance during basin infilling. This will be considered for geodynamic and fluvial reconstructions of the history of the Eastern Andean Cordillera and the Putumayo sedi- mentary basin. (FAPESP Grant #2020/11047-1, Human Resources Program 43.1 - Petroleum Geology, financed by the National Agency for Petroleum, Natural Gas and Biofuels).

Keywords: sediment provenance; luminescence sensitivity; Putumayo Basin; Eastern Andes; Northwest Amazon

Attenuation of daylight in different rocks and its influence on the detrapping rate

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Optically stimulated luminescence (OSL) is used increasingly to determine the exposure or burial age of rocks. These methods rely on the resetting of latent geological OSL signals with depth into the rock surface, or the re-accumulation of new signals after burial [1]. It is well known that the quartz OSL signal bleaches more rapidly than both the feldspar $IRSL_{50}$ and post-IR IRSL signals, in sediment grains exposed to daylight [2]. However, it has also been observed that the bleaching front of the quartz OSL signal is often shallower (i.e. less well bleached) than that of the feldspar $IRSL_{50}$ signal in solid rock samples [3]. This unexpected effect may be attributed to the differential attenuation of the wavelengths that are effective at bleaching quartz and feldspar signals, as daylight penetrates into the rock. Published data suggests that some rocks show larger attenuation coefficient (μ) for short wavelengths than those in near infrared [4], and it is known that feldspar IRSL is more sensitive to longer wavelengths than quartz OSL [5-7].

Therefore, there is a need for more information on the wavelength-dependence of the attenuation coefficient in various rock media. In this study, the change in the daylight spectrum through the rock slices of different lithology (quartzite, K-feldspar, syenogranite and sandstone) and thicknesses was investigated using a portable solar spectroradiometer. The effective attenuation coefficients in the wavelength range of 300-1100 nm were determined for each rock type. Based on these results, we then perform forward modeling to understand the luminescence-depth profiles of quartz OSL and feldspar IRSL signals resulted from different bleaching scenarios in various rock types.

Keywords: Rock surface luminescence; Solar spectrum; Attenuation coefficient; Detrapping rate

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Investigating luminescence and electron spin resonance characteristics of quartz derived from sandstones: An insight into provenance and sediment transport in ancient depositional environments

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Identifying source(s) and transport history of sediments is key to quantitative reconstruction of sediment routing systems, which consequently reflects the role of climate and tectonics on earth surface processes and landforms. Most quantitative provenance studies focus on investigation of accessory minerals; in contrast the most abundant and robust mineral in sedimentary systems, *Quartz,* remains largely unexplored. In recent years, in addition to the classic application of trapped charge techniques (luminescence and electron spin resonance) to age determination of quartz, it is also being widely explored as a tool to determine the provenance and transport history of quartz in sedimentary systems [1, 2 and references therein].

In this study we investigate late Oligocene-early Miocene sedimentary rocks from the Kliwa and Fusaru formations of the Eastern Carpathians and the Ediacaran sedimentary rocks from the Moldavian Platform of the Eastern European Craton. Geochronological evidence based on detrital zircon U-Pb ages as well as petrological and sedimentological analyses [3, 4] suggest that these sandstones are not only derived from different sources of varying ages, but also have variable transport and depositional histories. Our measurement of paramagnetic centres, E' and peroxy, in coarse grain quartz extracted from sandstone corroborate with detrital zircon U-Pb age distributions, indicating different source areas for the sandstone. These results further re-affirm previous observations [1 and references therein] that these defects correlate with the age of undeformed source rocks, which underpins its application as a provenance indicator. Furthermore, our preliminary investigation of luminescence sensitivity (thermo-luminescence as well as optically stimulated luminescence) of quartz exhibits a signal most likely dominated by its sedimentary history rather than the age of the source rock; however, this presumption will be further tested through luminescence measurements on individual quartz grains.

Keywords: Quartz, Luminescence, Electron Spin Resonance, Sediment transport, Provenance

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Testing the performance of an EMCCD camera in measuring single grain feldspar (thermo)luminescence

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Besides dating there is increasing attention to use luminescence dating as a method to trace sediment transport. Tracing methods require rapid repeated single-grain (SG) measurements on slow-to-bleach signals. In developing luminescence tracing techniques our focus is on single-grain feldspar luminescence, because the slow resetting speed of post-IR IRSL (pIRIR) and thermoluminescence (TL) signals make feldspar a potentially ideal intrinsic sediment tracer. Slow-to-bleach signals have a better transport memory imprinted. We seek the best approach in measuring these signal types.

Conventional single-grain measurements are performed using laser-based stimulation combined with photon multiplier tube (PMT) detection. An alternative approach is to stimulate all grains on a single-grain disc simultaneously by LED diodes and image the arising luminescence signal with an Electron Multiplying Charge-Coupled Device (EMCCD) camera [1]. The EMCCD camera is advantageous for tracing purposes because it may offer rapid measurement of large numbers of single grains. The EMCCD can spatially resolve all types of OSL signals, therefore also enabling single-grain TL measurements and polymineral approaches. Similar to conventional single grain methods, EMCCD detection allows rapid repeated measurements without user interference. Moreover, the EMCCD provides extreme low-level light detection for dimmer signals [1]. The EMCCD approach has the additional advantage of simultaneous measurement of all grains on the disc, minimizing thermal erosion during prolonged elevated-temperature post-IR measurements.

So far comparison between the two systems has only been performed on quartz [2]. Here, we show our prospective feldspar results: the two systems yield similar dose estimations and the imaging system seems around twice less sensitive than the conventional system, which also has been concluded by Thomsen (2015) [2] on quartz data. We now aim to present our work on (1) optimization of feldspar system settings to maximize number of accepted grains for analysis, one of the aspects is optimization of the crosstalk trade-off (2) quantification of the differences between the two systems by performing dose recovery tests on the same samples (cross-referenced) on both machines for several pIRIR signals. Results are compared in terms of the obtained equivalent doses and percentage of grains accepted for analysis. Furthermore, we aim (3) to present the detection of SG feldspar thermoluminescence signals with the EMCCD, and place its use in the context of sediment tracing purposes.

Keywords (max. 5): single-grain, thermoluminescence, EMCCD, feldspar, sediment tracing

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Evaluating the impact of sediment sample size and heterogeneity on High Resolution Gamma Spectrometry

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An accurate determination of the dose rate is crucial for Optically Stimulated Luminescence (OSL) and Electron Spin Resonance (ESR) dating. Among the various analytical techniques available for this purpose, High Resolution Gamma spectrometry (HRGS) is commonly used to measure the activity of radioisotopes for the alpha, beta and gamma external dose rate components. However, previous studies specifically pointed out the absence of standardized procedures among laboratories for the determination of U, Th and K activities [1, 2]. While several parameters such as sample size, density, heterogeneity or measurement geometry, among others, may have a great impact on the recorded spectrum, as far as we know there is no agreement within the community on the best laboratory practices for HRGS sample preparation.

As part of the implementation of an accurate measurement protocol in our laboratory, we performed several experiments to compare the resulting U, Th and K activity derived from various measurement configurations, e.g., using raw vs. ground sediment or varying filling ratios (i.e, volume of the sample / volume of the box). Two sediment samples (S1 & S2) of different geological origins were selected for this experiment: S1 was collected from a homogenous sandy fluvial deposit, while S2 originates from a heterogeneous sandy gravel alluvial deposit. Both samples were placed in transparent crystal polystyrene boxes (71x20 mm) and measured using a Canberra Xtra High Purity Germanium (HPGe) detector. Energy and efficiency calibration was specifically adjusted to each measurement configuration. All samples were sealed with tape and stored over 25 days before counting to ensure equilibrium in the ^{238}U-series. ICP – MS/OES analysis of the 2 sediment samples were performed for comparison.

In this poster, we will discuss the variability of the resulting U, Th and K activity and evaluate to which extent the dose rate determination may be impacted.

Keywords (max. 5): Gamma spectrometry, sample geometry, sample preparation, OSL dating, ESR dating.

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Extended-range luminescence and ESR dating of Iberian fluvial terraces (Duero and Guadiana basins) associated with the Lower Palaeolithic sites of La Maya I, II, Burganes and Albalá (west-central Spain)

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A large proportion of the Lower Palaeolithic (Acheulean) records from the Iberian Peninsula are associated with fluvial archives located in the major river basins of the Duero, Tajo and Guadiana drainage systems. Unfortunately, these open-air archaeological records are often difficult to constrain chronologically due to a lack of suitable material for dating (e.g., faunal remains) or because their Middle Pleistocene antiquity precludes the use of otherwise applicable geochronometric techniques, such as optically stimulated luminescence (OSL) dating of sedimentary silicates. As a result, many important Acheulean sites lack precise and accurate chronologies, and their existing temporal frameworks are based solely on morphostratigraphic correlations with regional fluvial terrace systems.

The Lower Palaeolithic (Acheulean) sites of La Maya I, II and Burganes are located in the western sector of the northern Meseta (Spain), within the Duero drainage system. The La Maya I (+6-8 and +14 m above river level) and II (+34 m) sites and the Burganes sites (+16-20 m and +34 m) are situated on the middle terraces of the Tormes and Tera rivers, respectively. Further to the south, the Acheulean site of Albalá is associated with a terrace (+8 m) of the Guadiana River.

This study reports on the first application of extended-range luminescence dating, namely multi-grain infrared stimulated luminescence (post IR-IRSL) dating of K-feldspars and single-grain thermally transferred-OSL (TT-OSL) dating of quartz, to these Lower Palaeolithic sites and/or associated fluvial terraces from central-west Spain. An additional quartz ESR age was obtained for a sample from one of the Tormes River terraces to carry out a multi-method age assessment.

We report on the suitability of these luminescence signals for dating the Middle Pleistocene deposits, which have been tested via a series of quality assurance criteria (signal composition, dose recovery tests, bleaching tests, sensitivity correction assessments). The resultant chronologies are presented and used to assess (i) the accuracy of existing chronostratigraphic frameworks developed for these sites, and (ii) the wider implications for understanding Acheulean occupation patterns in the Iberian Peninsula more broadly.

Keywords (max. 5): single-grain TT-OSL, post IR-IRSL, Acheulean, Fluvial terraces, Iberian Peninsula

OSL dating of Late Pleistocene raised shorelines in northwest Scotland

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One of the largest uncertainties related to future projections of sea-level rise is the influence of ice sheets: their retreat, glacio-isostatic adjustment, and relative sea-level changes. Past ice sheet behavior and relative sea-level changes provide important analogues of how contemporary systems may respond to climate change. The presence of the British and Irish Ice Sheet and the Minch Ice Stream during the Last Glacial Maximum makes the northwest of Scotland an ideal study area to provide new constraints on relative sea-level limits and changes. 25 samples were collected for OSL dating from raised shorelines at elevations up to 20 m.a.s.l, along the coast from the Isle of Skye to Ullapool.

Quartz separates were extracted with standard procedures and samples were dated with the SAR method [1]. Quartz samples investigated to date show favorable luminescence properties. OSL signals are on the order of 10,000 cts/0.4s after irradiation with 10 Gy (3mm aliquots). Preheat temperatures, as determined with plateau tests and dose recovery tests, are in the range of 180°C - 220°C. Recuperation values are well below 5% and recycling ratios are in the range 0.9 - 1.1. Dose recovery tests resulted in deviations of less than 10% for reliable aliquots. We will discuss further luminescence properties such as sunlight resetting and differences between samples from different sites. Finally, we will present ages for selected sites and their correlation with shoreline elevation.

Keywords: quartz, OSL, raised shorelines, British Isles, sea-level change

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Luminescence dating of playa sediments from the Qaidam Basin in the Tibetan Plateau using both Quartz and K-feldspar

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Playa, with a salt crust layer of ~0.5 m thick, is widely developed on the surface of Qarhan Salt Lake (QSL) area, Qaidam Basin, Tibetan Plateau, where wind and drought prevail. It effectively prevents further wind erosion of the underlying lacustrine strata [1], and, occasionally, is embedded by aeolian sands that directly pile on the lacustrine strata. The unconformable contacts among the sediments of Qarhan playa, including the salt crust layer, lacustrine strata and aeolian sands, indicate important environmental shifts. However, their ages are not clear, limiting our further understanding of the environmental evolution of the arid region.

In this study, nine samples (i.e., four from salt crust layer, four from underlying lacustrine strata, and one from eolian sands) were selected for luminescence dating. For the lacustrine sediments, due to the saturation of ^{14}C dating and quartz optically stimulated luminescence (OSL) [2, 3], K-feldspar post-infrared infrared stimulated luminescence (pIRIR) dating are used. For the other samples, quartz OSL are used. Laboratory tests are conducted for checking suitability of the dating protocols. Aeolian sand components are found from the lacustrine strata [4, 5]. These coarse particles have been brought in by dust storm, and are exacted for luminescence dating. The single-grain technique is used for partially bleached samples, and brighter aeolian sand particles with more concentrated D_e value distribution were selected for age calculation.

Dating results suggest geomorphological processes from paleo-lakes to fluvial salt crust, and from aeolian sands to aeolian salt crust, since Late Pleistocene. The playa developed in a relatively wet climate, rather than a hyper-drought when no water follows in.

Keywords: Qarhan, playa in the Tibetan Plateau, luminescence dating, Quartz OSL, K-feldspar pIRIR

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Luminescent chronology of coastal sedimentary strata in Northern Jiangsu Basin over the last 350,000 years

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The Northern Jiangsu Basin is a typical sea-land transitional zone, and the eastern part of the basin has deposited with thick interoceanic sedimentary strata. The studies of geological landform and the sea-land changes in this area deserves deeper exploration. Abundant studies on the northern Jiangsu basin mainly focused on the process of sea level changes during the Holocene and Late Pleistocene periods, but studies on the sedimentary environment changes in this region of the area at older ages than 200,000 years still needs to be studied further due to insufficient chronology. The chronological study of the strata in northern Jiangsu Basin has significant value to explore the history of land-sea interaction and the formation and evolution of coastal geomorphology in the eastern coastal region of China since the Quaternary.

This study selected 12 samples from two boreholes（CDA01 and CDA04）in Yancheng for systematic optically stimulated luminescence (OSL) dating research. According to the grain size characteristics of the sediments, fine-grained feldspar minerals of 4-11μm were extracted during the pretreatment process for OSL dating. The age framework was established by the agedepth relationship model.

The main conclusions are shown as follows:

1.The luminescence dating method has good applicability in Yancheng coastal sediments. The ages obtained by the standardized growth curve (SGC) method are in good agreement with those obtained by the Single aliquotregene rativedose (SAR) protocol method. For some older samples, the growth curve still increased when the regeneration dose reached 800Gy, which provided the possibility for the application of SGC in older sedimentary samples.

2. The trend of luminescence age and depth is consistent. The luminescence age measured at the top sample (42.55m) of boreholes CDA04 is 174.0±10.2ka, and the bottom sample (130.3m) is 345.2±39.8ka. Due to some samples are older than the upper limit of the traditional luminescence dating method, the obtained ages may be underestimated, so they should be used with caution in further studies or treated as the minimum age measured.

Keywords: Northern Jiangsu Basin; Luminescence dating; Standard growth curve

Chasing snails: automating the processing of EMCCD images of luminescence from opercula

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Devices for imaging luminescence emissions have been used for a number of years [e.g. 1], but where analysis of a sequence of measurements of the luminescence signal following different treatments is required a significant challenge has been to accurately register the images so that a signal measured from a region of interest defined in one image is compared with the corresponding part of the other images. This is particularly an issue with automated instruments where sample repositioning varies from one measurement step to the next, resulting in samples moving laterally and/or rotationally with respect to the EMCCD field of view.

The calcitic opercula of *Bithynia tentaculata* are of interest for their TL emission which grows to doses in excess of 8,000 Gy, meaning it is potentially able to date the entire Quaternary period. The opercula are teardrop shaped and typically 2-4 mm on their longest axis. Imaging using an EMCCD permits spatially resolved equivalent dose determination, but registering the images has been a major impediment to analysis of sequences of measurements. Previous work [2] manually determined the translation and rotation of the opercula using distinctive features on the periphery of the opercula as markers. However, this approach is time consuming, especially where between 30 and 50 images of each opercula may need to be aligned for a sequence of measurements; it is also prone to human error.

An automated process of image registration has been developed using ImageJ [3] capable of tracking each opercula. This procedure identifies the outline of the opercula in each image and then registers them. Using the translation and rotation of each image, any region of interest defined on one image looks at the same part of the opercula on all other images. Additionally, since the process identifies the outline of the opercula it allows a series of morphometric measurements to be made automatically, and for a series of regions of interest to be defined within the confines of the outline shape.

The new approach is described and illustrated. A number of techniques are used to assess the accuracy of the registration process, and the impact upon the determination of D_e or other measurements such as pulse annealing are shown. This approach could also have applications for other types of object, such as rock slices, although they would need to be non-circular to be able to assess rotation of the object. It could also be adapted to enable the comparison of images captured by different devices mounted on the same instrument.

Keywords: imaging luminescence, EMCCD, data analysis, calcite, TL

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Single grain quartz OSL signal properties assessed using EMCCD imaging

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Single grain quartz optically stimulated luminescence (OSL) dating has become a frequently used geochronological technique within earth and archaeological sciences. During routine single grain measurements within the Risø reader set-up, single grain luminescence signals are stimulated using a solid-state laser beam which is focused on individual grains mounted within specialized single grain discs, and signals are detected using a photomultiplier tube (PMT) [1]. The recently developed electron multiplier charge coupled device (EMCCD) Risø attachment [2] offers an alternative means of measuring luminescence signals from single grains, where signals are imaged rather than detected using a PMT, and signals are stimulated with light emitting diodes (LEDs) instead of a laser. Whilst the detection sensitivity of the EMCCD system is lower when compared with the laser system, using LEDs rather than a laser system for signal stimulation offers two key benefits. The first is that the LED power density is lower, resulting in a lower rate of charge de-trapping that can be of benefit for mathematical treatment such as curve deconvolution. The second is that the use of the LEDs for stimulation results in an effective stimulation power at the sample location within the reader which is more constant and consistent in comparison to the laser set-up. This circumvents the unquantifiable variability in effective stimulation power associated with laser stimulation [3]. Therefore the EMCCD set-up can be used to better compare single grain luminescence signals, and offers the opportunity to capture single grain thermoluminescence signals, as well as OSL signals.

Variability in the intrinsic properties of quartz OSL signals has been widely recognized, and for example intra- and inter-sample variation in signal intensity and characteristic dose are frequently commented upon in chronology-focused papers. Analyzing single grain quartz OSL signals imaged from a range of samples using a Risø EMCCD system, Durcan and Duller [4] report intra-sample signal intensities varying by 2-3 orders of magnitude, as well as variability in decay curve form and fast ratios. Photoionization cross sections from single grain signals were also presented, and differences in the number and combination of quartz components present was observed both within and between samples. This paper further develops this work by calculating characteristic doses and thermal stabilities from the same EMCCD-derived single grain signals. This extended single grain dataset of quartz luminescence signal properties will allow the relationship between commonly considered characteristics, such as sensitivity and degree of fast component domination in the signal, to be compared against signal properties such as saturation level and thermal stability.

Keywords (max. 5): Quartz, OSL, thermal stability, characteristic dose, EMCCD

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Dating the earliest evidence of human presence in western Europe: New results from Pirro Nord (Italy)

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Our understanding of early human dispersals in Europe is based on a handful of archaeological sites spread across the southern margin of the continent. Among them, Pirro Nord-13 (Italy) is usually considered to document the oldest evidence of human presence in Western Europe, although the site itself has never been numerically dated. Instead, the age of the Mode 1 (=Oldowan) lithic assemblage and associated fossils found in this karst fissure has been inferred from biochronology and estimated to be 1.3-1.6 Ma [1]; making it older than the Spanish Mode 1 pre-Jaramillo localities of Atapuerca Sima del Elefante, Barranco León and Fuente Nueva-3, which have been dated by a combination of numerical methods and palaeomagnetism.

We provide here the results from the first dating study of the site involving a wide range of methods: Electron Spin Resonance (ESR) and single grain thermally-transferred optically stimulated luminescence (SG TT-OSL) dating of quartz grains, combined U-series/ESR dating of fossil teeth and palaeomagnetic analyses of sediment. Such a multi-technique dating approach offers the possibility to obtain chronological constraints for both the fossil assemblage and the host sediment.

The (semi-)independent methods consistently yield an Early Pleistocene age for the site, although the resulting estimates are much younger than initially inferred from biochronology. We discuss potential reliability considerations with the new numerical ages and existing biochronological inference. Nevertheless, these results suggest either a complex taphonomic history in which fossil remains, lithic artifact and host sediment might not be coeval, or at least the sediment was most recently exposed to sunlight during the latest part of the Early Pleistocene.

Keywords: ESR dating, TT-OSL dating, combined U-series/ESR dating, Quartz grains, Tooth enamel

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Luminescence ages of the ceramics from the Urewe and Kalundu Traditions, Lydenburg Heads site, Mpumalanga, South Africa

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Farming communities first moved into South Africa in the first millennium CE, around 2000 years ago. These agro-pastoralist communities settled near water sources to provide easy access to water for their cattle and suitable soils for crop cultivation. One of the best-known Early Iron Age sites in north-eastern South Africa is the Lydenburg Heads' (LH) site. The site yielded the Lydenburg Heads, the earliest examples of complete ceramic sculptures in South Africa. The associated ceramics are important for re-constructing early agricultural activities in the region.

Late twentieth-century excavations of three trenches at the site found separate pottery sherds in the Kalundu and Urewe traditions in two of the trenches and a combination of both traditions in a third trench. Radiocarbon dating on the site yielded two mid-600 CE dates. However, subsequent reanalysis of the excavated material revealed that the LH site was occupied during two periods. The first period was dated to around 600 CE and the second from 900 to 1100 CE. The earliest period is characterised by ceramics made in the Urewe Tradition, which suggests connections along the eastern seaboard. The more recent Kalundu Tradition ceramics suggest links into north-western South Africa through Botswana and Zimbabwe. These more recent dates and archaeological affiliations are largely based on ceramic typologies.

Because the LH site was heavily eroded and the ceramic sculpture sherds were removed from their context, absolute dating has been difficult. Based on the ceramic style, it is believed that the LH sculptures date to the second period of occupation. Here we report on the optically stimulated luminescence (OSL) dating to constrain the timing of the pottery sherds to establish whether the pots originated in successive or contemporaneous occupations. In addition, we assess the effectiveness of the minimum extraction technique (MET) in dating the pots without causing extensive damage to the sherds.

Keywords: Lydenburg Heads pottery, Kalundu Tradition, Urewe Tradition

A safe procedure for HF etching as part of sample preparation for luminescence dating

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Extraction of quartz and alkali-feldspar grains for luminescence dating includes etching with hydrofluoric acid (HF) which is highly corrosive [1]. Concentrated HF is extremely hazardous and can cause severe burns and poisoning, even leading to death [2]. Therefore, it should be handled with extra caution, and any work with it should be carried out with full protective gear and in designated fume hoods. In most laboratories, in order to avoid exposure to light and bleaching, HF etching is performed in a dark laboratory under weak orange-red light in wide open beakers using access HF acid. Even when taking all precautions, handling HF in open beakers in the dark could result in unfortunate accidents due to unintentional spillage.

Here we present a protocol for HF etching which avoids the two main safety issues – working with open beakers and under poor lighting. The HF volume required for etching 3 gr of quartz was calculated, turning out to be much lower than usually used (5 ml/gr). The grains are etched in 250 ml black, light-tight polyurethane bottles with caps and a narrow opening that prevents any light from reaching the bottom of the bottle. Therefore, the procedure can be safely performed in comfortable light levels within a chemical fume hood. The acid is transferred to the bottles with a peristaltic pump which delivers the precise necessary HF volume per sample. So, the chance for any accidents is minimal. To validate the harmlessness of the laboratory environmental light, bleaching experiments of quartz were carried out under the same conditions as the protocol. These showed that no bleaching occurs during this procedure.

Keywords: quartz, alkali-feldspar, hydrofluoric acid

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ESR/U-series and IRSL dating of Middle Pleistocene site of Lunel Viel (LV I), Hérault, Southern France

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The Mas des Caves site at Lunel-Viel, Southern France, is a complex of several caves, dug in Miocene limestone, that have yielded a rich archaeo-palaeontological sequence attributed to the Middle Pleistocene with abundant vertebrates and lithic artefacts. The first caves (LV I, II and III), discovered in 1800, were excavated at the beginning of the 19th century [1] before falling into oblivion for over a century. The main cave is LV I when LV II and III are smaller subparallel galleries. In the early 1970s, research was conducted in main the gallery by E. Bonifay who discovered, as well an extension named LV IV and the natural entrance (sinkhole, doline) both completely closed now.

Recently, a multidisciplinary approach has been set up (DRAC-SRA Occitanie) to contextualize the ancient collections with the recent ones and to allow a better understanding of the site formation, palaeoenvironmental and behavioural history of the animals and humans who lived there [2]. The previous chronology based on faunal elements yields important biomarkers (including new genus and species/subspecies) making Lunel-Viel a major Middle Pleistocene site in the European record. Among various dating techniques used in this study, trapped-charged methods such as combined ESR/U-Th and IRSL were applied on fossil tooth enamel and on feldspars respectively. The results obtained by both methods are in agreement and suggest a period of human occupation between 300 and 200 ka. This age range matches well with the composition of the faunal assemblage attributed to the second part of the Middle Pleistocene (biochronology) and which constrain the occupation to a cool/temperate and humid period which could be contemporaneous with the MIS9 or the beginning of MIS7 [3].

Keywords: Lunel Viel, Southern France, Middle Pleistocene, ESR/U-series, IRSL

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Wavelength-resolved thermo- and radioluminescence of two quartz reference samples

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A better understanding of the physical mechanisms and point defects involved in quartz's charge trapping and luminescence processes enables improving the luminescence dating and dosimetry applications relying on this mineral. Here we report on the progress in our systematic investigation of two reference quartz samples using various spectroscopic techniques [1]. One sample originates from the "Silver Sands of Morar", Scotland – UK, and the other one from the Oligocene Fontainebleau Sandstone Formation, France.

We conducted wavelength-resolved thermally stimulated luminescence (WR-TSL) measurements over an extended temperature range, from 10 K to 630 K, to point out similarities and differences between the luminescence properties of the two samples. We identified various luminescence emission bands, studied their correlation with specific TSL traps and compared the results with the data reported in the literature. We will show which emission bands previously evidenced by X-ray radioluminescence (RL) measurements are also detectable in TSL emission spectra [2]. In particular, we focus on the so-called 190 K TSL peak, which has been correlated to the $[SiO_4/Li]^0$ centres and is known to display a pre-dose-like behaviour analogously to the 110 °C peak, resulting in an enhancement of their UV emission [3]. We attempt to determine which of the previously reported UV bands, i.e., the 3.42 eV emission (C band) or the 3.73 eV one (M band), is enhanced in the pre-dose, like sensitization of the 190 K peak.

Finally, we report RL measurements over the range of 10 K – 320 K to determine the temperature dependence of the luminescence emissions and quantify the contribution of the self-trapped exciton (STE) band. The results obtained, together with the data reported on the same samples in previous works, provide a more comprehensive picture of the luminescence properties of these reference materials. The data will be discussed in relation to experimental results reported in the literature on different types of quartz.

Keywords (max. 5): quartz, emission bands, thermoluminescence, radioluminescence, spectrometry

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Dating glacial sediments from drill-cores with single grain pIRIR luminescence methods.

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Overdeepened structures preserve Pleistocene sediments and can therefore serve as geo-archives for the reconstruction of depositional processes and paleoenvironmental conditions. Overdeepened valleys and basins are recorded over most of the extent of the European Alps and their foreland[1].

The multinational pan-alpine research project ICDP - DOVE (International Continental Scientific Drilling Program - Drilling Overdeepened Alpine Valleys) currently investigates overdeepened structures in the northern realm of the Alps. Drill-cores in the investigated overdeepened structures retrieved sedi- mentary sequences that are expected to span multiple glacial cycles. One of the main ICDP-DOVE re- search questions is building a robust geochronological framework for the drill-cores by implementing a combination of different numerical dating methods, including luminescence dating approaches.

The focus of the project are sediments predating the last glacial cycle, in effect the penultimate glaci- ation and beyond. Quartz OSL had to be omitted because of signal saturation effects in sediments beyond the last ~100 ka. Therefore, luminescence signals from potassium-rich feldspar are used to extend the possible dating range. With the cores comprising mainly glacial, glacio-fluvial, and glacio-lacustrine sed- iments, the expected effects of incomplete bleaching prior to deposition on the feldspar luminescence signals are investigated and discussed. Previous studies showed age overestimation, often limited by signal saturation of multigrain feldspar aliquots. This was potentially caused by signal averaging effects[2]. Single grain (SG) measurements of potassium-rich feldspar using a pIRIR@225[3] SAR dose protocol showed promising results to circumvent this issue. Here we present first results from initial samples of comple- mentary glacial overdeepenings with a focus on the applicability of different statistical evaluation tech- niques of the SG datasets in comparison to the approach described by Rades et al. (2018)[4]. In addition, the luminescence signal properties of each overdeepened structure are characterized and compared with each other. Furthermore, preliminary ages are presented.

Keywords: pIRIR225, single-grain feldspar, European Alps, glacio-fluvial sediments, glacio-lacustrine sediments

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Rock surface luminescence dating of the burial mound at Saint-Bélec (Finistère) in Western France

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From the Neolithic to the Bronze Age, megalithic architecture is widespread in Europe and encompasses a variety of burial mounds and standing stones. Megalithic archaeology has long required a direct numer- ical dating technique on which an understanding of the contexts and behaviour patterns leading to the construction of these monuments can be based. A more direct dating method is required to address these very important questions in our European heritage. From this perspective rock surface luminescence da- ting is a dream come true for megalithism specialists.

Here we present the preliminary attempts to derive a direct chronology for the construction and use of a burial mound (made up of granite, quartzite and shale rock) in Saint-Bélec, France, which has been at- tributed to the late Bronze Age. This site has received significant attention and media coverage this past year due to the interpretation of markings on one of the slabs that made up the funerary chamber as an ancient map of the local topography, probably the oldest map in Europe [1]. In 2022, six sediment samples and nine cobbles were sampled from Saint-Bélec excavation site. Of the nine cobbles, three of them were white quartz-rich sandstones, five were feldspar rich granite, and one was a blue quartzite rock. Four of the rock samples were sampled with a diamond saw in the field, leaving behind ~15 cm large scars in the field samples. Sensitivity test measurements were done on these samples in the field using the IRPL im- aging system [2]. Other samples were removed whole from the excavation site.

Preliminary measurements on the rock samples show no or very little quartz sensitivity using pulsed blue OSL before and after IR stimulation. However, heating sample material to 640°C for one hour, shows sensitivity changes of blue stimulated signals, with orders of 100 to 1000 times the signals with no heating. This indicates the presence of quartz grains that unfortunately were not sensitive in the rock samples at deposition. Strong IRSL signals were observed from the granite samples, but no IRSL signal from the blue rock sample, and only a dim IRSL signal from the white sandstones. IR-stimulated luminescence depth profiles are presented for the granite and white sandstone samples together with IRPL imaging profiles.

Keywords (max. 5): Rock surface luminescence dating. Megaliths.

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A synchrotron study of the defects associated with the principal trap in feldspar

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Infrared-radiofluoresence (IR-RF) is a promising luminescence-based dating technique that determines the burial age (i.e., time since deposition) of potassium (K)-rich feldspar grains contained in sedimentary deposits. The method relies on detecting an IR-RF signal from prompt recombination of charges in the main dosimetric trap during exposure to ionizing radiation. The technique has been successfully applied in several geochronology studies. However, we identified that the sensitivity of the IR-RF signal (i.e., signal shape/intensity) varies across feldspar grains, and this can introduce significant uncertainties and limit the application of the method.

A few recent studies point out that the origin of the IR-RF signal can be linked to the presence of Lead $(Pb)^{+}$ when Pb^{2+} captures a free electron during exposure to natural ionizing radiation [1,2]. More recently, the presence of Iron (Fe)-ions in the vicinity of the principal trap has been shown to affect the charge-trapping process during irradiation. Fe-emission may be produced when Fe^{2+} accepts a hole or Fe^{4+} accepts an electron [3]. The relationship between Fe and Pb has not been studied in detail or confirmed independently. To (i) examine the chemical origin of the IR-RF emission and (ii) assess whether the grain geochemistry influences the age limit of this dating method, we undertook a high-resolution spectroscopy study on individual grains at the National Synchrotron Light Source (NSLS-II), USA.

Thirty individual K-feldspar grains were selected to represent a diversity of (i) geological context, (ii) geochemistry, and (iii) shape of the IR-RF signal (i.e., decreasing, increasing, and flat). The grains were fixed on a polymer microscope slide with a suitable adhesive to avoid misplacement during measurement. High-resolution (1 μm) X-ray fluorescence (XRF) maps were obtained on the grains. Among the analyzed grains which display a decreasing IR-RF signal (category #1), 100% contain Fe, K, and Pb, and 85% contain Ba, among other elements. 100% of the grains which display an increasing IR-RF signal (category #2) have Fe and K, and some have Pb and Ba. Furthermore, 100% of the grains showing a flat low-intensity IR-RF signal (category #3) contain Fe, some with K and Pb, but no Ba. Most grains from categories #2 and #3 have Ca, while none of the grains from category #1 have Ca. The X-ray absorption near edge structure (XANES) maps also enabled us to identify that within feldspars, Fe exists as Fe^{2+} and Fe^{3+} while Pb is present as Pb^{2+} and Pb^{4+}. We repeated the experiment on polished thin sections of grains to generate topology-effect free μ-XRF and μ-XANES maps. As a result, we almost systematically observed that higher concentrations of Fe^{2+} and Fe^{3+} are present on the outer surface of the grains.

At the conference, we present our initial findings and discuss our hypotheses on the cause of the IR-RF signal sensitivity/shape in feldspars.

Keywords: IR-RF, feldspar, XRF, XANES

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Optically Stimulated Luminescence dating of the Xujiayao site reveals diversification of hominin lineages during the Penultimate Glacial Period in East Asia

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One of the most important Paleolithic archaeological sites in East Asia, the Xujiayao locality in the Nihewan Basin, North China, has yielded twenty *Homo* fossils as well as tens of thousands of artifacts and mammalian fossils. The Xujiayao hominin possibly represents a new *Homo* lineage, since it exhibits specific evolutionary characteristics of Neanderthals, modern *H. sapiens*, and Denisovans, which permits a deeper understanding of the diversification of the genus *Homo* and the origin of *H. sapiens*. However, the evolutionary history of the Xujiayao *Homo* is still unclear, due partially to controversial associated chronometric dates.

We carried out detailed OSL dating measurements using a post-IR IRSL SAR protocol involving two experimental conditions with different preheating and stimulation temperatures on coarse-grained K-feldspar on 14 samples from Xujiayao. The first experimental condition included a preheat temperature of 320°C for 60 s to natural/regenerative/test dose measurements, and stimulation with IR LEDs at 290°C for 200 s following IR stimulation at 200°C for 200 s, while the second protocol included IRSL stimulation, first at 50°C and then at 225°C. Our results show that the sensitivity change of the natural/regenerative pIRIR 290°C and pIRIR 225°C signals from the coarse-grained K-feldspar of all samples could be corrected by the test dose, and both the pIRIR 290 and pIRIR 225 signals could be recovered with the ratio of recovered dose to the given dose of over 0.9, indicating both protocols are suitable for reproducible De determination. After correction for anomalous fading, the pIRIR 225 protocol yielded an age range comparable to that of the pIRIR 290 protocol, ranging from 182-108 ka. Subsequently, Bayesian analyses were conducted on these and previously published OSL data, suggesting that the upper and lower cultural layers of the Xujiayao site fall within a range from 141±13 ka to 126±35 ka and from 172±22 ka to 166±16 ka, both corresponding to the cold and dry Penultimate Glacial Period (MIS 6), and agreeing well with conclusions drawn from palynological and mammalian faunal analyses conducted at Xujiayao, but slightly younger than the $^{26}Al/^{10}Be$ burial dating results from the lower cultural layer of 240±50 ka. Thus, our OSL results provide independent age constraints of 172±22 ka-126±35 ka for the presence of hominins at Xujiayao.

Considering the great morphological similarity between the Xujiayao and Xuchang (or Lingjing, Henan) fossil crania, we conclude the age of the Xujiayao hominin remains to be 141-126 ka, during the cold and dry Penultimate Glacial Period. During this phase, diverse representatives of archaic *Homo*, including the Baishiya, Gansu Denisovan, *H. longi* (also known as the Harbin Dragon Man), and the Xuchang hominin, coexisted with *H. sapiens* from Zhiren Cave in Guangxi, South China, possibly indicating significant heterogeneity existed among hominins in East Asia during MIS 6. The comparatively inhabitable monsoonal environment of East Asia and the region's relative geographical isolation from Europe may have played important roles in shaping the diversity of hominin lineages emergent in this region.

Keywords: post-IR IRSL, Archaic *Homo*, Bayesian analysis, MIS 6, Nihewan Basin

Towards luminescence rock surface dating of rock engravings at Murujuga, Western Australia

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Anthropogenic rock engravings are a globally ubiquitous archaeological site type. In addition to being significant to living populations, they are a valuable resource for understanding past human behaviour. Rock art provides a visual archive of past cultural expression that can reflect the material culture, practices, ideologies, territoriality, social organization, and environments in ways that other archaeological remains cannot. However, rock engravings have, thus far, proven difficult to date. Anthropogenic rock engravings result from the removal of small amounts of rock or weathering rind from exposed rock surfaces. Stratigraphic relationships are thus rarely present between the engraving and datable material, except in exceptional circumstances such as rockfall events or areas of secondary carbonate or mud wasp nest formation. The recent development of luminescence rock surface dating approaches has the potential to contribute to our understanding of these types of sites. Luminescence rock surface exposure dating methods can be used to tell when mm-scale volumes of rock were removed on decadal, centennial, and millennial time scales. This opens the possibility to directly date how long ago a rock surface was engraved.

Here, we report our work applying a luminescence rock surface dating approach to the globally significant rock art at Murujuga, Western Australia. The Murujuga cultural landscape contains over one million motifs across the >400 km^2 archipelago and is currently on UNESCO's World Heritage Tentative List. There are currently no absolute age estimates for any motifs at Murujuga but a deep-time style sequence with a relative chronological framework has been developed that considers re-weathering of engraved surfaces (contrast state), subject matter, stylistic attributes, and superimposition relationships. Our project aims to date various diagnostic motifs and provide absolute ages to anchor the chronology. We present our investigation of the luminescence properties of polymineral slices from the gabbro, rhyodacite/granophyre, and volcaniclastic rocks on which most Murujuga engravings are made. We characterise the luminescence properties and present results from three bleaching experiments: laboratory-based experiments using cut and engraved rock surfaces exposed to solar simulator bleaches up to 100 ks and field-based experiments with natural sunlight exposure durations up to two years of engraved surfaces. These results reveal the potential of the luminescence rock surface dating approach to Murujuga's vast petroglyph assemblage.

Keywords (max. 5): Rock surface dating, gabbro, OSL, rock engravings, archaeology

Dose rate measurements with correlated U, Th and K uncertainties using full NaI gamma spectrum analysis

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U, Th and K contents are frequently measured with NaI gamma spectrometry [1-2]. In this work we determine of U, Th and K contents by fitting model reference spectra. This is with dedicated program written in Python that allows full gamma spectrum analysis with correlated U, Th and K uncertainties for dose rate determination. Measurements were performed using Canberra InSpector 1000 spectrometer calibrated with RGU-1, RGK-1 and RGTh-1 reference materials. Out results are compared with high resolution gamma spectrometry and dose rates are calculated with μRate [3] that takes into account U, Th and K correlations.

Keywords (max. 5): NaI, dose rate, full spectrum analysis, scintillation gamma spectrometry

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Applying luminescence signals to trace sedimentary provenance

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Investigating the source or provenance of quartz grains generated at a specific location enables us to narrow down their transportation paths, helping us to solve various problems in earth science and related fields. Up till now geochemical and isotopic (Sr and Nd) proxies are widely used to trace sediment sources [1]. However, these proxies may have overlapping ranges among probable sources, making it tough to precisely decode the sediment's provenance [2]. This complexity demands an added sedimentary provenance proxy in complex geologic settings. In this direction, luminescence (OSL and TL) is being seen as a potential provenance tracker as it is sensitive to even minor variations in crystal impurities [3]. Since using luminescence as a provenance tracer is still new, it allows us to further explore its development and application to new research problems.

The current work utilizes the differences in the luminescence signals from different geological provenances to quantitively estimate the sediment influx to the mainstream. The study is conducted using natural river confluence samples and controlled samples. Therefore, in this study, we discuss the feasibility of optically stimulated luminescence (OSL) and thermoluminescence (TL) properties like signal sensitivity and their spectral emissions as a tool for tracing sedimentary provenances.

Keywords: sedimentary provenance, quartz, OSL, TL

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Looking at different time scales – the conflict between sampling resolution and stratigraphic constraints from a Bayesian perspective

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In the frame of geochronology, Bayesian modelling aims at improving the resolution by taking account of prior information such as stratigraphic constraints. Recent growth of the community has led to an increase in the number of OSL laboratories and facilities inside each laboratory, but also to a refinement of research questions involving OSL. Both factors have led to higher and higher resolution sampling. While both the increased number of measurements inside a stratigraphic sequence and the development and Bayesian models specifically designed for OSL (BayLum [1]) aim at improving statistical inferences, they lead to a fundamental problem in – to our knowledge – all existing chronological models (BayLum, but also e.g., OxCal [2], widely used in radiocarbon).

Let us consider n samples in stratigraphic order with measured ages A_1, A_2, … A_n, where sample 1 is the youngest. Let us consider a case where the time lapse between the deposition of successive samples is negligible in light of the ages themselves (e.g., samples taken close to each other from a varved lake core). In such a case, all measured ages should be statistically indistinguishable. However, all currently existing models impose $A_1 < A_2 < \ldots < A_n$ and so the ages are estimated under these constraints. In such a case, the bigger the n, the more scattered are the ages estimated with the models. The modelled age for sample 1 will be way younger than says the measurement for this sample, while the modelled age for sample n will be much older. In other words, the strict constraint imposed by the models renders statistical inferences distant from the measured data.

In this presentation, we illustrate the issue with various case studies using radiocarbon and OSL datasets modelled with OxCal and BayLum, and highlight the resulting pitfalls. Then, we discuss several alternative mathematical models which could overcome the difficulty, and how these new models might be implemented in existing software.

Keywords: Bayesian modelling, stratigraphic constraints, chronological resolution

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OSL dating of the Xinmiaozhuang Locality 2 (XMZ2) site in the Nihewan Bansin, northern China

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The Paleolithic site of Xinmiaozhuang Locality 2 (XMZ2) is located at the east bank of the Xigou gully, a branch of the Qian River that flows north into the Nihewan Basin, about 200 m west of Xinmiaozhuang village in Yangyuan County of Hebei Province, China. The sediment profile for this site is about 20 m thick, consisting of alluvial-colluvial deposits (sandy silt interbedded with angular gravels and lens with coarse sands and gravels, ~15 m) in the lower part and loess (~5 m) in the upper part. In 2022, the upper loess was excavated and over 4000 stone artifacts and abundant animal fossils had been recovered. Relics indicating the modern human behaviors were also recovered, e.g., typical blade products, fireplace, ochre powder etc. Two radiocarbon ages of animal bones from the cultural layer are over 42 cal ka BP. Since the ages are close to the up limit of the radiocarbon dating technique, it is necessary to date the site using other numerical dating methods to cross-validate the accuracy of the radiocarbon results.

In this study, we dated this site using the optically stimulated luminescence (OSL) dating method on quartz samples. A total of 20 samples were collected from the sedimentary profile. Experiments are undergoing in the lab. Grain sizes of 4-11, 63-90 and 180-212 um were isolated and dated on multi-grained single aliquots and on individual quartz grains. The potential differences in the age results between different sizes of quartz grains and between the radiocarbon results will be discussed.

Keywords (max. 5): OSL, quartz, Xinmiaozhuang Locality 2, blade products

Using single-grain feldspar luminescence to decipher river dynamics and sediment transport processes

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Recent studies have shown that luminescence signals have potential beyond dating to trace earth surface processes and quantify sediment transport [1,2]. Here, we tested potential and limitation of using single-grain feldspar luminescence to study river landscape dynamics based on two approaches.

First, we have tested the link between erosion dynamics and proxies derived from single-grain luminescence signal. For this, we measured feldspar post-infrared infrared luminescence signals (pIRIR) of modern fluvial sediments in 8 catchments in the Southern Alps of New Zealand (SANZ). We compared proxies derived from single-grain pIRIR with catchment-wide erosion rates obtained from ^{10}Be cosmogenic nuclide concentrations in modern fluvial quartz grains. We found a high correlation between pIRIR-based proxies and ^{10}Be erosion rates. It shows that pIRIR luminescence signal is reflecting the erosion and sediment fluxes of a catchment, and probably the landslide dynamics.

Second, we also study how the pIRIR based proxies vary alongstream wide braided river system. We measured pIRIR in modern sediment from the Rakaia and Waimakariri rivers, draining the SANZ. We observe that the pIRIR based proxies vary in function of the downstream distance of sediments in the plain, with a better bleaching of the grains downstream. Based on a simple numerical model that considers the evolution of bleaching during transport and storage, we were able to estimate a mean transport length of the particles between 2 and 10 km and a mean resting time between 20 and 150 years.

Our work illustrates the great potential of single-grain feldspar luminescence signal to study erosion dynamics and sediment transport processes in rivers. In the future we aim to carry out more tests with the perspective to use single-grain pIRIR luminescence signal as a new tool to quantify erosion and sediment transport parameters in a wide variety of rivers.

Keywords (max. 5): pIRIR, single-grain, fluvial system, bleaching, erosion

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Dating the northernmost evidence of *Gigantopithecus* by combined ESR and U-series method

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Gigantopithecus was a giant ape once lived in Southeast Asia and China during the Pleistocene period. Longgupo and Jianshi Longgudong sites in West-Hubei and Three Gorges region in South China are the northernmost evidences of *Gigantopithecus* presence in the world up to date. To obtain the detailed chronology of these two sites, paleomagnetic and radiometric dating methods were attempted, including cosmogenic burial dating of the sediment. However, the efforts failed because of the scarce of quartz minerals in the sediment. Combined electron spin resonance and uranium series (ESR/U-series) method which could date the fossil teeth directly with the age range from Early to Late Pleistocene was also applied and the results obtained at Longgupo site already published. Here, we report the first radiometric dating results for teeth carried out from Jianshi Longgudong Western Branch cave which is renowned for the discovery of both *Gigantopithecus* fossils and undoubted stone artifacts. The main challenge of dating Jianshi Longgudong site is the reconstruction of external dose rate of the fossil samples where their provenance sections were not preserved. The mean radioelement concentrations in the sediments measured in the laboratory with different water content estimation were initially used to calculate the ESR/U-series ages. Our ESR/U-series dating of two mammalian fossil teeth from the lower layer 8 gives a weight mean age of 1512 ± 94 ka, while a mean age of 1044 ± 53 ka was obtained for two teeth from the upper layer 4. These ages support one of the previous paleomagnetic dating interpretation which propose that the hominin fossil layer in Jianshi site was not older than 1.78 Ma, i.e. that the upper boundary of the Olduvai subchron, and are in agreement with the faunal evidence which suggest that Jianshi site is younger than the adjacent Longgupo site dated also by combined ESR/U-series and paleomagnetic methods to 2.0-2.5 Ma. Further study of the site including the radiometric dating study of the fossil layers preserved in the Eastern Branch cave may help to achieve a definitive conclusion of the chronology of *Gigantopithecus* settlement in Jianshi Longgudong site.

Keywords (max. 5): ESR/U-series, fossil teeth, *Gigantopithecus*, Longgudong, Early Pleistocene

Luminescence Dating and Alluvial History of the Platte River Valley Fill, Nebraska, USA

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The braided Platte River system flows from the Rocky Mountains eastward across the Great Plains and into the Missouri River on the glaciated Central Lowlands. The valley of the Platte River proper has an alluvial fill composed primarily of sand and gravelly sand that attains 40 m in thickness in Nebraska. This alluvial fill also contains varying quantities of fine-grained alluvium as well as loess units that predate the last glacial period. Overbank sediments (clayey silt to silty sand) capping the valley's alluvial fill vary in thickness from 0 to approximately 2 m. We are studying the alluvial fill to determine how the Platte River system responded to climate changes during the Holocene and over the last glacial-interglacial cycle. We have dated the fill at ten localities using 75 OSL samples collected from cores as deep as 21 m. OSL dating of quartz allows us to establish a chronology for sediments deposited between approximately 55 and < 0.6 ka. Late Holocene sediments show the impacts of partial bleaching, but older sediments do not appear to be adversely impacted by inadequate sunlight exposure. Our chronology indicates widespread aggradation on the Platte River during the Pleistocene and local aggradation during the early Holocene. From the mid-Holocene to the present, however, the channel belt has become entrenched into these older sediments.

Keywords: quartz, alluvium, braided rivers

How old are the coastal dune deposits and shell middens on the West Coast near Yzerfontein, Western Cape, South Africa?

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The dynamic nature of the coastal dune deposits on the southwestern coast of South Africa results from multiscaled systems of tides, currents, wave dynamics, and climate. Coastal erosion due to anthropogenic climate change has altered the sea level, wave dynamics and the frequency and intensity of extreme weather events. As a result, recent erosion has exposed underlying palaeosols and buried shell middens along the Yzerfontein and Sixteen Mile Beach coastline of South Africa.

Twenty-three samples were obtained for geochronology, of which 15 dune samples were dated using optically stimulated luminescence (OSL) dating, and eight shell middens were dated using radiocarbon (^{14}C) dating. The samples were dated using the OSL and ^{14}C techniques as the first step in reconstructing the palaeoenvironment

The older samples are located inland towards the Rooipan region are YZF5: 48.57 - 38.41 ka; YZF6: 115.56 - 100.68 ka, YZF7: 49.656 - 40.457 ka (^{14}C age) and YZF10: 170.75 - 150.83 ka; whereas the younger samples are closer to the ocean and within the tidal range are YZF12a: 0.306 - 0 ka (^{14}C age), YZF12b: 0.641 - 0.198 ka (^{14}C age), YZF15: 0.66 - 0.48 ka and YZF17: 0.21 - 0.17 ka. This is expected through the processes of reworking of the sediment within the coastal region. The oldest sample (170.75 - 150.83 ka) dates to prior to the Last Glacial Maximum within the mid-Pleistocene Epoch [1]. However, located close to the oldest deposit (YZF10) are the samples YZF5-7 which date to around 100 ka.

The radiocarbon age at YZF7 is shown to be contemporary, with YZF5 at 49.66 - 40.46 ka. The samples YZF6, YZF7, YZF5 and YZF11 are dated within the late Pleistocene Epoch [1]. The youngest samples obtained were not provided with specific dates as they were modern shells and experienced death after 1950, disallowing radiocarbon dating accuracy. Excluding the modern samples (YZF22 and YZF23c) the remaining samples are dated within the Holocene Epoch [1]. The radiocarbon and OSL ages are comparable in what information is provided, although they are both shown to span similar timeframes and epochs within related regions. The ages found allow a timeframe of depositional activity on the southwestern coast of South Africa to be produced. The exposed beach and eroded dunes from increased destructive wave patterns allow access to the older deposited materials.

Keywords: Coastal reworking, radiocarbon dating, quartz

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ESR chronology of interior facies of Galería complex (Zarpazos-Galería-Tres simas)

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The Galería complex is located in the intermediate level of the Atapuerca multilevel karst in Burgos (Spain). The Galería complex is formed by three subsections filled with sediments and connected to each other: Covacha de los Zarpazos, Galería site, and Tres simas. These cavities are filled with extensively dated entrance facies, rich in fossil and archaeological materials, and on the other hand, with interior facies, barely dated and without fossil and archaeological remains. Studying in greater depth the interior facies deposits is of interest as they record the entrenchment of the regional fluvial system and a transition period between the formation of the intermediate and lower levels of the Atapuerca endokarst.

Previous geological works suggest that these interior facies in the Galería-Tres Simas Complex should have been deposited during the Lower Pleistocene-Middle Pleistocene; however, geochronological studies have provided disparate ages by ESR and OSL on the top of the interior facies. Therefore, the objective of this study is to date the lowermost part of the interior facies to complete the chronological framework of the Galería complex and, to provide minimum dates for the formation of this keyhole cross section.

With this objective, 5 and 22 samples were taken to be dated by ESR and Paleomagnetism, respectively. Our first results suggest Middle Pleistocene ESR ages that are in agreement with previous results obtained by OSL. In contrast, paleomagnetic data reveal reversal polarity. These results may suggest post-sedimentary processes or geological events that underestimate the ages obtained by trapped charge dating techniques. Our results are important to better understand this interval of the fluvio-karstic system of the Sierra de Atapuerca, which preceded the opening of the Gran Dolina and Gallery cavities and their infill by entrance deposits.

Keywords (max. 5): Geochronology, ESR, Atapuerca, Arlanzón Valley, karstic sediments.

Employing luminescence dating to decipher the timing of past earthquakes through faulted colluvium and fault gouge at the North Tehran fault zone

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Luminescence dating is an effective means to investigate faults' past behaviours [1]. It has been successfully applied to offsets of geomorphic features or distinct stratigraphy in many tectonically active regions around the globe. This approach, among others, brought insights into the timing of past major earthquakes.

The Central Alborz mountains in Iran are one of the tectonically most active regions globally, in which major earthquakes have been documented in historical records. This area encompasses the megacity of Tehran, which is crossed in the north by the North Tehran fault (NTF), a prominent oblique-slip fault zone extending over 68 km.

Over the last decades, a few studies have been conducted to constrain past activity phases of the NTF during the late Quaternary [2,3]. However, due to its significant contribution to geohazard for Tehran, more studies are required to shed light on the NTF's behaviour, temporally and spatially.

In this study, for the first time, we contribute to this demand by employing luminescence dating simultaneously on two different sample series: faulted colluvial deposits and fault gouges [4]. If successfully applied, this twofold approach can enable us to discuss the pros and cons of indirect and direct dating of past earthquakes at the NTF using luminescence techniques.

We extracted the polymineral fraction (4-11μm) to probe the samples' general luminescence behaviour. Then, the equivalent dose will be determined through elevated post-infrared infrared stimulated luminescence (post-IR-IRSL) [5]. Combined with dose-rate measurements using gamma-ray spectrometry, the first ages will be established. We will share and discuss our preliminary findings about the applicability of luminescence dating in this geological setting, particularly for the fault gouge.

Keywords (max. 5): fault gouge, faulted colluvium, polymineral fraction, post-IR-IRSL

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Formation history of marine terraces in the southeastern coast of Korea during the late Quaternary revealed by quartz OSL dating of marine and colluvial sediments in Nulchado island

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Quaternary marine terraces are valuable archives of past local sea level changes and crustal movements. Thus, understanding the formation history of marine terraces based on reliable chronological framework is essential for reconstructing palaeo-sea level responses to global climate changes and also for evaluating potential seismic hazards. However, in the Korean peninsular, dating marine terraces are often limited because marine terrace sediments, which are the usual targets for dating, are rarely preserved, shallow in depth and dissected into small patches. Further, it is not always possible to trace paleo-coastal sediments as they are covered by topsoil deposits or disturbed by anthropogenic activities.

Recently, we found a well-preserved marine terrace at the elevation of ~ 5 m (a.m.s.l) with distinguished lateral extension of ~ 250 m at Nulchado island in the southeastern part of the Korean peninsula. This is covered by colluvial sediments (> ~ 2 m in thickness), and considered to be well-suited for the investigation of the formation history of marine terraces along the southeastern coast of Korea because it is rich in the sedimentological, geological and stratigraphic record, together with clear topographical setting. For OSL dating, we collected fourteen samples (seven samples from marine terrace sediments and another seven from colluvial sediments). From the OSL dating of marine sediments, we obtained the depositional age of ca. 80 ka (MIS 5a; interglacial period), which is in good agreement with previously reported OSL ages from the marine terraces located at ~ 50 km away to the northeast from Nulchado island (e.g., [1]).

In this paper, we first examine the suitability of quartz grains of the samples for reliable OSL dating and present multiple and single grain quartz OSL ages of marine and colluvial sediments. Then, we discuss the developmental characteristics of marine terraces in Nulchado island and implications for the formation of marine terraces along the southeastern coast of Korea in comparison with palaeo-sea level changes of this region.

Keywords: marine terraces, quartz OSL dating, marine isotope stage, the late Quaternary, paleo-sea level change

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Application of single-grain pIRIR dating to beach ridges deposition from the inner Tibetan Plateau

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Beach ridges, as direct geomorphological indictor of the past lake level variations, are widespread around the lake basins over Tibetan Plateau (TP). During the last decades, luminescence techniques have been extensively applied to age constraints of these beach ridges. Most studies used single aliquot (SA)-regenerative dose protocol with multiple grains of quartz or K-feldspar fraction, suggesting sufficient bleaching existed these lake sediments. But recent small aliquot and even single grain (SG) attempts showed obvious dispersion of the obtained equivalent doses (D_e) [1], which is likely due to insufficient reset of luminescence signals in sediments before deposition. If so, previous age calculations by simply averaging all SA D_e could result in age overestimation, particularly for the relatively young sediments. This technical inference may need further examination by detailed SG measurements and even comparison with independent age controls.

In this study, we select the Lake Dawa Co, a representative closed basin in the inner TP, to validate if these typical paleoshoreline sediments were well bleached or not with SG method and then reconstruct its water level variations in long-term timescale. Our recent study has corroborated the suitability of K-feldspar post-IR IRSL protocol with SG aliquot method for dating the Holocene shoreline sediments by comparison with independent ^{14}C age [2]. The purpose of this study is to further test the applicability of the SG method with K-feldspar $pIR_{50}IR_{225}$ protocol to dating more 25 beach ridge sediment samples newly collected around Dawa Co. We choose grains with proper IRSL characteristics according to the established criteria; dose recovery and residual dose tests for SG will be done on two representative samples; at least 100 grains for each sample will be obtained for D_e statistical analysis. Furthermore, two charcoal samples collected from the surface of two beach ridges were also dated with AMS radiocarbon method, and will be used for independent age comparison.

Keywords: single-grain pIRIR, radiocarbon dating, beach ridge sediments, inner Tibetan Plateau

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The Optically Stimulated Luminescence dating of centennial-millennial paleoseismic events along the middle section of the Altyn Tagh fault, China

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Paleoseismology can evaluate past earthquakes ranging in time scale from centennial to tens of thousands of years. Characterization and dating of large prehistorical earthquakes further compensate for the incomplete historical and instrumental fault history [1,2]. The middle section of the Altyn Tagh fault (ATF) is an ideal nature place to conduct paleo-earthquake studies, because of its well-preserved evidence and clear fault track on the surface [3,4,5]. Radiocarbon dating is most routinely used in establishing the chronology of paleo-seismic events. However, materials with organic matter measured by using radiocarbon dating are not always available and are not directly associated with past earthquake-related deposits. For instance, organic matter is often scarce in arid and semi-arid regions of northwest Chinese.

Optically stimulated luminescence (OSL) dating is an alternative technique to radiocarbon dating for providing the timing of paleo-earthquakes [4,6]. The sediments in the excavated trenches were usually deposited since the Holocene. Thus, to better constrain the timing of young earthquakes (for example ages (<5 ka), the accuracy and precision at the centennial and millennial-scale of the OSL dating need to be improved [7]. In this work, we choose the Copper Mine trenches along the Xorkoli section of the central ATF as a case to carry out the OSL dating of the paleo-seismic events [5]. Because the published ^{14}C dating ages can provide an independent age control. Therefore, we collected the OSL samples to provide the timing of the young earthquakes. The OSL characteristics of quartz and K-feldspar grains, such as bleachability, OSL signal sensitivity, signal stability, etc., will be investigated. The suitable protocols for quartz and K-feldspar grains will be constructed, respectively. The reliability of young quartz and K-feldspar ages will be corrected by the ^{14}C ages. Finally, a reliable procedure can be established for yielding the centennial and millennial-scale ages. This work can provide an auxiliary dating method of paleo-earthquakes not only for the ATF but for western China.

Keywords (max. 5): OSL, young paleo-earthquake, young quartz and K-feldspar, centennial and millennial-scale

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Fluvial downcutting and its influence on human activities in the middle reach of the Lancang River during the late Holoence

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The Lanchang River is the upper stream of the Mekong River, which was one the most important communication gallery between the Yunnan Province and Southeast Asia region. Due to the intensive erosion of the Lanchang River, the landscape change is very rapid. However, the human activity and adaptation to the environmental changes in this region is still unknown. In this paper, Optically Stimulated Luminescence (OSL) and radiocarbon (^{14}C) dating techniques were applied to determine the ages of fluvial landforms around the Jicha archaeological site, Middle reach of the Lanchang River since the Last Glacial Maximum. Combining these dating results with archaeological evidence, the relation between fluvial landscape change and human adaptation was discussed. The results showed that the two terraces (T1 and T2) of the Lanchang River are fill-cut terraces, and that these were formed after ~0.7-1.5 ka and 20-40 ka, respectively. With the downcutting of the Lanchang River, the floodplain facies on T1 being transformed into fossil soils, the latter being hostile to the planting of rice. The abandonment of the Jicha archaeological site might therefore be related to the downcutting of the Lanchang River.

Keywords: OSL, ^{14}C, Lanchang River, Changes in fluvial landscapes, Human activity

Low temperature thermochronology using isothermal thermoluminescence signals from calcite

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Thermoluminescence (TL) signals from calcite are sensitive to thermal annealing, and insensitive to sunlight bleaching. For old rocks like limestones, TL signals are directly related to the thermal history since the crystallization of the calcite in the rock. Therefore, TL signals of calcite have advantages in being used for geothermometers over others from minerals such as quartz and feldspars. Exposures of limestones were widely available for geological bodies of tectonic and geothermal activities.

A single-aliquot regenerative dose (SAR) protocol for calcite with low-temperature measurements is proposed to measure the equivalent doses (D_e). It uses the isothermal TL (ITL) signals measured at around 225-240 °C, e.g. 235 °C, where a D_e vs. ITL temperature (D_e-T) plateau can be observed. The width of the temperature range of such a plateau can be sample dependent, as it relates to the proportional contributions of the signals from corresponding TL peaks. The signals at the ITL temperature plateau range largely correspond to the TL signals of the 280 °C TL peak. Similar to 235 °C ITL, other temperatures were studied. Each ITL temperature might be regarded as a "thermometer". The ITL signals at 285 °C mainly correspond to the 330 °C TL peak. The absence of detectable anomalous fading of ITL signals indicates that the signal is free of fading. Dose recovery tests confirm the suitability of the SAR-ITL protocol for D_e estimation. Using the SAR-ITL protocol, the measuring temperatures are below 300 °C, so the effects of spurious luminescence signals induced by high-temperature heating have been avoided. Multiple thermometers with different "close" temperatures were obtained from ITL D_e determined from different measuring temperatures.

We have applied the protocol to the exposure of limestone rocks from tectonically active areas in the southeastern Tibetan Plateau. Where uplifting and incision happened in magnificent altitudes over the last 2 million years. The denudation rates of the last 500 ka were estimated. The implication and significance to geological studies were discussed.

Keywords: Thermochronology, Isothermal TL, Calcite, SAR-ITL protocol, Southeastern Tibetan Plateau

Combined ESR and U-series dating of a Paleolithic-Neolithic transition site - Naminan cave, China

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Combined ESR and U-series methods have been increasingly applied to the paleolithic and paleoanthropological sites from Early to Middle Pleistocene period. However, this dating method is seldom used for the Late Pleistocene or even younger sites comparing with other radiometric methods, such as ^{14}C charcoal dating, U-series carbonate dating and OSL sediment dating. The important advantage of ESR dating is that it allows direct analysis of fossil tooth from animal and human remains. Here, we report a combined ESR and U-series dating study of Naminan paleolithic site, a Paleolithic-Neolithic transition site located on the border between China and Myanmar. The stone artifacts with typical "Hoabinhian Industrial" characteristics indicate the human migration and interactions between Southeast Asia and South China. Apart from an obvious older age of 31 ka, our ESR analysis of ten tooth enamel samples gives the age estimation of 12-21 ka on fossils from the paleolithic cultural layer of Naminan site. The obtained ESR ages of fossil teeth are in agreement with the ^{14}C and U-Th chronology for Naminan site in general. When dating the young fossil samples from the site like Naminan, we noticed that due to the relative low uranium concentration in the enamel tissues (0.01-0.3 ppm), the internal dose rate plays a much less important role than the external beta and gamma dose rate to the total dose rate in the fossil samples. Therefore, the dose rate evaluation of the surrounding sediment is the main source of uncertainty that may affect the reliability of the ESR dating results. In this study, we also attempt to use a standard growth curve (SGC) of enamel to determine the D_E and compared with the values obtained by additive dose (AD) method (12-34 Gy). Although the current precision of D_E results estimated by SGC are lower than AD, it shows the potential to quick decide a more reasonable D_{max} for irradiation and identify the possible intrusion fossil samples.

Keywords: ESR and U-series dating, Fossil tooth, Paleolithic-Neolithic transition, Hoabinhian, Naminan

Measurements of uranium, thorium, and potassium as an inter-laboratory comparison: it takes two to tango!

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Recently we were made aware that our OSL ages were all systematically offset by 8%, for the past 20 years [1]. What led to this? The fact that we are guilty of placing all of our eggs in the same basket. How can we minimize our exposure to another such effect that may be currently hiding from us? One way is to take part in an inter-laboratory comparison. It is the present objective of our project to compare the measurement of uranium, thorium, and potassium between various laboratories for various techniques. The most recent (and only, as far as we know) wide-ranging inter-laboratory comparison on the dose rate concluded in 2015 [2], along with a few smaller comparisons throughout the intervening time. The 2015 comparison ended on a perplexing note: the measurement of the equivalent dose had good reproducibility between labs, with an average relative standard error (RSE) between 2% and 3%. However, unexpectedly, the (simple) measurement of uranium, radium, thorium and potassium was far more dispersed, ranging from 3% to 13% RSE.

Various luminescence labs, mostly among the New World luminescence dating community, are working together in a small inter-laboratory comparison. The objective is to measure the abundance (or respective specific activity) of uranium, radium, thorium and potassium in a common sediment. This sediment is taken from a massive silty fine sand on a Colorado River terrace exposed in a quarry. It was coarse sieved in the field and then homogenized, sieved, and bottled at the USGS standard facility in Denver. This study is aimed at collecting results in a double-blind fashion, publishing the results, and using the information to better inform on best practices for the luminescence community.

We took the analysis one step further. By combining the results obtained from a single laboratory for this sample, along with their performance with the 2015 comparison, we hope to identify the presence of systematic uncertainties. It is the kind of simple, yet vital, experiment that is often needed to identify areas of strengths and weaknesses in each laboratory.

Keywords: dose rate, comparison

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Luminescence dating the glacial history of the Pamir Mountains (Central Asia)

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The Pamir Mountains in Central Asia are one of the highest mountain systems in the world. Throughout the Quaternary, these mountains have acted as one of the main sources of water to most of Central Asia. The large rivers of Amudaria and Syrdaria also transported large amounts of sediment, which was then reworked into the Karakum and Kyzylkum deserts. Orographic and climatic conditions have caused the widespread formation of glaciers, and the Pamir have experienced several large glaciations. Studying the timing and extent of glaciations in the Pamir helps us to understand the temporal evolution of the High Asia climate. For many decades, geomorphologists and glaciologists have strived to reconstruct glacial chronologies for the Pamir Mountains, but only in the last 20 years has CRN dating of moraines allowed researchers to obtain any quantitative results on the glacial chronology [1].

As part of the THOCA project ("Timing and Ecology of the Human Occupation in Central Asia"), we wish to further improve our knowledge of the climate history of the Pamir and to understand the possible effects of mountain glaciation on the supply and provenance of aeolian dust. To achieve this, luminescence dating has been applied to the glacially dammed lake deposits in the basin of the Panj River, the largest tributary of the Amudaria. Our study area is located on the right bank on the Panj River, on the southern slope of the Ishkashim ridge (southwestern Pamir). Within a small tributary, on the upper part of the slope, a unique series of glacial lacustrine deposits has been preserved. These lacustrine silts are evidence of the blocking of the Panj valley by a large glacier, forming a lake within the tributary arm.

Quartz OSL and K-rich feldspar $pIRIR_{50,290}$ measurements were made on sand-sized grains. Dose recovery ratios are satisfactory for both quartz (n=25) (1.01±0.02) and feldspars (n=25) (1.08±0.4). The average $pIRIR_{290}$/OSL age ratio is 1.12±0.05, confirming that the quartz OSL signals are very likely sufficiently well bleached. The new luminescence ages indicate that this large glacial event in the Pamir Mountains took place in MIS 6.

Keywords: luminescence dating, Pamir Mountains, glacial history, Ishkashim Range, High Asia, proglacial lake

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An overview of infra-red photoluminescence: achievements and challenges

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Infra-Red PhotoLuminescence (IRPL) signal arises from intra-defect transitions in the principal electron trap in feldspar [1]. Unlike optically stimulated luminescence, this signal can be measured non-destructively since it does not require the electron-hole recombination mechanism for luminescence production. IRPL is, therefore, highly attractive for investigating luminescence mechanisms and developing new imaging applications that demand a high signal-to-noise ratio.

Since its first report in the LED 2017 conference in Cape Town, IRPL has been applied to: 1) dating sediments using multi-grain or single-grain techniques, 2) rapid high-resolution imaging of luminescence - depth profiles in rocks, 3) determining trap parameters using site-selective measurements, 4) refining feldspar luminescence model by deconstructing recombination and tunnelling using coupled IRPL-IRSL (infra-red stimulated luminescence) measurements, 5) exploring the richness and variability in electron traps and their behaviour in feldspar, and 6) applying luminescence exposure dating to complex geometries such as cracks.

We will provide a brief overview of the achievements and challenges, and discuss the potential of IRPL for further advancing luminescence geochronology.

Key words: luminescence imaging, radio-photoluminescence, luminescence model

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Evaluating the signal bleaching degree of the Al and Ti-Li signals in quartz of fluvio-lacustrine sediments and the chronology of volcanic eruption in Datong, North China

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Evaluating whether the quartz Electron Spin Resonance (ESR) signals were completely bleached at the time of deposition is critical to sediment ESR dating. Datong volcanic group is located in Datong City, Shanxi Province, which is one of the most famous volcanic groups in China. The eruption of the Datong volcanoes during the geological period produced a large amount of high-temperature lava flow, which directly covered the Quaternary lacustrine deposits and caused high-temperature baking on the underlying lacustrine layer. Therefore, by investigating the field profile in the Yujiazhai area, located to the southeast of the Datong Volcanic Group, we propose a new pattern to evaluate the signal bleaching degree of ESR centers by comparing the ages of the baked and unbaked sediment layers by lava flow. The result showed that the quartz Al and Ti-Li centers in the lacustrine sediments can be adequately bleached during transportation and bleaching in natural conditions in our study area. In addition, the chronology of volcanic eruption in the Yujiazhai area is about 350 ka. The determination of the eruption age will help us to better understand the detailed eruption history of the Datong volcanic group.

Keywords: ESR dating, optical bleaching, Al center, Ti-Li center, Datong volcanic group

Luminescence ages of offset and unfaulted alluvium along the San Andreas Fault in Southern California

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In the region of the central Transverse Ranges, the San Andreas fault system is distributed into multiple fault strands. Geochronology datasets constraining slip histories along the individual fault strands can help to gauge the seismic hazard posed by these strands. The Mission Creek strand of the San Andreas fault has previously been thought to be inactive during the Holocene and Late Pleistocene. However, recent studies (Fosdick and Blisniuk, 2018; Blisniuk et al., 2021) argue that the Mission Creek strand is the primary plate boundary fault at this latitude, capable of producing large earthquakes in future. In this study, we examine whether the Mission Creek strand has been active during the Holocene and Late Pleistocene.

To investigate this issue, we use single-grain post-IR IRSL dating of K-feldspars to estimate the depositional ages of unfaulted alluvial terraces north of the Mission Creek Stonehouse (Fig. 4 of Yule et al., 2021) and a tectonically offset channel deposit (Fig. 6 of Blisniuk et al., 2021), all within a ~1-km length of the Mission Creek strand of the San Andreas fault. The apparently unfaulted alluvial deposits overlie the fault zone, so their depositional ages should provide a minimum age for the most recent activity of the Mission Creek strand at these locations. Based on the regional sediment accumulation rates, soil development, and ^{10}Be surface exposure ages of similar surfaces, Yule et al. (2021) have argued that these deposits constrain the most recent event to be older than >3 - 18 ka. Additionally, we sampled deposits from a fluvial channel that has been deflected by ~50 m off a right-lateral offset by the Mission Creek strand. These deposits should therefore pre-date the observed offset (Fosdick and Blisniuk, 2018) and hence provide a strong constraint on the recent motion along the Mission Creek strand. We report these depositional ages with implications for seismic hazard in the region.

Keywords : pIR IRSL, Single grain, feldspar, seismic hazard, Mission Creek

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The effects of transport on ESR and OSL properties of quartz: a case study in an area with a simple granitic lithology

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We present an electron spin resonance (ESR) and optically stimulated luminescence (OSL) study performed on quartz grains extracted from samples collected in Retezat Mountains (Romania), in order to investigate the effect of short transport on the properties of these trapped charge signals.

The exposure to sunlight occurring during transport results in a redistribution of the charge trapped in the crystal during its residence in the host rock, which can affect the concentration of paramagnetic centres detected by ESR. For the ESR signal to be useful for determining provenance it must be stable or reach a quantifiable steady equilibrium level that corresponds to the same level as attained in the host rock. On the other hand, for a signal to be used as a sediment tracer it must change in a predictable and quantifiable way during transport. Some ESR signals, such as the so-called heat-treated E' [1], the native E' [2], or Al and Ti related defects [3] have been proposed to have such properties, but a field study necessary to test that hypothesis by directly comparing the properties of sediments to those of the sorce rock has not been conducted so far.

Here we carry out such a study for the first time by analysing the effects of short transport on ESR signals in quartz in a simple catchment draining a single granite lithology of known age. The chosen sampling site – Retezat Mountains (Romania), is a relatively simple magmatic (granitic) system of earliest Permian age (290-300 Ma) [4]. The samples were collected from the range crest and from the modern streams at about 2 km intervals from headwaters toward the northern foothills. The bedrock sample was identified as Leucrocratic granite. We complement the ESR analysis with investigations of OSL sensitivity, as it remains debatable whether luminescence sensitivity is something acquired during transport, a characteristic of the source rock, or a combination of both factors is at play in the sensitisation mechanism.

Keywords (max. 5): ESR, OSL, provenance, sensitivity, quartz

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Luminescence dating at the loess-palaeosol sections Baix and Collias in the Rhône Rift Valley, southern France, and chronostratigraphic implications

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Loess deposits along the Rhône rift valley in southern France are mostly reworked and/or intensively bioturbated but still represent valuable terrestrial archives for reconstructing past environmental changes. The north-to-south trending corridor leads from the temperate to the Mediterranean zone. It is, therefore, essential for linking loess palaeosol stratigraphies of the Central European loess belt to those of the Mediterranean. However, loess palaeosol sections (LPS) of the Rhône rift valley are under-researched, with new investigations having commenced only recently [e.g., 1].

Two thick and well-differentiated LPS in the Rhône rift valley are at the sites Baix, near Valence, at the transition from the temperate to the Mediterranean climate zone, and Collias, ca 90 km further south in the Mediterranean zone. The stratigraphy, and the sedimentary and palaeopedological features of the two LPS are detailed elsewhere [e.g.,1].

Here we focus on the single-aliquot regeneration (SAR) [2] dating approaches to both sites. These include blue light stimulated luminescence (BLSL) and post-infrared (at 60 °C) infrared (at 225 °C) luminescence ($pIR_{60}IR_{225}$) [4]. $pIR_{60}IR_{225}$ was applied to a sequence of semi-continuously collected (5 cm intervals) but only minimally prepared samples ("quick and dirty" polymineral coarse grains) for an optically stimulated luminescence (OSL) screening. We also investigated specifically collected OSL samples prepared following standard procedures and applied $pIR_{60}IR_{225}$ to potassium feldspar coarse grains (125–212 µm) and polymineral fine grains (4–11 µm), and BLSL to quartz fine grains (4–11 µm). We report on the sample characteristics, the dating results and the implications for a preliminary Rhône rift valley LPS chronostratigraphy. The OSL ages support the stratigraphical expectations of two LPS from the last interglacial to glacial cycle. The temporal setting of a palaeosol associated with prominent carbonate nodules, which could possibly serve as a marker horizon for the loess landscape of the Rhône rift valley, could be narrowed down to the lower Middle Pleniglacial period.

Keywords (max. 5): OSL screening, feldspar coarse grains, polymineral fine grains, quartz fine grains

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Study of trap distribution in $Sr_4Al_{14}O_{25}:Eu^{2+},Dy^{3+}$ – a persistent luminescent phosphor

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$Sr_4Al_{14}O_{25}:Eu^{2+},Dy^{3+}$ is a commercially available green light emitting persistent luminescent phosphor. Owing to its complex crystalline structure and induced point defects, it shows fascinating luminescence that persists to typically up to 18 hrs after excitation. We report a trap-spectroscopic analysis of $Sr_4Al_{14}O_{25}:Eu^{2+},Dy^{3+}$ using thermoluminescence (TL). A TL glow curve measured at 1 $^oC/s$ following irradiation to 2 Gy at 20 ^oC shows two maxima at ~64 (labelled as P1) and 252 ^oC (P2). The variation of integrated TL intensity as a function of heating rate shows competition between radiative and non-radiative recombination processes. Beyond 1 $^oC/s$ heating rate, the non-radiative recombination process dominates and the luminescence efficiency drops sharply beyond 100 ^oC. The activation energy for thermal quenching is estimated to be $W = 0.69 \pm 0.07$ eV. The peak maxima of P1 and P2 after correction for thermal quenching are found at ~70 and 275 ^oC. In addition, a secondary peak appears on the high temperature side of P1. Both the peaks show a gradual shift in their peak position T_m towards high temperature with preheating temperature T_{stop}. Moreover, the peaks also show a similar shift in T_m towards high temperature with increase in irradiation temperature T_{irr}. This suggests that peaks P1 and P2 are combinations of several closely spaced overlapping components. The activation energy of the component peaks comprising P1 is estimated to be ~0.63 – 0.68 eV whereas that of the component peaks comprising P2 is ~1.22 – 1.65 eV. An analysis of the fractional area between a pair of glow curves measured from the sample irradiated at different temperatures (T_{irr}) shows that the trap distribution associated with peak P1 is non-Gaussian whereas that associated with peak P2 follows Gaussian distribution.

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Keywords: $Sr_4Al_{14}O_{25}:Eu^{2+},Dy^{3+}$; persistent luminescence; thermoluminescence, activation energy, Gaussian distribution

Luminescence dating of sandy loess along the middle Yellow River and its implications for the interactions between aeolian and fluvial processes

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Different from fine silt dominated classic loess on the southern and central Chinese Loess Plateau (CLP), coarse sandy loess is widely distributed along the southern bank of the middle Yellow River, which is up to approximately 100 m thick. However, its deposition time and formation processes are still unclear. Here, three representative sandy loess sections in the middle Yellow River were dated using the single-aliquot regenerative-dose (SAR) optically stimulated luminescence (OSL) and recuperated OSL (ReOSL) protocols on fine quartz grains (4–11 μm). The validity of these two protocols was robustly verified through conventional checks in luminescence dating. Our dating results showed that the sandy loess was mainly deposited within the last glacial period, with extremely high dust accumulation rate, which was much larger than that of the classic loess in the southern and central CLP. With respects to atmospheric circulation and geomorphology settings, and grain size and magnetic susceptibility results from both the sandy loess and surface sediments from the Yellow River beds and fluvial plains, it is suggested that the sandy loess was dominantly sourced from the proximal fluvial sediments of the Yellow River, transported by the northerly East Asian winter monsoon (EAWM) winds. During the last glacial period, the East Asian summer monsoon (EASM) was weak with low rainfall in central and northern China, which led to reduced runoff and vegetation cover in the middle Yellow River valley. Therefore, the river beds and fluvial plains promoted sufficient dust material supply. Finally, the dust was transported by the strong EAWM winds and deposited along the southern bank of the middle Yellow River, which resulted in the formation of the thick and high-sedimentation-rate sandy loess. Our study highlights the significance of the interactions between aeolian and fluvial processes at sandy loess deposition in the middle Yellow River and also implies the potential of the investigated sandy loess at high-resolution paleoclimate reconstruction.

Keywords: OSL dating, sandy loess, dust, monsoon, the middle Yellow River

Optical dating of post-1930 CE charcoal kilns remains: a test of accuracy

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During the medieval and post-medieval periods, charcoal production was a major industry in numerous forested regions of Northwest Europe. Utilizing LiDAR maps and field research, more and more remnants of charcoal production sites (relic charcoal kilns) are discovered. The charcoal fragments preserved in these remains are used in a wide range of scientific research, for instance, former forest composition, woodland exploitation, fuel production, and how biochar may affect soil properties. All of these fields of study necessarily require a chronological framework, which is most frequently established by ^{14}C dating of charcoal. This method, however, is of very limited use for post-1650 CE features. For instance, the de Vries and Suess effects cause plateaus in the ^{14}C calibration curve, implying that events from the last 350 years cannot be resolved in time. We previously reported on the potential of OSL dating of heated sediments associated with these past charcoal production, in particular for application to post-1650 CE features [1,2]. Here, we apply the same approach to kiln remains that are known to post-date 1930 CE and pre-date 1945 CE.

The relict charcoal kilns were sampled in the Veluwe region, Central Netherlands. From a historical point of view, there was no real need to try and date these features. Their interbellum to end of World War II is well-established and inferred from aerial photographs, newspaper articles, and other written accounts. However, from an OSL- perspective, they are interesting. Can these features be dated as accurately?

We use OSL signals from small (2 mm diameter) multiple-grain aliquots of quartz from the fine-sand fraction (125-180 μm) to document the OSL characteristics in terms of signal composition, sensitivity, dose-response, and the diagnostic tests commonly used to determine the suitability of the single-aliquot regenerative-dose (SAR) protocol for examining the distribution of equivalent dose (ED) in the samples. The outcomes are compared to known historical sources and will be presented during the meeting.

Keywords: relict charcoal kilns, quartz, heating, accuracy

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Alongstream single-grain luminescence signal along a pluviometric gradient in Chile: A preliminary dataset

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Single-grain post-infrared luminescence (SG-pIRIR) protocols allow dating of fluvial deposits that present large scatter in equivalent dose (De) distribution because of heterogeneous bleaching (zeroing) of the grains by sunlight exposure before deposition. In such settings though, luminescence signals measured in modern deposits tend to be better bleached downstream. It suggests that the study of alongstream luminescence signals may allow the quantification of fluvial transport processes and the transient storage of particles in floodplains [1, 4, 5, 6].

In this study, we aim to measure the alongstream distribution of SG-pIRIR signal from modern floodplain deposits of several braided and wandering rivers running in Chile along a latitudinal climatic gradient (Rio Tolten, Rio Allipen, Rio Ñuble, Rio Itata, Rio Choapa, Rio Huasco). Those rivers run from 1000km South of Santiago, where catchments receive up to 2000 mm of annual precipitations, to Huasco in the South of Atacama desert, with precipitations less than 100 mm per year. Measurements of Terrestrial Cosmogenic Nuclide (TCN) ^{10}Be concentrations in modern fluvial sediments indicate a latitudinal gradient in catchment-wide erosion rates from 10^{2} to 10^{-1} mm/kyr northward [2]. Our catchments of interest are therefore distributed over a distance of more than 2000km between latitudes of 40°S and 28°S, and take place under different climatic conditions, from an oceanic climate in the South to a desertic one in the North, which likely influences the fluvial style of rivers.

In this study, we would like to take advantage of this climatic and erosional gradient to investigate further the differences that can occur alongstream in the luminescence signal, and see if we can document different transport parameters along those gradients. Finally, we will combine our luminescence data with state-of-the-art quantification of rates of surface processes by in-situ TCN measurements (^{10}Be, ^{26}Al, ^{14}C and Kr isotopes [3]).

Keywords : SG-pIRIR, storage time, fluvial transport, climatic gradient, cosmogenic nuclides

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Algerian Islamic ceramics TL dating and origins identification

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Despite its long history, Algerian Islamic pottery and ceramics have not been widely studied, and much of the knowledge about this important aspect of Algeria's cultural heritage remains fragmented. Nevertheless, it continues to be an important part of Algeria's cultural identity and serves as a testament to the country's rich artistic heritage. This Algerian Islamic pottery refers to ceramics produced in Algeria during the Islamic period, typically between the 8th and 19th centuries. In this work, ceramics fragments from bowls, plates, and jars collected around *Hammadite* Islamic historical cities and castles of *M'sila* and *Bejaia* localities [1]. Six ceramics fragments fabricated with double firing technique were dated using thermoluminescence (TL) method. Moreover, the origins of the used material for their fabrication were studied through a statistical comparison of their compositions to a reference dataset of row materials [2]. The fabrication and row materials were analyzed using X-ray fluorescence (XRF).

Results of TL dating show that most of the dated fragments are from the 10th and 12th centuries corresponding to the *Hammadite* regency between *M'sila* and *Bejaia*. The errors on age reach in some cases 25%. Comparisons between row materials and ceramics fragments compositions allow us to conclude that the studied ceramics fragments are locally fabricated except for one fragments (sample N°3) where no hard evidence and no correlation with the considered row materials dataset were found. Indeed for most ceramics fragments, the performed statistical test demonstrate well that the used fabrication materials fit well with the row materials collected from deposits around the *Hammadite* cities and castles like *oued Fredj* in *M'sila*.

Keywords: Islamic Pottery and Ceramics, Hammadite, TL dating, X-ray fluorescence, Materials Origins

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Quartz OSL and K-feldspar IRSL dating of terrestrial sediments in Quaternary movement sections along the Yangsan and Ulsan faults, southeastern part of the Korean peninsula

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Over the decades, there have been lots of debates regarding the tectonic stability of the Korean peninsula. However, recent earthquakes that occurred in Gyeongju (12 Sep. 2016, Mw 5.5) and Pohang (15 Nov. 2017, Mw 5.4) cities in the southeastern part of Korea suggest that the Korean peninsula is no longer safe from seismic hazards. Accordingly, extensive researches have begun to understand Quaternary faults based on palaeo-seismic approaches.

Recently, in many places, along the Yangsan and Ulsan Faults (SE part of the peninsula), unconsolidated terrestrial sediments were found to be cut by Quaternary faults with unknown age, thus establishing chronology of these sediments is expected to provide essential information to constrain the timing of last fault movements.

In this paper, we performed luminescence dating on terrestrial sediments which are cut by or covering the age-unknown faults in three Quaternary movement sections (Byeokgye, Cheongun and Samnam sections); Hereafter, these sections are referred to as BG, CG and SN, respectively. Dose recovery experiments using quartz OSL and K-feldspar $pIRIR_{225}$ signals indicated that most samples were suitable for luminescence dating. Comparison of quartz OSL and K-feldspar $pIRIR_{225}$ ages showed that the latter could overestimate the depositional ages of the samples by ~ 20 ka at maximum, probably due to incomplete bleaching of K-feldspar $pIRIR_{225}$ signals at deposition in alluvial fan environments.

The youngest ages of the sediments cut by faults in each movement section are 3.2 ± 0.2 ka, 37 ± 4 ka and 178 ± 4 ka for BG, CG and SN, respectively. On the other hand, the quartz OSL ages of the sediments covering the faults (i.e., those unaffected by faulting) are 1.2 ± 0.1 ka (BG), 4.0 ± 0.6 ka (CG) and 4.2 ± 0.3 ka (SN). These ages clearly indicate that the southeastern part of the peninsula has been tectonically active during the late Pleistocene – Holocene period, with the last faulting event occurred in the middle Holocene in this region.

Keywords: Quartz OSL, K-feldspar $pIRIR_{225}$, Quaternary faults, last fault movement

Borehole calibration of ESR thermochronometry

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Electron spin resonance dating of quartz minerals offers a significant advantage over luminescence dating because of its later signal saturation. We are seeking to exploit this to build upon earlier studies [e.g. 1] in the development of a thermochronometry system capable of resolving rock cooling rates throughout the Quaternary. Whereas the luminescence thermochronometry system is limited to areas experiencing very rapid rock cooling (exhumation) of 10s of mm/yr, our data indicate that ESR thermochronometry can resolve rates of <1 mm/yr over Quaternary timescales.

To determine a rock cooling history using ESR thermochronometry, signal accumulation and signal thermal loss must be robustly determined within the laboratory. We have collected a series of borehole samples with known isothermal histories to investigate the potential of this technique. Our objective is to use the latter rocks to confirm the validity of our laboratory measurements and data-fitting/numerical models by using the ESR-thermochronometry method to recover their known in-situ temperatures. Specifically, we have investigated known-thermal history samples from the MIZ1 borehole (Japan) and the KTB borehole (Germany).

Preliminary data reveal that the ESR dose response and thermal decay of different quartz samples is highly variable. Whereas the Al-centre of some samples exhibits linear dose response to laboratory irradiation up to 15 kGy, the Al-centre of other samples exhibits exponential, or double-exponential growth and saturates at doses of 3-4 kGy. The Ti-centre of most samples is well described by a single saturating exponential function, however samples from the MIZ1 borehole exhibit pronounced sub-linearity in the low-dose response region. Furthermore, whereas for some samples the Al-centre is less thermally stable than the Ti-centre, for other samples the inverse is observed. These observations suggest that a uniform measurement protocol and data-fitting approach may not be appropriate for quartz ESR data.

Inversion of two KTB samples yielded temperatures within uncertainty of borehole temperature, however results for the MIZ1 borehole are more variable and can only recover temperature at best within ~10%. Investigations into the cause of the poor results for the MIZ1 borehole are ongoing (i.e. measurement protocol, data-fitting/numerical model) and will be discussed.

Keywords (max. 5): Thermochronometry, quartz, ESR, borehole

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Feldspar, fading and correction: A systematic investigation of parameters influencing the performance of fading correction techniques

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In the recent past, great effort has been made to develop suitable approaches to cope with the long known, but still poorly understood problem of 'anomalous fading'. Carrying the risk of severe age underestimation, this phenomenon has long been hampering feldspar-based luminescence methods in paleo-environmental research. Among other things, a number of new measurement protocols have been introduced that either aim to completely circumvent the fading problem (e.g., IR-RF and IRPL) or at least significantly reduce its impact (e.g., post$IRIR_{225}$). However, with respect to particular environmental settings (e.g., short transport distances or other unfavorable conditions for signal resetting), many of these approaches stay challenging. Furthermore, for some of these new measurement protocols there is a still ongoing scientific debate whether they are capable of reducing the impact of fading to a negligible level or whether fading – although it might be reduced to some extent – still has to be taken into account.

As a result, fading correction approaches will remain of crucial importance for paleo-environmental research when feldspar-based techniques are applied to derive age information. A look at the published literature seems to confirm this conclusion since correction methods are either explicitly or implicitly applied in many studies dealing with feldspar-based chronologies. However, there seems to be no generally accepted strategy on how to implement such correction procedures in detail. A literature review shows that there are large differences in the experimental designs to determine fading rates and substantial variations in the way fading correction models are applied. Recent studies [1,2] showed that the fitting algorithm applied to construct the dose response curve as well as the regenerative doses considered for the dose response curve construction are decisive factors strongly influencing the results obtained by applying fading correction techniques.

Our presentation highlights results of a systematic investigation on the influence of specific measurement parameters and other decisive factors such as fitting algorithms and fading rates on the results obtained from various fading correction models. With our contribution we would like to initiate a discussion on whether the experimental designs applied for fading rate determination as well as the application of fading correction procedures should be standardized. Such a standardization will be beneficial for ensuring the comparability of luminescence ages derived from feldspar-based techniques, which is of crucial importance for the interpretation of paleo-environmental studies dealing with periods beyond the last glacial-interglacial cycle.

Keywords (max. 5): fading, correction techniques, feldspar, polymineral finegrains

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Sediment transport revealed by residual doses of modern K-feldspar sands in the Kujukuri coast, central Japan

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In K-feldspar IRSL, residual doses associated with incomplete breeching are prone to occur. While residual doses are a problem for accurate dating, fewer researches have been carried out on them compared to the diversity of depositional environments that cause them. Additionally, residual doses reflect exposure during sediment movement and could be used to trace sediment transport. Therefore, this study characterises the spatial variation of residual doses in coastal zones and utilises them to decipher sediment transport.

Surface sediment samples were collected from dunes, beaches and offshore areas of the Kujukuri Coast, and mineral particles with a high proportion of K-feldspar (180-250 μm) were extracted from them and IRSL was measured to evaluate the residual doses. The signals used for the measurements were the IR_{50} signals and the $pIRIR_{50/150}$, $pIRIR_{50/225}$, and $pIRIR_{50/290}$ signals measured subsequently. The preheat temperature was set at +30 °C above the pIRIR measurement temperature.

Residual doses at beaches tended to be higher on the northern beaches closer to the sediment source (sea cliff, Byobugaura), and were ~0.7 Gy from IR_{50} (Ph180), ~6 Gy from $pIRIR_{50/150}$, ~13 Gy from $pIRIR_{50/225}$ and ~43 Gy from $pIRIR_{50/290}$. On the other hand, on the central to southern beaches, the residual doses were ~0.2 Gy from IR_{50} (Ph180), ~1.2 Gy from $pIRIR_{50/150}$, ~4.5 Gy from $pIRIR_{50/225}$ and ~11 Gy from $pIRIR_{50/290}$. This decrease in residual dose in the alongshore direction is in harmony with the direction of sediment transport in this area, suggesting that residual doses are an effective tracer of sediment. On the beach, the residual doses tended to decrease from the foreshore towards the dunes. This may reflect exposure resulting from wind-driven sediment transport. Offshore surface samples were collected in water depths from 5 m to 129 m. Residual doses were ~0.2 Gy from IR_{50} (Ph180), ~2 Gy from $pIRIR_{50/150}$, ~6 Gy from $pIRIR_{50/225}$ and ~25 Gy from $pIRIR_{50/290}$, except at sites close to the sediment sources, where the change in residual doses with water depth was less clear than the change in doses longshore on the beaches. The residual doses at water depths of tens to a hundred and a few tens of metres were similar to those at the beaches samples, suggesting that sediment discharge from the beaches may occur if no breaching occurs in the water.

If the underwater exposure conditions can be clarified and the resolution improved in the future, it may be possible to reveal the details of sediment transport in coastal zones on the basis of residual doses.

Keywords: IRSL, Residual doses, Coastal sediment, Sediment transport, K-feldspar

Optical bleaching in the luminescence reader using an LED based solar simulator

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Resetting of the luminescence clock by sunlight forms the basis of sediment and rock surface dating. It is, therefore, desirable to reproduce the sunlight spectrum under different conditions to study the luminescence resetting mechanism. Equally, it is important to quantify the efficiency of individual wavelengths in the solar spectrum in depleting the latent luminescence signals. Advances in Light Emitting Diode (LED) technology make it possible to develop compact light sources that closely reproduce the solar spectrum while providing a reasonable flux. Such light sources raise the possibility of *in-situ* bleaching in the luminescence reader using individual wavelengths or a full daylight spectrum under different latitude, longitude or cloud cover conditions.

Here we describe an optical bleaching unit coupled to the Risø TL/OSL reader. The unit consists of a commercial LED based solar simulator (Pico., G2V Optics Inc.) combined with a UV light source module to match the missing 300 - 350 nm range. The unit has 32 wavelength channels and the maximum optical power at the sample position of 400-500 mW/cm^2, i.e. 4 to 5 Suns. The flux from each channel can be adjusted using a software interface to generate a desirable daylight spectrum.

We will report and discuss the data obtained from the bleaching attachment using quartz, feldspar and rock samples. Different bleaching conditions will be simulated, e.g., partial or no cloud cover. An intercomparison with Hönle SOL2 lamp-based bleaching will be presented, where applicable.

Keywords: Luminescence resetting, solar simulator, light emitting diodes

XLUM: an open data format for the exchange and long-term preservation of luminescence data

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Luminescence-dating studies produce vast bodies of *primary* data that usually remain inaccessible or incompatible with future studies or adjacent scientific disciplines.

To facilitate open data exchange and long-term data preservation in luminescence dating studies, we propose a new XML-based structured data format called XLUM [1]. The design applies a hierarchical data storage concept consisting of a root node (node 0), a sample (node 1), a sequence (node 2), a record (node 3) and a curve (node 4). The curve level holds information on the technical component (e.g., photomultiplier, thermocouple). A finite number of curves represent a record (e.g., an optically stimulated luminescence curve). Records are part of a sequence measured for a particular sample.

Our format proposal allows the user to retain information from the measurement process on a technical component level. The additional storage of related metadata fosters future data mining projects on large datasets. The XML-based format is less memory efficient than binary formats; however, in focus is data exchange, preservation and hence XLUM long-term format stability. XLUM is inherently stable to future updates and backwards compatible. We support XLUM through two new software packages for R and Python, each called 'xlum' [2, 3]. Both packages facilitate the import of XLUM files into the respective environment. The R package 'xlum' converts existing luminescence-data file formats (e.g., *.bin/binx, *.psl, *.xsyg) into the new XLUM format. XLUM is licensed under the MIT license and hence available for free to be used in open and closed-source commercial and non-commercial software and research projects.

Our presentation will outline the basic concept of XLUM, discuss advantages and disadvantages and sketch possible future format progress.

Keywords (max. 5): data format, XML, data exchange, long-term data preservation

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Using Single-Grain OSL of Anthropogenically Placed Rocks to Determine Headward Gully Migration in Wyoming, USA

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The Wiggins Fork River drains the Absaroka Mountains in Northwestern Wyoming, USA. Terraces along the drainage record fluvial response to the glaciation of the Yellowstone Plateau and change in climate through the Quaternary [1]. The terraces contain 46 km^2 of abundant cultural features such as rock circles, lithics, and drivelines, constituting a bison jump complex. A riverbank stratigraphic profile displays beds of butchered bison bone linked to one of the jumps. This site yields radiocarbon ages indicating use in the late 1500s AD and projectile points typologically associated with Late Prehistoric Shoshonean people. The stratigraphy and topography of the deposit suggests buried cultural material and evidence of adjustments to the driveline alignments adds to the uncertainty of the age and duration of site use.

The first terrace of the Wiggins Fork, 25 m above the river, has four parallel rows of cairns that follow the edge of the terrace riser and extend for ~1km. These drivelines are bisected by gullies cut into the terrace surface. The relationship between the gullies and successively inward-placed drivelines suggest adaptation in response to headward gully migration. Research will use single-grain OSL to determine the age of the underlying terrace and timing of successive driveline emplacement, with the goal of understanding the timing of gully formation and rates of headward migration.

Samples were collected from sediment under thirty-two anthropogenically placed rocks comprising drivelines at five locations on terrace surfaces and upland positions. Five samples from the terrace alluvium and associated deposits were also collected to date terrace formation. Single-grain analysis will be used to date sediments underlying cairns to determine placement age [2]. Older terraces and other deposits in the study area will be dated using small aliquots of quartz sand [3].

The samples collected from the four parallel drivelines on the first terrace will use rock placement ages to determine geomorphic change related to past climate change. Results will help determine the timeframe of driveline construction and site occupation of the largest known hunting complex in North America [4].

Keywords (max. 5): OSL, quartz, single-grain, geoarchaeology, quaternary geomorphology

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Radiation detection with a Si-based time-pixelated quantum counting/imaging detector: potential for trapped charge dating

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Dose-rate heterogeneity (i.e. individual mineral grains receiving different radiation doses per unit of time) is now considered to be a major cause of dispersion in equivalent dose (D_e) estimates in trapped charge dating. This is caused by the inhomogeneous spatial distribution of radionuclides within sediments or archaeological materials (1-2) and relates to the different ranges (a few millimetres in the case of β-particles) of particles/radiation emitted during the decay of natural radioisotopes (3-5). Realizing this experimentally has been difficult but some attempts have been made [6-8].

Here, we investigate and demonstrate the potential of a silicon (Si)-based time-pixelated detector (Timepix 3) to determine the spatial distribution of different types of radiation (α-particles, β-particles, and γ-rays) and to help identify radionuclides such as potassium (K), uranium (U) and thorium (Th). Timepix detectors are small (area:14x14 mm, pixel matrix: 256x256) complementary metal-oxide semiconductor (CMOS) hybrid pixel detectors that are capable of directly detecting and visualizing ionizing radiation without needing a complex experimental setup. We first discuss the pattern-recognition algorithm to distinguish between different types of particles and then demonstrate the timepix's capabilities in spotting radionuclides on polished sections rich in K, U and Th.

Keywords (max. 5): dose rate, luminescence dating, micro-dosimetry, timepix

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Dating the Middle and Late Quaternary Caspian sea-level fluctuations: first luminescence data from the coast of Turkmenistan

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The Caspian region, being a basis for stratigraphy and paleogeography of the Pleistocene of Central Eurasia, has been actively studied during last two centuries. Up to date, many issues on the paleogeographic history of various basins of Caspian Quaternary are unsolved, but the main problem is the chronology. Previous studies mainly focused on the detailed description of the sedimentation history in the Lower Volga region and Eastern Caucasus. Meanwhile a number of unique sites on the Central Asian coast remained unstudied, mainly due to inaccessibility. Here, we studied one of the most complete sections, Western Cheleken, located along the Caspian coast of Turkmenistan which is covered by vast sand deserts. Late Pleistocene and Holocene units are uncovered in the coastal cliff of a brachyanticlinal fold. This fold was active throughout the Quaternary and thus retained a detailed sedimentation history of Caspian Sea transgressions and regressions.

Stratigraphical, geomorphological and paleontological studies of the section were supplemented with luminescence and radiocarbon dating. We obtained 12 new luminescence ages from all main stratigraphic units and 2 radiocarbon dates from the Caspian mollusk shells for the upper part of the section. Luminescence dating was performed on the sand-sized grains with OSL measurements on quartz and $pIRIR_{50,290}$ for K-rich feldspar grains. In the lower part of the section 6 samples showed that the quartz OSL signal was fully saturated, while for the top part we obtained both quartz and feldspar data. Three samples have doses ranging from 50 to 150 Gy and a $Q/pIRIR_{290}$ ratio close to 1, reflecting the long exposure of sediments to light before sedimentation, which is expected for coastal-marine and aeolian deposits. For the lower part of the section feldspar doses vary from 300 to 650 Gy. Dose recovery is satisfactory for both quartz (1.02±0.03) and feldspars (1.06±0.5). For a very specific unit of marine sediments representing Khvalynian stage, the largest Late Quaternary transgression of the Caspian Sea, we obtained a collection of characteristic mollusk shells, for which two radiocarbon ages are close to luminescence dating results, additionally confirming reliability of the resulting chronology for the Western Cheleken section. The new ages allowed assigning the age of the main events to the end Middle and Late Pleistocene: Khazarian transgression (dated to MIS 7 and 6); Hyrcanian transgressive basin (MIS 5); Early Khvalynian basin (MIS 2 after LGM).

Keywords: luminescence dating, sea-level fluctuations, transgressions, Karakum Desert, Caspian Sea, marine sediments

Middle–Late Pleistocene fluvial landscape evolution in the Granada Geopark: Application of a challenging pIRIR dating approach

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The formation of river terraces is a common geomorphological phenomenon worldwide. The complex interplay of erosion and accumulation processes and the environmental conditions controlling the dynamics and timing of river terrace formation is just one of the many questions related to fluvial landscape evolution that have not yet been adequately answered. Therefore, it is of particular importance to establish regional chronologies of fluvial systems to gain better insight into landscape evolution processes and their specific driving forces. Based on substantial technical and methodological innovations, various luminescence dating approaches have successfully been used on fluvial systems. However, considering signal resetting, equivalent dose determination, and dosimetry, fluvial systems remain challenging. This is particularly true for river terrace sediments of middle to late Pleistocene age. Due to the relatively low dose saturation of quartz minerals, feldspar-based techniques have to be applied to derive age information for such sediments. Feldspars, however, have long been known to suffer from the phenomenon of 'anomalous fading', which might result in severe age underestimations.

The Baza/Guadix Basin in northeastern Andalusia, which is part of the Granada UNESCO Geopark, provides ideal conditions for investigating the dynamics of river terrace formation. From the Pliocene to the middle Pleistocene, this intra-montane basin was a broad, undrained depression that was continuously filled with sediments from the surrounding mountains [1]. At some as yet unknown time in the middle to late Pleistocene, a source river of the Rio Guadalquivir entered this endorheic basin [2], and a new river system formed, which cut the sediments of the original basin, leaving several generations of river terraces in deeply eroded valleys. In multiple places, the river terraces are associated with travertine and tufa formations.

The project presented here (funded by the German Research Foundation) aims at studying the evolution of this newly formed fluvial network. We applied a variety of luminescence dating techniques to cope with the specific problems associated with this complex fluvial setting. Particular challenges arise from the ages of approx. 200-800 ka expected for the terrace formation, which we address with a combination of feldspar pIRIR, quartz SAR, and complementary IR radio fluorescence (IR-RF) and IR-PL measurements. U/Th dating of tufa and travertine formations will be used to provide independent age control.

The research project will establish a regional chronostratigraphic framework that demonstrates the dynamics of the fluvial landscape evolution ever since the capturing event. We anticipate that our results will provide a first estimate of backward erosion rates and determine typical incision rates for local rivers.

Our poster outlines the major goals of the research project, provides information on the methods used so far, and presents first geochronological results based on pIRIR-225 measurements on small aliquots of coarse-grain K-feldspars.

Keywords: landscape evolution, fluvial terraces, Pleistocene, K-feldspar, pIRIR, small aliquots

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Luminescence chronology of core JNZK1 from Jinan in the middle Yellow River Plain

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The Yellow River is one of the largest rivers in the planet. Some part of its channel in its low reaches of the flooding plain is now more than 10 meters higher than the surrounding land, imposing great threat for human life. It is critical to decipher the sedimentary and channel migrating history to sort out the issue. Core JNZK1 was obtained from Jinan in Shandong Province in the Yellow River Plain in China with a depth of 740 m, in order to reconstruct the history of the river. The OSL ages are very limited in these area, and there is by far no systematic OSL chronology for drilling cores. In these study, OSL samples were collected from the top 40 m of the core in order to establish detailed chronology. OSL ages showed that a sample at the depth 15.6 m had an age of c. 11 ka, indicating the bottom of the Holocene sediment. OSL age then soon reached saturation at a depth of c. 22 m, suggesting a hiatus occurred in between possibly due to the erosion during last glacial. Radiocarbon samples were also collected where available. The current study tried to provide a preliminary chronological framework for further sedimentary and paleoenvironmental studies in the flooding plain.

Keywords: Yellow River Plain, drilling core, luminescence dating, radiocarbon dating, channel migration

Geochronological advances in human first arrival date in the Philippines Archipelago (Cagayan valley, Luzon island)

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The Paleolithic site of Kalinga, in the Cagayan River basin (Luzon Island), preserves the oldest known traces of human occupation of the Philippines archipelago (709 ± 68 ka1). Luzon island is also known for the fossil's discovery of *Homo luzonensis* (Callao cave) recently dated at 66.7 ± 1.0 ka2, that constitute the oldest human remains in the Philippines. This contribution presents the results of a geomorphological and geochronological study of the Kalinga site: the Cagayan valley, in order to precise the geochronological framework of this first human settlement. In this area, the sedimentary deposits are mainly fluvial sands terraces partly formed from volcanic minerals. Following the discovery of abundant paleontological remains and lithic tools on surface, the region was the subject of numerous excavations on several sites from the 1970s until now. Since 2014 a new project led by our research team unearthed hundreds of archeological remains (lithic tools and butchery traces) discovered undisturbed in several sequences. Apart from the early middle Pleistocene ages obtained for the Kalinga site, the geomorphology and geochronology of the area are still little known. Through the use of ESR on bleached quartz and $^{40}Ar/^{39}Ar$ on plagioclase dating methods in association with palaeomagnetism analyses, the chronology of four sequences has been constrained. Our results assert a human occupation between 709 ± 68 ka and 528 ± 40 ka reducing the chronological and archaeological gap between Kalinga and Callao hominins and placing this basin as a central piece of the human arrival in insular Asia.

Keywords (max. 5): ESR, $^{40}Ar/^{39}Ar$, Paleomagnetism, Geochronology, Human peopling.IR-RF, quartz, polymineral finegrains, gamma dose

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The evolution of post-isothermal feldspar luminescence in a Milankovitch time-scale glacigenic sedimentary basin

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A newly developed approach in the dating of sediments using K-feldspar, known as post-isothermal (pIt) IRSL, requires the measurement of artificially induced luminescence from aliquots thermally annealed at various temperatures and durations. For each thermal treatment, one measures both the IRSL at 50°C and the post-IR IRSL at 225°C, following a preheat at 250°C for 60s. The thermal evolution of the IR_{50}/pIR_{225} ratio (50/225 for the following) behaves similarly to the athermal tunneling process and hence has been proposed as a potential circumvention to the problem of anomalous fading in feldspar.

In spite of several sites for which the application of the pIt method has been successful, there are limitations for sediments that had not been properly bleached before burial, much as for several other luminescence methods. In order to develop laboratory criteria to detect unwanted high IRSL residuals, our laboratory has embarked into the comparison of the evolution of the 50/225 IRSL ratio following laboratory bleaching, as well as the naturally observed 50/225 luminescence signals for a large spectrum of sediments in modern contexts. It is observed that the 50/225 ratio is anti-correlative with the length of pre-depositional sunlight exposure. Interestingly, this variability can be traced following burial and acquisition of post-depositional latent luminescence up to a few hundred Gy. Using relatively young (ca 10 ka) sediments for which the absolute age of deposition is strongly constrained, methodologies are being tested to assess the residual 50/225 upon burial and hence correct pIt ages.

A systematic analysis of the natural 50/225 ratio in a glacigenic (*senso lato*) Quaternary sequence from the St. Lawrence River drainage area, in Southern Québec (Canada), will show this ratio to be a reliable proxy for assessing sedimentary aggradation and recycling in the context of a waxing and waning regional glacial margin.

Keywords : post-isothermal luminescence, K-feldspar, dating, bleaching, sedimentary processes.

Optically stimulated luminescence dating of coastal sediments from southwestern Korea: some discontinuities with concentrated organic layer

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The fourteen sample were collected from three outcrops from the Ujeon Coast of the southwestern Korean Peninsula. A single-aliquot regenerative-dose(SAR) optically stimulated luminescence(OSL) and single-grain post-infrared infrared stimulated luminescence(pIR-IRSL) were applied to quartz grains of 4-11μm in diameter and K-feldspar grains of 180-212 μm in diameter, respectively. As a result of fine-grained quartz OSL, the OSL ages range from 127±8.12 ka to 0.15±0.01 ka and are mostly in stratigraphic order. In contrast, the age reversal occurred in the lower part. In the case of the fine-grained quartz, equivalent dose (De) steadily increased throughout the sequence. And, most aliquots passed the acceptance criteria to check the SAR suitability. Also, the shape of the decay curve is dominated by the fast component. A pIR- IRSL using K-feldspar was applied to the same sample to determine whether the age underestimation was caused by saturation of equivalent dose in quartz and for extending the age range. Despite the ~20% increase in pIR-IRSL ages of K-feldspar single grain compared with fine-grained quartz ages, the age re- versal still existed in the same section as fine-grained quartz OSL. The age reversal may have arisen mainly from a sudden increase of 150% dose rate to the lower part. On significant potential error in dose rate determination is the non-consideration of the attenuation of organic-rich sediments and intercalation of low dose layer. The dose attenuation caused by organic material is substantial and our correction may not be sufficient for this. In this study, an experiment was conducted on the dose rate measurement and the effect of the direct organic layer to overcome the limitations of dose rate measurement. Also, the reliability of OSL ages from the high-dose linear region of the dose-response curve was considered.

Keywords: single grain K-feldspar, fine grain Quartz, pIR-IRSL, dose rate, Korean Peninsula

Luminescence chronology for the first terrace of the Pearl River in the Baise Basin, South China

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A large number of paleolithic and neolithic sites have been excavated from the river terraces of the Pearl River in the Baise Basin, Guangxi Zhuang Autonomous Region, South China. However, the ages for the terraces have not been published by far. Two drilling cores have been obtained in 2022 from the first terrace (T1). The upper part (~14-15 m in depth) of the cores consist of loess deposit (aeolian silt/sands), and the lower part of fluvial gravel. Wood logs (about 0.15~0.20 m in length) were found between the two parts, which are nice materials for radiocarbon dating. We combine quartz optically stimulated luminescence (OSL) dating (about 15 samples) and radiocarbon (^{14}C) dating (3 samples) to establish the chronology for T1. Dating result shows that the river incision occurred during the late glacial forming the T1, and that the loess on top of the fluvial sands accumulated mainly during the Holocene and was relatively continuous. This indicates that this aeolian sediment, with a thickness of 14~15 m, could provide high resolution records for paleoclimatic reconstruction. The dating data may also contribute to understanding origins and evolution of paleolithic and neolithic culture.

Keywords: river terrace, luminescence dating, radiocarbon (^{14}C) dating, Pearl River, South China

Photoluminescence study of different types of single crystal feldspars and the implications to PL dating using a Raman system

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In this study, we investigated photoluminescence (PL) characteristics (emission spectra and the dependence of the intensity on irradiation dose) of both single-crystal alkali feldspars (orthoclase, microcline, and anorthoclase) and plagioclases (albite, oligoclase, and labradorite) using a RENISHAW inVia™ confocal Raman microscope instrument configured with 532 and 785 nm laser excitation. The results show that feldspars have intensive PL bands peaking at 577-606, 704-733, 859-865, and 912-917 nm under 532 nm excitation; while their PL spectra consist of two broad peaks at 864-869 and 909-926 nm under 785 nm excitation, although the number of emission peaks and the exact median peak position is sample-specific. This is possibly linked to the slight variations in chemical composition and crystal structure of the feldspar minerals.

The dependence of PL intensity on irradiation dose varies among the type of feldspar and the median peak position within a single crystal feldspar. Under 532 nm excitation, anorthoclase, oligoclase, and labradorite show no clear change in PL intensity with the increasing irradiation dose. For orthoclase, microcline, and albite, their spectra have an increasing trend in PL intensity with the increasing irradiation dose in the long wavelength region (e.g., ~860 and ~915 nm peaks), but no clear change for peaks centered at ~580 and ~720 nm. Under 785 nm excitation, anorthoclase and labradorite show no clear change in the PL intensity with the increasing irradiation dose, while for orthoclase, microcline, albite, and oligoclase, PL intensities of main emission peaks (e.g., ~865 nm) increase with the increasing irradiation dose. It is mainly due to the different responses of PL intensity to irradiation dose, which are linked to electron trap depths. We proposed that PL bands peaking at ~865 and ~915 nm of alkaline feldspar show the priority in the PL dating application and the potential of using a commonly available Raman system for dating.

Keywords: Photoluminescence, Feldspar, Emission spectra, Raman system, PL dating

A Bayesian hierarchical age model for single-grain dating of feldspars

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The distribution of equivalent dose (D_e) of single-grain feldspars is affected by a range of variables, including the distributions of internal dose rate, external dose rate, residual dose and uncertainties associated with luminescence behaviours and measurement errors. The distributions of these variables may be non-gaussianary and, consequently, result in a complicated pattern of D_e distribution that provides a challenge to interpret and analyse using the conventional statistical models. In order to address this problem, here we present a hierarchical model, so-called Bayesian hierarchical age model for feldspar (BHAM-F), which integrates key components involved in age determination for single-grain optical dating of feldspars. The model is based on the application of standardised growth curve and L_nT_n methods to obtain full distribution of single-grain D_e and the prior information on the major sources of uncertainties that can be obtained experimentally or theoretically. The Bayesian Outlier Model is also adopted to detect and deal with outliers. The BHAM-F is validated and tested using experimentally-gathered data sets obtained from sediment samples and simulated data sets from various simulated samples. Our results show that the BHAM-F provides a robust and flexible way to hierarchically deal with single-grain optical dating data for feldspars, and is suitable to various samples including those affected by insufficient bleaching or post-depositional disturbance.

Keywords (max. 5): Bayesian model, post-IR IRSL, single grain, optical dating, feldspar

Pace of alluvial river incision constrained by luminescence dating

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For the alluvial river-fan system, the river incision process concentrates the water and detrital materials and forms an effective passage for mass transport. The global connection between climate change and river aggradation/incision phases have been intensively investigated on orbital scale. However, the pace of alluvial river incision on sub-orbital scale (10^3-10^4 a) is rarely studied.

On the northern piedmont of Chinese Tianshan, alluvial rivers entrenched the fan surface formed during the last glacial period, to a depth up to 200 m [1], with multi-level terraces abandoned since the late glacial. Jingou River, flowing across the Huoerguosi Anticline and Anjihai Anticline, incised the fan surface formed 13 ka to 12 ka ago [2], and left up to ten levels of terraces preserved. This terrace sequence holds part of river incision history. In this study, the luminescence dating methods, using both sediment grains and cobbles collected from the sandy-lens and cobbles of terrace deposits and overlying silty sands, are employed to constrain the abandoned ages of the terrace sequence and reveal its temporal rhythm. Both single grain potassium feldspar pIRIR technique and cobble slice pIRIR technique will be carried out to determine equivalent doses. Compared with the terrace on the south of Huoerguosi Anticline, the process of aggradation/incision of terrace on the north was influenced by a fault. Therefore, detailed abandoned age sequence would help evaluate the role of tectonic activity on the alluvial river incision on sub-orbital scale.

Keywords (max. 5): alluvial fan-river system, Cobble luminescence dating, incision sequence

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Luminescence dating of young glacial cobbles and sediments; implications for rock surface luminescence dating of glacial landforms

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Incomplete/heterogeneous bleaching is a challenge for the luminescence dating of glacial sediments, which can complicate the application of sand and silt-size luminescence dating. The luminescence dating of rock surfaces [1] is able to identify whether the buried cobble was completely exposed to daylight prior to deposition due to the presence of sub-surface bleaching profiles [2]. Dating modern or young cobbles is one of the best ways to test the bleaching hypothesis. This study investigates cobbles and sediment grains from different settings such as recently-formed recessional moraine and bars, late Holocene lateral moraine and outwash terrace (< 2 ka) in front of the modern glacier in Yingpu Valley, eastern Tibetan Plateau. One hundred and thirty cobbles were collected, including 20 cobbles that were exposed to light at the time of collection, and 70 buried glaciofluvial cobbles from modern recessional moraine and bars.

Post-IR IRSL protocols were applied for cobble and grain samples. The luminescence-depth profiles of cobbles showed evidences of being bleached at most sampling sites. Approximately 20 % of buried cobbles were 'well-bleached'. Cobbles from different types of sedimentary environment show different degrees of bleaching. Those cobbles from the top of lateral moraine have the best degree of bleaching, followed by a glaciofluvial terrace and modern glaciofluvial cobbles. Glaciofluvial cobbles collected from small depression between modern recessional moraines in front of modern glacier contained no well-bleached samples. Very low $IRSL_{50}$ equivalent doses (D_e) were obtained for the exposed cobbles collected from the ground surface (with a theoretical age of 0), indicating that cobbles were sufficiently bleached in the field. Low $IRSL_{50}$ dose plateaus at the near surface part of buried cobbles show that $IRSL_{50}$ signal were well-reset inside those cobbles, with different depths ranging between 3-7 mm, For most cobbles, the post-IR_{50} $IRSL_{130}$ signal shows less sub-surface bleaching than the $IRSL_{50}$ signal, with well-bleached depths between 0-5 mm. Finally, three sediment samples were collected from the same sites as the above three sampling sites of cobbles. D_e measurements were determined using single grains of K-feldspar. Heterogeneous bleaching of sediment samples was common. The relationship between the characteristics of cobble (roundness, sphericity, color, grain size, average diameter of cobbles, etc.) and the degree of bleaching was also investigated. This study will discuss implications for rock surface luminescence dating of cobbles from a range of glacial deposits, and provides in-field sampling recommendations.

Keywords: Rock luminescence dating, Feldspars, Heterogeneous bleaching, post-IR IRSL, Tibetan Plateau

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Timing of fluvial-lacustrine sedimentation in the North China Plain since the late Pleistocene by multiple luminescence dating approaches

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Thick fluvial and lacustrine sediments reaching several hundred meters have been deposited in the North China Plain since the Quaternary, regarded as the ideal materials for understanding sedimentary process and the driving factors in various timescales. Chronostratigraphy in the North China Plain has been investigated using the paleomagnetic approaches for the entire Quaternary period in several studies. However, detailed numerical dating has rarely conducted on the sedimentary archives for the last glacial-interglacial period.

Luminescence dating is promising and have been widely used to provide robust and reliable chronology for the fluvial and lacustrine sediments [1]. To explore the sedimentation in the North China Plain since the Late Pleistocene, two new boreholes were drilled at two different sites. In total of 15 luminescence samples were collected from the two cores. Quartz, K-feldspar or polymineral fractions were extracted for luminescence dating. The standard single-aliquot regenerative dose protocol has been used for quartz OSL dating, while the coarse-grained K-feldspar or fine-grained polymineral have been measured using two post infra-red (IR) IRSL protocols, which are $pIRIR_{50,\ 150}$ and $pIRIR_{200,\ 290}$. The apparent $apIRIR_{50,\ 150}$ ages were fading corrected using two fading correction models [2,3]. The three sets of ages were subsequently compared to evaluate the degree of signal bleaching. The integrated luminescence chronology of the fluvial-lacustrine sediments in the North China Plain since the Late Pleistocene was finally proposed.

Keywords (max. 5): quartz OSL dating, IR dating, signal bleaching, Late Pleistocene, North China Plain

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OSL and radiocarbon dating of core SXG06 from Dongguan in the Pearl River Delta

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Accurate dating forms the basis for deciphering eustatic and climatic changes on deltaic sedimentary process. In the Pearl River Delta (PRD) in south China, the lower marine sequence (M2) is rarely preserved in cores and profiles, which leads to scarce chronology evidences for M2, especially in the eastern PRD. This hinders the detailed interpretation of sedimentary history of the PRD. In this study, optically stimulated luminescence (OSL) dating and radiocarbon (^{14}C) dating were applied to establish a chronological framework of core SXG06 (23 m depth) from the eastern PRD. SXG06 is composed of, in descending order, brownish grey clay (the upper marine sequence, M1), the mottled clay (T1) and blue grey clay (M2). Thirteen quartz OSL sample yielded eight ages from 5.2 to 0.32 ka for M1, two from 61 (minimum age) to 38.7 ka for T1 and three minimum ages (>82 ka) roughly falling in MIS 5 for M2. The compilation of these ages and sedimentology data of other published cores reveals the late Quaternary sedimentary history of the PRD: (1) The chronostratigraphy of M2 of SXG06 is well consistent with OSL-based records from other PRD cores, which further supports the fact that M2 formed in MIS 5 of sea-level highstand. (2) Mottled clay of SXG06 is prevailed in the PRD with burial depths from c. 30 m to 5 m, and indicates a sedimentary hiatus from c. 60 to 5 ka when the sea was far from the eastern PRD plain. (3) Being constrained by the relatively higher altitude of bedrock and further north geographical setting, the incipience of post-glacial marine deposition of the eastern PRD is at c. 5 ka, postdating the central and southern PRD by at least c. 3 ka. Since c. 5 ka, SXG06 experience a low depositional rate / hiatus in response to reduced sediment supply at 5–3 ka and an accelerated progradation rate (6–7 m/ka) related to enhanced human activity during c. 2.8–0.3 ka.

Keywords: Pearl River Delta, optically stimulated luminescence (OSL) dating, radiocarbon dating, late Quaternary, sedimentary history

The vertical and lateral erosion rates of Manas River, North Tianshan: insight from luminescence dating of terrace deposits

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Rivers cutting into bedrock to form terrace sequences commonly record a complex history of vertical incision, aggradation of bed cover, and lateral bedrock erosion that can be interpreted as a result of environmental, tectonic, and autogenic changes. The relative magnitudes of changes in vertical and lateral erosion rates has important implications for interpreting the timing and rate of tectonic forcing, as well as the response of rivers to climatic changes [1]. Constraints of detailed vertical and lateral erosion processes and their rates, as well as the potentially complex interactions, are still lacking. Whereas it put forward higher requirements for chronology data.

The difficulty in getting well-targeted materials and the uncertainty of dose rates caused by heterogeneous sedimentary environment limit the validity and accuracy of dating. Optical dating of buried rock surface has been applied to dating fluvial terrace cobbles [2], and thus is promising to be employed to reconstruct the vertical and lateral jiggling processes of alluvial rivers. In this study, we exploit fluvial terrace cobble optically stimulated luminescence (OSL) dating, combining with the sandy samples OSL ages with dose rate corrected by inhomogeneous media, to reveal vertical incision, aggradation of bed cover and lateral bedrock erosion of Manas River, and determine their respective rates. Our study deciphered a detailed lateral and vertical jiggling processes of Manas river since the last glacial maximum, and their alternations in response to climatic and tectonic forcing. This study also shed light on understanding the alluvial evolution history for similar geolgocial settings.

Keywords: terraces; fluvial cobble OSL dating; lateral erosion rate; incision rate

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Geochronology of multiple dating methods on quaternary drilling hole: a case study from Shinaimiao core in the transition zone from the eastern foothills of the Taihang Mountain to the North China Plain

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The main body of Hebi City is located in the transition zone between the mountain and the plain on the north bank of the Yellow River. It includes two major geomorphological units, the bedrock uplift area of the Taihang Mountain and the sedimentary area of the North China Plain. The Shinaimiao (SNM) core locates in Hebi City of China, belongs to the accumulation plain of the eastern foothills of the Taihang Mountains which is part of the North China Plain, and composed by quaternary alluvium and flood deposits in lithology.

The SNM core is 126.64 m deep. Environmental magnetism and ESR dating method are used to divided the lower and middle Pleistocene, and determine the quaternary bottom boundary. OSL and radiocarbon (^{14}C) dating methods are used for the division of the middle and upper Pleistocene, and Holocene. Quaternary stratum of SNM core is divided by multiple dating methods, which have provided the basic data for the study of urban active fault detection and environmental evolution in Hebi City and its vicinity.

Keywords: ESR, OSL, Radiocarbon, environmental magnetism, Taihang Mountains

Comparison of OSL and radiocarbon dating on core LFZK06 from Lufeng of the coastal South China Sea

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Reliable chronology is crucial for reconstructing coastal landscape evolution. Optically stimulated luminescence (OSL) and radiocarbon (^{14}C) dating are two main methods for establishing chronological stratigraphy of late Quaternary sediments. Recently, a number of cores have been obtained from Lufeng area (Guangdong Province) in the coastal South China Sea. Core LFZK06 (38.6 m in depth) is located at the lower reach of the Luohe river, about 5 km upstream from the coastline, which documented critical information on marine and river interaction shaping the coastal landform. Its sediments contain one marine unit lying between two units of fluvial sediments, with the lower fluvial unit underlain by bedrocks. In this study, quartz OSL and accelerator mass spectrometry (AMS) ^{14}C dates were obtained for age comparison. Dating results showed that, (1) for the Holocene sediments, ^{14}C ages were generally older than OSL ages from the same depths by about 1-2 ka, which was possibly due to old carbon contamination by enriched carbonates from sedimentary rocks in the upper stream, (2) the accumulation of the marine unit started in the early Holocene, (3) lower fluvial sediment unit could be correlated to MIS3.

Keywords: Coastal South China Sea, drilling core, luminescence dating, radiocarbon dating, late Quaternary

Single-grain K-feldspar luminescence dating of late Quaternary lake expansion over the Tibetan Plateau

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Lakes are not only the critical natural resources on the earth, but also key indicators of local and regional watershed changes, making them useful for detecting Earth's response to climate change. More than 1000 closed lakes having stood much higher than now decorate the Third Pole, i.e., mainly Tibetan Plateau (TP), and yet the timing and duration of their past expansions and hence climate forcing that sustained large hydrologic variations remain unclear particularly for the late Quaternary.

Well-preserved shorelines located 100s of meters above present lake levels are widespread in the lake basins over TP, allowing to reconstruct the past hydroclimate changes according to age control of palaeoshorelines. Previously, single aliquot (SA) luminescence methods of both quartz and K-feldspar fractions have been extensively utilized for dating of the lake-level related sediments, but very few considered the issue of partial bleaching which often occurred especially for the water-lain sediments from TP [1,2]. Because it is quite difficult to evaluate the bleaching level of sediments with SA, in which many grains are measured simultaneously, causing averaging effects, and any variability in resetting between grains will be masked [3]. With the development of measurement protocol and facility, it becomes very feasible to determine the luminescence signals from single grain (SG), able to improve the reliability of ages by explicitly assessing the bleaching condition of sediment sample.

In this study, we applied the SG K-feldspar technique with post-IR IRSL (pIRIR) protocol to build up the chronologies of a set of selected palaeoshorelines from the two largest lakes, Qinghai Lake from the north TP and Selin Co from the south TP, with aims: (1) to choose which thermal treatment is the most suitable for K-feldspar SG dating of the late Quaternary shoreline sediments over TP; (2) to verify if the relevant sediments were bleached sufficiently or not before deposition; (3) to constrain the timing of late Quaternary lake expansion based on SG data, and compare with previous SA data; (4) to assess asynchronous evolution pattern for the lakes from the north and the south of TP.

Keywords: Single aliquot, single grain, K-feldspar, post-IR IRSL, palaeoshoreline sediments

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Luminescence dating of the Diring Yuriakh Early Palaeolithic site (North-Eastern Siberia)

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Diring Yuriakh in Eastern Siberia is the northernmost known Early Palaeolithic site in Eurasia. It is located on the oldest terrace (VIII) (Tabagan) of the Lena River in Yakutiya. The prominent Soviet archaeologist Yu.A. Mochanov discovered Diring Yuriakh in 1982. Lithostratigraphic criteria were used to identify up to 16 geological units, all of alluvial or aeolian origin. The cultural layer, containing quartz-rich pebbles and artefacts, lies on the eroded surface of reddish ferruginous channel sands and epigenetically embedded polygonal sand-filled ice wedges. More than 4,000 artefacts were found at the site, all made from pebbles, boulders and fragments of quartzite. Various types of tools are represented: unifacies, hammerstones, flakes, and choppers. Most have traces of wind polishing and grinding.

The age of the Diring Yuriakh site is of particular importance to our understanding of the dispersal of ancient hominins in Northern Asia. The artefacts, and the geology and geomorphology point to an Early Palaeolithic age. From the typological and technological parameters of the lithics, Mochanov argued that Diring Yuryikh was comparable to the Oldowan complexes of East Africa and could be dated to between 1.8 and 3.2 Ma [2]. This led him to the hypothesis of a separate centre of hominin evolution in Northern Siberia, and this argument initiated a wide discussion of Diring Yuriakh and its position in the Early Palaeolithic of Eurasia. Prior to this study, various dating methods have been attempted, e.g. the presence of several magnetic reversals indicate the site is older than 780 000 years, a result supported by Soviet TL ages (older than 1.1 Ma) [2].

In early 1990 new TL ages between 270 and 370 ka were obtained [3]. Analysis of these results by Huntley and Richards [1] emphasized that these ages were probably saturated and thus underestimates. In the site discussion, particular attention was paid to the climate at the time of occupation. When did conditions, in what is now one the most inhospitable parts of Siberia, allow hominins to colonize it? What was the timing of the initial hominin dispersal in Beringia? Until now, this issue remains unclear.

To address these questions, we undertook new studies at Diring Yuriakh and obtained 14 new ages focussing on cultural layer 5. Using quartz OSL and feldspar $pIRIR_{50,290}$ signals from sand-sized grains, quartz and feldspar were compared to determine the degree of bleaching in the upper part of the section, and showed that quartz was probably well bleached before sedimentation. Our results provide new chronological constraints on the cultural layer and the geomorphological evolution of Diring Yuriakh. The study was supported by the RSF No. 21-17-00054.

Keywords: OSL, Early Palaeolithic culture, archaeology, Siberia

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Age Reassignment Using Luminescence Dating for The Mammoth Site, Black Hills, South Dakota, USA

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The ~21 m deep Mammoth Site (MS) bone bed site at Hot Springs, South Dakota, provides a unique opportunity to reconstruct paleoenvironmental conditions on the northern Great Plains of the United States. Past published radiocarbon analyses of mammoth bones found within the MS sinkhole suggested they were deposited ~23,000-42,000 yrs 14C cal BP. However, two U-series ages ranging between 129,000-150,000 years ago and a thermoluminescence (TL) age of 101,000 ± 10,000 yrs suggested the bones were considerably older. We analyzed three samples from nearby terraces as well as six samples from the bone bed using optically stimulated luminescence (OSL) dating; the ages ranged from ~130,000-255,000 yrs, showing greater consistency with previous U-series and TL analyses. The OSL dating was on fine sand sized potassium feldspars in the middle "Phase II" section while the deeper colluvial gravels of the sinkhole bottom await renewed borehole drilling for a more complete analysis of the sedimentation record. In addition, we dated a late Pleistocene paludal proxy site using luminescence, incorporated those results with previous radiocarbon dating, and tested bleaching rates on modern sediments in the Fall River. Our new OSL ages also show that the sediments of the MS were well bleached prior to deposition, were derived from pond margin runoff events, and deposited as sandy-silt laminae couplets. The OSL and U-series ages indicate that a 6 m thick section of bone-bearing sinkhole sediments accumulated at a rate of 13 mm/yr and span all of Marine Isotope Stage (MIS) 6 and MIS 7 but not MIS 2 and 3 as has been previously published.

Luminescence dating of large clast rock surfaces buried in glaciofluvial sediments of the southern Upper Rhine Graben

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Rock surface dating, a relatively new approach within luminescence dating, determines when a rock surface was last exposed to sunlight by measuring the amount of latent OSL signal accumulated after burial. However, the potential and applicability of rock surface dating in glaciofluvial settings of the Alps has seen very limited application so far (Rades et al., 2018). Therefore, different luminescence methods including rock surface dating have been applied in a unique setting at the Hartheim gravel pit in the southern Upper Rhine Graben to establish a chronological frame for distal glaciofluvial deposits.

First, a detailed field study was conducted in order to gather a comprehensive understanding of the different sediment types present. Fine grain sand, cobbles, pebbles and matrix sediments embedded within large clasts were collected and analyzed using a combination of OSL and IRSL dating. Conventional OSL dating of fine sand quartz is considered as robust age control compared to the other sediment types. A substantial amount of luminescence measurement has been done on the sand lens and gravel matrix sediment collected from Hartheim. OSL ages range around from ca. 19 ka to 32 ka for the different sediment types. Feldspar IRSL has been measured using a MET-pIRIR protocol to avoid problems with fading. Furthermore, a detailed dosimetry study was conducted to measure the varying levels of radionuclide concentration within materials of different grain size, in order to obtain accurate depositional ages. Overall, the purpose of this research contributes to our existing knowledge in the field of luminescence dating by showing the potential and versatility of different luminescence methods in different sediment types and environments that provide an ideal framework for future studies in similar contexts.

Keywords: Upper Rhine Graben, rock surface dating, age control, gravel matrix, luminescence

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Towards improving Luminescence Rock Surface Dating through imaging methods

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The development of luminescence Rock Surface burial Dating (RSbD) and Rock Surface exposure Dating (RSeD) carries considerable prospects for investigating the bleaching and burial history of archaeological artefacts (e.g. stone tools and flakes, megalith and housing structures) and geological rock surfaces (e.g. coarse-grained deposits from floods, mass movements or glaciers). However, we often observe a large scatter in the luminescence-depth profiles, both in the saturation regions and across the different cores drilled from the same rock. This scatter, as well as its causes, such as small-scale variation of rock opacity[1,2], dose rate heterogeneity, representativity of the sub-sampling) may induce uncertainties in the signal by depth model that can result in inaccurate or imprecise burial and/or exposure ages.

The recent developments in EMCCD camera systems and in IRSL/IRPL dating offer the possibility of spatially-resolved luminescence analysis, which in turn opens-up new vistas in studying rock luminescence processes. We investigated several ways to take advantage of spatially-resolved analysis in order to improve the accuracy and robustness of rock surface dating. Here we focus on:

- Examining the variability of luminescence and equivalent dose within and between samples in order to identify underlying causes.
- Exploring beta dose rate heterogeneity within the sample and its impact on the shape of luminescence-depth profiles and thus RSbD and RSeD accuracy.

We will discuss the advantages and prospect of spatially resolved RSD over the classical approach with the objective to improve the robustness of RSD.

Keywords: Rock surface dating, Imaging, IRPL, IRSL

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New Electron Spin Resonance, Luminescence and Aspartic Acid Racemization dating results for the Pleistocene sedimentary infill of Cueva Mayor (Atapuerca, N Spain)

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The Cueva Mayor karst system (Atapuerca, N Spain) contains a set of archaeo-palaeontological sites whose chronology ranges from the Middle Pleistocene to the Iron age. We present here new dating results for two localities, Galería de las Estatuas and Sala de los Cíclopes, which are examined through a combination of numerical dating methods applied to both the fossil assemblage and host sediment.

Galería de las Estatuas documents a stratigraphic sequence in which various Neanderthal occupation levels have been identified and has been previously dated to between 112 ka and 70 ka [1,2,3]. We processed two fossil teeth from the current excavation level of one pit (level 4, GE-I) for combined U-Series/ESR and Aspartic Acid Racemization (AAR) methods. The dating results position this archaeological level at the beginning of the Upper Pleistocene.

Sala de los Cíclopes contains a palaeontological assemblage formed exclusively of cave-bear bones, hibernation beds and footprints, belonging to the *Ursus deningeri* species. The estimated age of this deposit, known as Cata Litario, is > 200 ka, pre-dating the closing of the Sima del Elefante/Galería Baja palaeoentrance [4]. One tooth extracted from the Cata Litario pit is dated in the present study, both by U-series/ESR and AAR methods, while 4 sediment samples collected through the stratigraphic sequence are dated by extended-range luminescence techniques (single-grain TT-OSL and pIRIR). The dating results constrain this bear occupation to the mid-Middle Pleistocene.

Beyond the chronological implications of this work, such a combination of independent dating methods may also provide some key insights into the contemporaneity of the sedimentary matrix and the fossil remains. The systematic application of both ESR and AAR to the same fossil specimens enables the identification of any potential methodological biases.

Keywords: Electron Spin Resonance, Luminescence, Aspartic Acid Racemization, Pleistocene, Atapuerca.

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Testing the applicability of standardised growth curves (SGC) for single-grain pIRIR measurements of chemically heterogenous feldspars from the Atacama Desert, Chile.

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Single-grain luminescence dating has successfully been applied to infer sediment transport and mixing processes in various geological settings [e.g., 1]. However, in some regions, single-grain luminescence dating can be challenging and time consuming, particularly when only a small percentage of grains emits luminescence. In such cases many single-grain discs have to be measured before a sufficient number of grains has been obtained to calculate a robust palaeodose. It has been shown that establishing a standardised growth curve (SGC) for single-grain feldspar pIRIR measurements reduces the measurement time considerably [2] and that SGCs are suitable for feldspars with unfavourable luminescence properties and a complex mineralogy [3].

The Atacama Desert, generally considered the driest place on Earth, is an ideal study site exploring the transition of biotically to abiotically driven processes in the Earth's Critical Zone. However, a previous study on the applicability of luminescence dating on coarse grain feldspars from the Atacama Desert found highly variable K-contents (0.67 - 11.17 % K_2O) within each sample and below 1 % of the measured feldspar grains gave a pIRIR signal suitable for dating [4]. We aim at establishing a methodological framework for single-grain luminescence-based analysis of feldspar samples to investigate small scale geomorphological processes in the Atacama Desert.

Here we test the applicability of SGCs for single-grain pIRIR age determination of Atacama Desert feldspars. In addition to five samples from the Atacama Desert, we include chemically and structurally different feldspar sediment extracts from various geological origins to test the effect of the sample chemistry on SGC behaviour. By performing a dose recovery test ($pIRIR_{175}$) on all samples, we gained a test dataset for SGC calculations. To enable a comparison of individual dose response curve behaviour with sample chemistry we constrained the major element chemistry of each grain measured using energy-dispersive x-ray spectroscopy (0,08 – 16,08 % K_2O). We establish three SGCs, one for the entire dataset and either one for Atacama Desert and non-Atacama Desert samples. The SGC performance is tested by comparing the equivalent dose (D_e) estimates from the SGCs to the corresponding D_e estimates measured using grain-specific dose-response curves and by evaluating it against the sample's chemical composition.

Keywords (max. 5): feldspar, standardised growth curve, single-grain, pIRIR, potassium-content

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TL characteristics of calcite obtained from terrestrial and marine samples

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There is a desire to date the calcite mineral as part of terrestrial and marine deposits. Thermoluminescence (TL) of calcite shows an impressive growth with dose up to several hundred Gray and apparent signal stability, both being attractive prerequisites for dating "old" deposits. Advert characteristics such as spurious TL, supra-linear dose response, and the apparent need for a red-sensitive detection setup (not readily available in most laboratories) have, however, hampered broad application. Moreover, the role of $(CO_3)^{3-}$, $(CO_2)^{-}$ and Mn^{3+} ions in the recombination processes and the type of charge transfer mechanism to the centres remain subject of discussion (e.g., Medlin 1964; Calderon et al 1984; de Lima et al., 2001).

Here we study the calcite dosimeter derived from a terrestrial cave deposit and from marine foraminifera shells and compared our data with those from the well-characterised monocrystal calcite ("Iceland Spar") and from synthetic calcite. To characterise the calcite dosimeter, in particular with respect to the carbonate and manganese ions, we measured electron-paramagnetic resonance (EPR) spectra, TL emission spectra, in addition to testing natural and regenerated TL.

The TL emission spectra confirm earlier results: all TL peaks originate from one emission centre at ~620 nm which is related to the Mn^{2+} impurity. The EPR spectra of all samples show the $(CO_3)^{3-}$ ion interacting with the Mn^{2+} defects. Moreover, sample-dependent signals are noted where the EPR from foraminifera show the already described orthorhombic CO_2^{-} signal (Hoffmann et al., 2001) interacting with the SO^{2-} defect. The TL analysis reveals a wide range of trapping parameter values indicating that in some samples the high temperature TL peaks are affected by non-single-order kinetics.

Overall, our study confirms the suitability of calcite as a TL dosimeter. Future work will focus on TL measurement protocols which consider TL characteristics and sample-dependent recombination processes.

Keywords (max. 5): EPR, carbonate ions, recombination process, charge transfer

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Spectral characterization of the IRSL and TL emissions produced by xenolithic feldspars collected from the Chaîne des Puys, France

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Issues with anomalous fading in feldspar have long prevented the widespread application of luminescence dating techniques to volcanic feldspar. It has been postulated that the degree of ordering in the feldspar lattice is correlated to fading, with severe fading for disordered volcanic feldspar (sanidine) and little to no fading for ordered plutonic feldspar [1]. Thus, ordered feldspar from plutonic xenoliths may be a promising dosimeter for luminescence dating of volcanic deposits [2]. Thermal alteration of xenoliths while entrained in the magma, however, presents the possibility of changes to the lattice structure, and to the luminescence behavior.

To investigate this, spectral characterization of the TL and MET-pIRSL feldspar emissions was conducted on six xenoliths from the Chaîne des Puys volcanic province in the French Massif Central. These xenoliths were selected because they represent a range of thermal alteration from unaltered maar deposits to a highly altered foamy xenolith. Preliminary spectral characterization from 300 – 750 nm has identified previously known feldspar emission peaks at ~405 nm and ~560 nm, in addition to possible emissions from 450 – 500 nm. Bandpass filters have been used to selectively characterize the luminescence behavior of each of these emission bands. Observations presented here provide information about the thermal stability of these emissions, their relation to the extent of thermal alteration, and their potential for dating applications. We consider these results to have wider implications for the luminescence dating of volcanic products and our understanding of anomalous fading.

Keywords (max. 5): emission spectroscopy , MET-pIRSL, TL, feldspar, volcanic deposits

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Polymineral fine grains as the alternative to date sedimentary material from New Zealand

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Establishing robust chronologies to understand landscape evolution and tectonic activity in New Zealand have been the focus of a number of studies over the past years. The use of optically stimulated luminescence has often been hampered by the change in the sensitivity of the quartz grains during the measuring process. A set of ten samples from a sedimentary sequence which shows deformation caused by the activity of the Te Puninga fault, in New Zealand, have been the target of this study. Analysis of the tephra and peat layers within the sequence suggest that the latter should cover, at least, 25 ka of activity.

Coarse quartz grains extracted from the sediment shows a severe sensitity change between the natural OSL and the test dose derived-OSL used for normalization. Attempts to monitor and correct this change in sensitivity did not lead to plausible equivalent doses, which do not increase at increasing depth, as expected, but instead, they show a saturation around 4 Gy, equivalent to 1.5 ka. These poor luminescence properties of quartz from New Zealand was also observed by other authors [1] who related it to the young sedimentary history of the quartz grains and concluded that this material was unsuitable for use as a natural dosimeter for luminescence dating.

Coarse K-feldspar grains have a dim and unstable IR50 signal and no postIR-IR signal was detected at any temperature. limiting the use of coarse feldspar for dating also.

In contrast, the polymineral fine grain fraction showed a reproducible response. A very different response between the coarse and fine grain quartz fractions from New Zealand was reported by other authors [2]. Artificially given doses have been recovered succesfully using the postIR-IRSL225 signal. Estimated equivalent doses for the studied samples are within the plausible dose range. Residual doses around 2 Gy, not significant compared to the natural doses, were measured after 24h of artificial exposure to light in a solar simulator. The quality control of the postIR-IR225 response indicates that reliable ages could be estimated using this signal from the polymineral fine grain fraction.

Keywords (max. 5): quartz, sensitivity change, low dose OSL saturation, polymineral fine grains

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Precipitation changes over the last 30,000 years over La Plata basin based on quartz luminescence sensitivity

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Marine sediment cores are continuous and well-preserved natural archives useful for reconstructions of continental palaeoprecipitation regimes because they hold continental sediments transported by rivers to the oceans over time. Hints on variations of continental drainage systems due to variations in precipitation, for instance, are potentially recorded in marine sediment cores collected near the mouth of important rivers that reach the coast. Recently, a new tool for palaeoclimatic reconstructions based on quartz sensitivity luminescence has been proposed and successfully applied to marine sediment cores in South America [1, 2]. The new proxy premise is that the luminescence sensitivity of quartz grains can be associated to their source (parent rock) as well as to their sedimentary history, which are aspects and processes directly affected by climatic variations such as those in the precipitation regime.

Here, the quartz luminescence sensitivity proxy was employed to investigate two marine sediment cores collected near the mouth of the Paraná River (Brazil), which is an important river on La Plata basin. Sub-samples of polymineral sediments were collected at various depths of the cores, covering the last 30,000 years; then they were processed for quartz sensitivity measurements following standard procedures [1]. Both quartz optically stimulated luminescence (OSL) and thermoluminescence (TL) sensitivities were investigated. The luminescence proxy data were compared (i) to other palaeoprecipitation and palaeoceanography classic proxies (e.g., $\delta^{18}O$, Mg/Ca, Ti/Ca) available for the same study area and/or marine sediment cores, and (ii) to the precipitation data estimated running the IPCC-class climate model (TraCE-21 ka) to La Plata basin. There is a good agreement between the luminescence proxy and the climate model for the last 22,000 years, for the La Plata Basin. These findings confirm the potential of employing luminescence-based tools for paleoclimate studies and provide new information on precipitation variations in the Río de La Plata basin over the last 30,000 years.

Keywords: quartz sensitivity; climate change; palaeoprecipitation proxy; Paraná-Plata.

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The Python time machine – an open source software application for luminescence-based rock surface dating

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Luminescence dating of rock surfaces is an emerging and exciting branch of research in geochronology with great application potential [1-3]. Originally, luminescence dating has been developed to constrain the burial age of fine-grained (i.e. sand to silt sized) Quaternary sediments, and today plays a key role in the geological and archaeological sciences. In contrast, luminescence dating of rock surfaces still undergoes substantial methodological development and testing [e.g. 4-7], yet, the technique holds great promises to constrain the age of hitherto undatable geological and archaeological materials or geomorphological landscape elements. As such, luminescence-based rock surface dating (RSD) is highly complementary to OSL sediment burial and other Quaternary dating techniques.

RSD basically comes in two variants: rock surface burial dating (RSbD) and rock surface exposure dating (RSeD) and over the last decade has evolved into a highly active and promising geochronological research field. Meanwhile numerous ways of analyzing RSb and RSe luminescence data exist and different approaches to calculate rock surface ages have been introduced, yet no standardized way of handling RSb or RSe luminescence data has been put forward. Here we present an open-source software package that is based on the software language Python©. The program enables users to evaluate their rock surface luminescence data via a simple graphical user interface (GUI). The program allows processing of data which originate either from CCD or EMCCD images or from the conventional "drilling and slicing" approach and takes various types of OSL, IRSL and IRPL signals into account. We incorporated all currently available and stat-of-the art bleaching models into the software package and provide the user with maximum degree of flexibility for normalizing luminescence signals. In the case of RSeD a novel calibration procedure option is implemented, deemed to generate robust RSe ages [7]. Ultimately, the software allows single as well as multiple exposure and burial ages from rock surfaces to be derived.

Keywords (max. 5): rock-surface dating, EMCCD, imaging, software, Python,

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Major dune construction during the Younger Dryers period along the Kankakee River Valley, Midwest USA: optically stimulated luminescence dating and ground penetrating radar

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Sand dunes and sand sheets are located along the south side of Kankakee River Valley in Illinois and Indiana, which overlie glaciofluvial outwash, lake sediments, and bedrock of Middle Paleozoic shales and carbonates. Dunes are prominent feature of the landscape, and most dunes are 15 to 25 feet (~4-7m) high, and some reach 50 feet (15m). Due to the lack of natural exposure and roadcuts, three dunes were sampled by hand augering for OSL (optically stimulated luminescence) dating. Ground penetrating radar (GPR) surveys were conducted for a better understanding of the stratigraphy where exposures are not available. Results show that all three sites contain ages within the Younger Dryas chronozone (11.5-12.8 ka). More importantly, we found that at site 1 there are about 8 meters of eolian sand yielded 5 ages within the Younger Dryas. Although the large error bar of singular individual OSL age (about 6-9%, about 0.8-1.2 ka) usually does not allow for the determination of a specific climatic event, multiple ages from multiple sites of these dunes and striking thickness in this study all fall into the range of Younger Dryas chronozone. Thus, we believe that the rapid climatic changes before, during and after Younger Dryas play key roles in the dune construction here in the Kankakee River Valley. These changes of the ages are consistent with GPR image and lithology changes observed in the field

Keywords: Sand dune, OSL dating, ground penetrating radar, Younger Dryers, Midwest USA

Quartz standardized growth curve for optically stimulated luminescence dating: case study from Amazonian fluvial deposits, Brazil

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Reconstructing landscape changes in Amazonia during the late Quaternary requires dating of fluvial sedimentary units occupying large areas. This demands dating of a large number of sediment samples. The equivalent dose (D_e) estimation through the commonly employed single-aliquot regenerative-dose (SAR) protocol applied to quartz may take a long measurement time, especially for estimating higher D_e and/or when many aliquots (tens) are necessary to get reliable D_e statistics. The standardized growth curve (SGC) has been proposed as an alternative approach, which speeds up the D_e estimation, increases the number of measured aliquots per sample, reduces OSL dating costs and allows dating of a higher number of samples.

The SGC is a general dose response curve constructed with OSL signals from samples of presumed similar behavior, which dismisses the need of establishing specific dose response curves for each aliquot. OSL signals (L) corrected by the test dose signal (T) and multiplied by the test dose (D_t) ($L/T \times D_t$) are used for constructing the SGC.

Here, we use a SGC built for quartz OSL in order to determine the D_e of sediment samples from terraces and floodplains of the Juruá River, western Amazonia. The Juruá River has a sub-Andean sediment source and is a large tributary of the right margin of the Solimões River, which becomes the Amazon River in central Amazonia. The Upper Juruá River drains Miocene rocks (shales and sandstones) uplifted by the Fitzcarrald Arch on the southern border of Peru and Brazil. In the mid-reach, its meandering channel flows over Quaternary sediments until it meets Solimões River, where the sequence of fluvial terraces analyzed here is placed. Determining the depositional ages of Juruá River deposits is crucial in order to understand how the fluvial systems on western Amazonia evolved through time and to assess which mechanisms (e.g. climate, tectonics, etc.) played the major role in the process.

Firstly, we present a SGC constructed using quartz OSL signals from previously dated samples (D_e range about 20 mGy to 60 Gy) from Amazonian rivers with similar sediment sources. This SGC includes the initial measurements data from SAR protocol of three Juruá River quartz samples. Then, D_e values from 17 Juruá quartz samples are estimated by using the SGC approach and by the SAR protocol. The SGC is validated by comparing its estimated D_e against the respective D_e obtained by the SAR protocol. Finally, OSL ages are determined to discuss the formation time of the Juruá River terraces.

Keywords: standardized growth curve, OSL, dating, quartz, Amazon

Signal component analysis of IR-RF decay curves of K-feldspars

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Infrared-radiofluorescence (IR-RF) dating of K-feldspars has the potential to increase our knowledge about sedimentation processes through its extended age range and low liability to anomalous fading compared to traditional luminescence dating methods [1]. However, the composition and the underlying physics of the IR-RF signal are still only partly understood. Improving our knowledge about the IR-RF signal behavior may help to find a robust theory regarding IR-RF of K-feldspar and to further improve IR-RF measurement and analysis protocols.

To contribute to this goal, we used the statisti0cal programming language R and the R packages 'OSLdecomposition' [2] and 'Luminescence' [3] to deconvolute the signals of a variety of IR-RF measurements from different workgroups and different sample origins. Preliminary results of four samples show that the IR-RF signal decay for natural dose samples can be described sufficiently as a superposition of just two exponentially decaying signals. This could indicate two independent radioluminescence mechanisms, both with first-order kinetics. Interestingly, the 'half-dose' (e.g. the point of accumulated dose where half of the components fluorescence photons were already emitted) for both IR-RF components is sample dependent.

However, unlike natural dose IR-RF signal curves, regenerated dose IR-RF curves after laboratory bleaching cannot be described sufficiently with double-exponential decay models and more complex models are necessary. In our preliminary results, the only exception where the signal complexity is not increased after bleaching, are those measurement taken with an 880/10 nm band pass filter instead of the 850/40 nm filters, usually used in Lexsyg luminescence readers. However, we have yet to determine whether this filter dependence is a coincidence or a true effect.

In our contribution, we will present further results and discuss the implications of our findings.

Keywords: IR-RF, K-feldspar, deconvolution, decomposition, radioluminescence

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Cross-checking the results of radiocarbon dating and optically stimulated luminescence as a tool for the stratigraphic model of fluvio-aeolian succession in the central part of the European Sand Belt

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Short-term climate oscillations known form the Last Glacial Termination (LGT) have been firstly recognized in the Greenland ice cores as well as in the deep-marine and lacustrine profiles. Such climate changes have also been marked in terrestrial depositional environments, particularly in the fluvio-aeolian succession of the European Sand Belt (ESB). This is due to the high sensitivity of this depositional environment to changes in environmental conditions. However, unlike, for example, annually laminated lake sediments, dating the chronology of these changes encounters great difficulty. These are due to the peculiarities of sedimentary processes (especially aeolian), punctuated by periods of stabilization and development of soil covers.

Comparison of previously accepted stratigraphic models of fluvio-aeolian succession with recent research results indicated the need for a new approach to the question of the chronology and rank of these processes. Therefore, a large-scale research project in the central part of the ESB was launched in 2019 to determine the chronology of sedimentary and soil processes and how they relate to global climate change during the LGT. To this end, detailed sedimentological, paleobiological, soil and geochemical studies have been carried out in more than 50 dune profiles. More than 300 luminescence and about 70 ^{14}C results have been madefor the studied sedimentary successions.

The results obtained so far indicate that the response of depositional environments and their evolution creates a more complicated pattern than previously assumed. First of all, the beginning of intensive aeolian deposition as early as the turn of the oldest Dryas and Bølling and 2 distinct phases of dune formation during the warming of the Allerød interstadial are marked. More variability in aeolian accumulation and soil-forming processes is recorded in the Younger Dryas. All this is compounded by several local factors (permafrost disappearance, river incision, bedrock lithology) that modified the response of the fluvio-aeolian environment to climatic oscillations.

The use of sufficiently dense sampling for OSL and radiocarbon dating made it possible to develop a new stratigraphic model, despite date inversions appearing in some profiles. This confirms the advantage of using both dating methods in the same profiles to cross-check them and eliminate reliably questionable results from further stratigraphic considerations.

Keywords: climate oscillations, chronostratigraphy, aeolian deposits, palaeosols

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Luminescence dating of Pleistocene pro-glacial deposits from northern Switzerland

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During the Mid- and Late- Pleistocene, the foreland of northern Switzerland has been exposed to repeated advances of Alpine glaciers. While those glacial advances had a lasting impression onto the evolution of the landscape, quantity, extent and especially timing is still lacking constraint. This is mainly due to a limited source of suitable dating techniques (beyond the radiocarbon dating limit) and a suspected upper age limit of quartz OSL ages at about 200 ka.

Additionally, transportation mode and duration of pro-glacial sediments may only allow for a partial resetting of the different luminescence signals. This can lead to the overestimation of equivalent doses (D_e) and hence ages when using an averaged luminescence signal. Averaged signals are obtained by multi-grain/aliquot measurements and often used of age determination, which are generally linked to instrumental limitations or low signal sensitivities. Nevertheless, this poses the risk for distortion of the finite equivalent doses and requires consideration.

To assess the degree of partial resetting and to circumvent the averaging of signals, single grain and small aliquot D_e values of conventional quartz as well as IR_{50} and pIR_{225} feldspar measurements were obtained from coarse-grained quartz and feldspar extracts of pro-glacial deposits from the Swiss northern Alpine foreland. Results are presented and D_e distribution challenges as well as implications for the glacial history of the region are discussed.

Keywords (max. 5): feldspar, quartz, single aliquot, single grain, pro-glacial archives

A chronology for Holocene sedimentation and landscape dynamics in South-East Central Asia

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The continental climate of Central Asia has led to the formation of large deserts and wide areas of loess accumulation. Regional Holocene events associated with landscape and climate evolution are clearly recorded in these sediments. Unfortunately, we know very little about either the stages and features of Holocene subaerial sedimentation or the influence of climate dynamics on the evolution of relief, soils, or flora and fauna. In the southwest of the region, within the loess plains and foothills of the Pamir Mountains, the development of soil cover in the Holocene occurred during the sub-aerial accumulation of considerable thicknesses of dust. In some areas, up to 3 distinct horizons of Holocene soil formation are preserved [1].

To improve our understanding of the Holocene climate and landscape evolution history in Central Asia, we are examining recent soils in Tajikistan. This study forms part of the THOCA project ("Timing and Ecology of the Human Occupation in Central Asia"). We have described 5 Holocene soil profiles located at different hypsometric levels along a temperature and precipitation transect (gradient) from the dry and hot conditions of the southwestern part of Tajikistan to the more humid and mild foothill regions of the northeast. A series of samples for luminescence dating was collected from each profile. To investigate further the degree of bleaching of quartz and feldspar signals at deposition, we also collected a sample of modern sediment accumulated during a dust storm. From each of 18 samples, sand-sized grains of quartz and K-rich feldspar were extracted for measurement of the OSL and IRSL signals; standard OSL and pIRIR protocols were used to measure equivalent dose.

The dating results show a high accumulation rate during the first half of the Holocene, and for two well-developed soil horizons we identify three Holocene warm events. Our continuing studies of these profiles will be used to identify trends in climate, soil and landscape evolution within the temperature and humidity gradient of southern Central Asia, for use in THOCA's Quaternary palaeoclimate reconstruction.

Keywords: Modern soils, Holocene, Tajikistan, Altitudinal zonality, Pamir Mountains

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Luminescence chronology of neotectonic activity on foothills of the Assam- Bhutan Himalayas: An Insight into Climate- Tectonic Relationship

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Landscape at active mountain fronts such as the Himalayas results from climate and/or tectonic interactions. Thus, they are important geomorphic archives that preserve information about such changes/activities in the past. These are a combination of crustal movement and erosion or deposition by surface processes. The Main Frontal Thrust (MFT), which marks the southern end of the Himalayas, has been considered the most active fault in the past. Thus, the landscape in the foothills preserves the signature of deformation events and, at the same time, also records changes in the monsoonal rainfall, controlled by glacial and interglacial events. The present study attempts to understand the evolution of alluvial fan deposits in the Assam- Bhutan Himalayan foothills of the Kokrajhar district of North-East India. The study mainly focuses on the uplifted 30 km long fluvial deposition from the Pinkhua Khola River in the west and Leu Pani in the east. The study is critical because it will help understand the southward propagation of the Himalayan fold and thrust belt. The initiation of the faulting events is marked by the clay layers, which were dated using OSL; the dating of clay layers from the hanging wall of three blocks suggests that the FTB was activated at ~76 ka and experienced three other phases of deformation at ~45 ka, ~27 ka and 12 ka, respectively.

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The luminescence dating potential of pebbles from pluvial lake beach deposits: Preliminary results from the Great Basin, USA

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Pluvial lake sediments are frequently luminescence dated using fine sand. Pebbles and cobbles, however, are much less susceptible to post-depositional reworking by wind, pedogenic processes and bioturbation, and thus have the potential to yield more accurate luminescence chronologies for pluvial lake highstands in the Great Basin. This presentation will provide an update on investigations into the dating potential of pebbles from pluvial lake beach ridges in Lincoln County, Nevada. By developing a luminescence protocol to date beach pebbles, we hope to improve upon previous age estimates from sand that severely underestimate the age of the ~16 ka pluvial Lake Coal highstand. In Coal Valley and neighboring valleys, the dominant pebble lithologies sampled include limestone and andesite. Each lithology presents a unique set of challenges regarding sample preparation and measurement; these will be discussed along with preliminary findings as well as proposed future avenues of research.

Keywords (max. 5): rock surface dating, pluvial lakes, Great Basin, limestone, volcanic

Transgressive-regressive cycles in the Yangtze River Delta since the penultimate glaciation

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The coastal zone is a densely populated area with faster rates of economic growth, which plays an extremely important role in promoting national economic development. Under the background of global warming, the rise of sea level and increasing intensification of human activities are becoming a serious threat to human welfare in the coastal zone with a relatively fragile ecological environment. The study of transgressive sequence during glacial-interglacial cycles can improve our understanding of sea-level rise and variability under present and future continuing global warming. However, due to the limitation of early experimental condition and dating technique, the occurrence time of transgressions mostly lacks absolute age constraints since the late Middle Pleistocene in the eastern coastal region of China. As a result, there is still debate about the degree of occurring at different climatic periods, which limits the understanding of the formation and evolution mechanism of transgressive strata.

In this study, a core (JH, 125 m thick) from the south wing of the Yangtze River Delta was investigated, which formed since the late Middle Pleistocene. Twelve samples were collected. Single-aliquot and single-grain optically stimulated luminescence (OSL) dating techniques have been carried out in determining quartz and feldspar samples with different grain size fractions (45–63 μm, 90–125 μm, 125–180 μm, 180–250 μm). Preliminary dating results show that the same sample with different grain size fractions or different samples with the same grain size fractions have different characteristics of the quartz or feldspar OSL signals, also showing significant age differences. The data is under further testing and analysis. The current results indicate that the upper 22 m of the core are Holocene deposits, and the lower part to 125 m is late Middle Pleistocene (~200 ka) deposits. Meanwhile, combining chronology with geochemistry, environmental magnetic and stratigraphy will be used to reveal evolutionary history of transgressive-regressive sequences, as well as on how to respond to global sea-level changes and paleotopographic variations in the southern wing of the Yangtze River Delta.

Keywords: Optically stimulated luminescence (OSL); Chronology; Yangtze River Delta; MIS6; Climate change

Exploring TL signal saturation in quartz and feldspar using emission spectrometry

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Thermoluminescence palaeothermometry uses signals appearing at ~180–250 °C in the glow curve, which are sensitive to temperature fluctuations occurring at Earth's surface over geological timescales. To infer the temperature history of a rock sample, the relative trap saturation of specific signals is determined along with their kinetic parameters [1]. Since laboratory results are thus extrapolated to geological time, slight inaccuracies may have large effects on the temperature reconstruction. As a result, further investigations are required to constrain the physical parameters describing TL growth and decay more accurately in response to irradiation and ambient temperature (fluctuations). Tackling this issue is central for TL palaeothermometry, and it is also relevant for luminescence dating, i.e., the definition of a signal saturation level.

We choose to study TL spectra as a function of dose to capture a maximum of information: Emission peaks at a particular temperature indicate traps from which electrons are released upon heating, whilst the spectral emission bands provide information on the recombination sites. 3-D TL spectra therefore enable defects in crystals relevant for radiation dosimetry and luminescence dating to be studied [2]. Specifically, it has been reported that the TL emission spectrum of quartz changes in its relative composition with irradiation and heating [3,4], potentially rendering it challenging to identify an unambiguous saturation level.

Here we report the effects of sample treatment (irradiation and heating) on TL emission spectra of quartz and feldspar from bedrock and sediment samples from different provenances. Preliminary results show that TL peaks of quartz samples irradiated in the laboratory are observed at around 110, 150, 200 and 325 °C when TL is measured up to 350 °C with a heating rate of 1 °C/s. For the 110 and 200 °C peaks analysed here, the position of the two main emission bands is sample dependent but is mainly centered around 485 nm (2.5 eV; blue) and 625 nm (1.9 eV; red). No shift of the emission energy was observed for all the studied samples with increasing dose up to 16 kGy, while a significant increase in the emission peak full width at half maximum was detected. For both the blue (2.5 eV) and red emission (1.9 eV), the signal increases with dose up to about to 16 kGy, and then decreases with higher doses. Further spectra will be measured by adding more dose points and using feldspar samples. The discussion will focus on the possibility of identifying a well-defined signal saturation level and the choice of filters or the photomultiplier tube for best isolating a specific luminescence signal for palaeothermometry.

Keywords: Bedrocks, Spectra, Dose response, Irradiation, Heating,

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Optimization of the electron transport layer in quantum dots light emitting diodes by co-doping ZnO with gallium and magnesium

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To optimize the electron-hole balance by controlling the electron transport layer in (ETL) in quantum dots light emitting diodes (Q-LEDs), ZnO was modified by doping with Mg and Ga and applied to commercial Q-LEDs as ETLs. By doping ZnO nanoparticles with Ga, the electrons easily inject due to the increased Fermi level of the ZnO nanoparticles. By co-doping with Mg, the valence band maximum of the ZnO nanoparticles deepens and blocks the holes more efficiently. Also at the interface of the QD/ETL, Mg reduces non-radiative recombination by reducing oxygen vacancies on the surface of the ZnO nanoparticles. As a result the maximum luminance and the maximum luminance efficiency of the Q-LEDs increased to 43 440 cd m^{-2} and 15.4 cd A^{-1} respectively. These results increased by 34%, 10%, and 27% for the maximum luminance and 450%, 88%, and 208% for maximum luminance efficiency with undoped ZnO and Mg or Ga single doped ZnO ETL. The effect of Mg and Ga co-doping on the maximum luminance and maximum luminescence efficiency will be discussed.

Keywords (max. 5): Quantum dots light emitting diodes, Zinc Oxide nanoparticles, Luminance efficiency

Thermal stabilities and sensitivities to dose of the low and high temperature components of ESR signals in quartz

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Electron spin resonance (ESR) dating of quartz has been applied to fault gouges, volcanic ashes and fluvial sediments being expected to be able to date samples older than the luminescence method does due to the high saturation dose. However, the ESR dating of quartz has still several problems. One of them is that, sometimes incorrected equivalent doses are obtained for older tephra samples [1], the characteristic of unbleachable Al center is not well understood [2], there are no clear evidence for whether or not preheating is necessary. The thermal stability may be related to them, however it is different from sample to sample [3, 4, 5, 6], and systematically investigations have not been done.

We have investigated the thermal stability of quartz from different origins under several conditions, such as irradiation, annealing and bleaching. The results indicate that there are two components below and above 280°C both in Al and Ti-Li center with different thermal stabilities and saturation doses. We found that the unbleachable signal of the Al center is thermally more stable than the bleachable component, that the kinetics of signal decay is compatible with mixed first and second order reaction, and that the signal lifetime of the low temperature component is shorter than previously believed.

In addition, we also found that high gamma ray dose modifies the thermal characteristics of the signals in tephra, i.e, predose effect. It enhances the sensitivity of both low temperature and high temperature components of the Al center but it reduces for Ti center. The measurement protocols should be considered depending on the samples.

Keywords: ESR, quartz, thermal stability, pre-dose

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Approaching Last Glacial Maximum to Holocene continental surface air temperature reconstruction using thermoluminescence paleothermometry

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Thermoluminescence (TL) paleothermometry enables direct determination of past rock surface temperatures. For this, it exploits the dependence of electron de-trapping on ambient temperatures over geological timescales. It focuses on trapping energies connected to shorter lifetimes and lower-temperature signals (i.e. TL signals in the ~180–250 °C range of quartz and feldspar) that are typically disregarded during dating applications. The use of feldspar is particularly promising due to the continuous distribution of trapping energies and thus paleothermometers. Recent methodological advances [1] have made it feasible to explore the possibility of worldwide continental rock surface temperature reconstruction. This allows for headway to be made in closing the knowledge gap of continental air temperatures during the Last Glacial Maximum (LGM) and Pleistocene-Holocene transition.

Our ultimate objective is to test the applicability of TL paleothermometry by studying sites from Scandinavia to equatorial east Africa, aiming to provide LGM to Holocene surface temperature fluctuations for a meridional gradient of approximately 7000 km length. In addition, we have recently sampled two altitudinal gradients for the Mont Blanc Massif (France) and Rwenzori Mountains (Uganda) to constrain changes in the atmospheric lapse rate since the LGM. Such data are critical in testing climate models and inferring the dynamics in atmospheric circulation across glacial-interglacial cycles.

This contribution presents the methodology and associated analytical steps of TL paleothermometry by relaying first results of kinetic parameter determination and dose response characterisation for samples from the Mont Blanc Massif. In addition, we address one of the main methodological challenges of the TL paleothermometry method: the inherent temperature offset between the reconstructed rock surface temperatures and respective past surface air temperatures. To overcome this challenge, reliable offset correction related to site-specific factors such as aspect, elevation and potential incoming solar irradiation is required. We thus conclude our contribution with discussing the potential of the method and future methodological work (e.g., temperature offset correction and definition of saturation levels for various quartz and feldspar signals) required to establish the TL paleothermometry method.

Keywords (max. 5): temperature sensing, thermoluminescence, paleothermometry, thermochronology, feldspar

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Reconstructing the thermal structure of shallow crust using OSL-thermometry of K-feldspar from deep borehole core: case studies in the Japanese Islands

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Optically stimulated luminescence (OSL)-thermochronometry has been developed as an ultra-low-temperature thermochronometer (<100 °C) [1–2]. Previous studies have mainly focused on tectonically active mountain areas because luminescence signals in slowly denuded regions saturate before the rocks are exhumated to the surface [2]. On the other hand, Guralnik et al. (2015) [3] validated OSL-thermochronometry using Na-feldspar infrared stimulated luminescence (IRSL) signals at 50 °C (IR_{50}) along the German Continental Deep Drilling Program (KTB) borehole and reconstructed palaeotemperatures successfully from saturated IRSL signals (1.1-2.3 km depth, corresponding to ~40–75 °C). This suggests that OSL-thermochronometry can provide recent information on the thermal structure of the sub-surface. However, Guralnik et al. (2015) used Na-feldspar because K-feldspar, which is more widely used than Nafeldspar for OSL measurements, is sparse in the KTB borehole. In addition, Guralnik et al. (2015) was the only study that applied OSL-thermochronometry to a well-documented thermally stable region. We applied multi-OSL-thermochronometry [4–5] to K-feldspars from borehole core samples drilled at the Tono (MIZ-1) [6] and Rokko regions (Kabutoyama), which are well-documented thermally stable regions (exhumation rates of ~0.1 mm/yr and 0.1–1.0 mm/yr, respectively).

For the K-feldspar obtained from the MIZ-1 core, the IR_{50}, IR_{100}, IR_{150} and IR_{225} signals were measured. The fading corrected ages of the IR_{50} signals decrease with depth at 1027–1265 m, corresponding to 39.2–43.8 °C, showing the partial retention zone. When a combination of four isothermal holding temperatures between 190 and 250 °C was used for thermal kinetic parameter derivation, the inverted temperatures for the IR_{50} signals of the samples at a depth of ~1 km (~40 °C) were most consistent with the in-situ temperatures. However, the inverted temperatures for IR_{100}, IR_{150} and IR_{225} signals were inconsistent with the insitu temperatures. This may be because IRSL measured at >100 °C are more thermally stable than at 50 °C and ambient temperatures are too low to reconstruct palaeotemperatures. From the results, OSL-thermometry of K-feldspar in a borehole using IR_{50} signals is useful to reconstruct the thermal structure over ~40 °C when adopting appropriate thermal kinetic parameters. The IR_{100}, IR_{150} and IR_{225} signals from K-feldspar may be sensitive at higher temperatures (>40 °C). In this presentation, we will also show the results of the Kabutoyama core to draw more comprehensive conclusions.

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Keywords: multi-OSL-thermometry, K-feldspar, borehole core, Toki granite

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OSL sensitivity of quartz as a provenance analysis tool: perspectives from the northern Andes uplift

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Provenance analysis allows for the detection of erosional windows in orogens by tracing sediment populations in their adjacent basins, providing useful information to track orogenic uplift and exhumation. A notable example of this can be found in the northern Andes, where rock uplift formed the current Amazon basin headwaters. In recent years, the luminescence of quartz has emerged as a potential tool for provenance analysis and sediment discrimination, specifically optically stimulated luminescence (OSL) and thermoluminescence (TL) sensitivities. The OSL (fast component) and TL (110°C peak) sensitivities are usually low in quartz crystals from igneous and metamorphic rocks but can vary, according to previous observations, within five orders of magnitude in Quaternary sediments [1]. This indicates that quartz sensitization occurs at some point between the source and the sink, and laboratory experiments show that sensitization is produced by irradiation-bleaching cycles, which could be driven by surface processes such as wildfires, sediment transport, and soil reworking [2]. Thus, surface processes would link OSL sensitivity with source area denudation rates and sedimentary recycling [3].

Luminescence sensitivity has been effectively utilized to discriminate sediments and for provenance analysis in modern deposits, but it has only been sparingly tested in ancient deposits. In this study, we measured the OSL and TL sensitivities in both polymineral and pure quartz sand grains of a ~10 km-thick exhumed crustal section of the Northern Andes in the Colombian Eastern Cordillera and one of its adjacent basins. The studied section encompasses rocks and sediments from the entire Phanerozoic eon and has a well-established provenance history of the orogeny based on thermochronometry, detrital geochronology, and petrography data, allowing for direct source-to-sink analysis. This is well suited to provide a proof-of-concept for the applicability of quartz luminescence sensitivity as a sediment discrimination and provenance tool in active orogens. Additionally, we aim to track changes in source area denudation rates and sedimentary recycling by measuring OSL and TL sensitivity changes throughout the entire crustal section and correlating them with other available proxies

Keywords (max. 5): Luminescence sensitivity, Source to Sink, Provenance, Northern Andes, Quartz

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Late Quaternary stratigraphic reconstruction based on OSL and radiocarbon dating of core sediments in the North Yellow Sea

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The North Yellow Sea (NYS) is a shallow, semi-enclosed sea situated on a low-gradient shelf bordered by China and Korean Peninsula, featured by strong land-sea interaction and sedimentary environment changes with sea-level fluctuations during the Late Quaternary. Previous studies on sedimentation and environments in Holocene have been carried out widely, while the work on the chronological stratigraphy and transgression-regression processes in response to interglacial-glacial cycles in NYS are sparse, due to the shortage of available high-resolution age dating [1, 2, 3].

This study presents new data on geochronology and lithology of a 70.6 m-long borehole obtained from the NYS, and we aim to reconstruct the depositional stratigaphy during the last glacial-interglacial cyle. Fifteen Optical Stimulation Luminescence (OSL) and seventeen ^{14}C ages are synthetically analyzed, providing robust constraints on the chronostratigraphy since MIS 5. Two transgression beds previously assigned to MIS 1 and MIS 3 are suggested to develop in MIS 1 and MIS 5 based on the high-resolution age dating respectively, which allows a new understanding of the late Quaternary sedimentary evolution in NYS.

Keywords: OSL dating, radiocarbon dating, chronostratigraphy, the North Yellow Sea

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What is the true age? Complicated transport history revealed by luminescence dating of multiple buried cobbles

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A significant advantage of rock surface luminescence dating for determining the burial age of cobbles is that well-bleached samples can be identified according to the variation in calculated luminescence age with depth. A plateau in the luminescence age-depth profile extending from the outer surface into the cobble that also gives a lower value than is seen closer towards the interior of the cobble is conclusive evidence of sufficient daylight exposure. The age of this sub-surface plateau represents the time elapsed since the cobble was last exposed to daylight, prior to burial. But there is speculation regarding whether this age of last exposure represents the true age of the formation of the features / landforms of interest for dating.

Over 300 cobbles were investigated in this study, originating from different glacial valleys in Tibet. Samples were taken from a range of depositional settings, including different types of moraines and from glaciofluvial sediments. Independent age control and expected ages were provided by cosmogenic nuclide exposure dating and by collection of modern samples. The Ln/Tn signal or equivalent dose were determined using post-IR IRSL protocols. The diverse shapes of luminescence-depth profiles indicate various bleaching / transport histories for different cobbles. Those considered as well-bleached samples could be found from all sampling sites. However, different sites show different proportions of well-bleached cobbles. We found that some cobbles show sub-surface plateaus that were lower than the values toward the centre of the cobble, but the sub-surface ages are apparently older than the independent or expected ages. One explanation of this is that those cobbles were exposed to sufficient daylight in the past to be well-bleached, but not at the time immediately prior to their last deposition which formed the feature or landform sampled for dating, but instead during a previous event since which time they had not been re-exposed to daylight. This means that the age determined for a feature could be overestimated even though a luminescence-depth profile with a low sub-surface dose plateau was obtained from a cobble indicating that the cobble was well-bleached. Unlike traditional luminescence dating of sediment grains, there are practical and logistical reasons why it is unrealistic, if not impossible, to routinely measure a large number of cobbles from every single site and apply statistical models to extract the true age for the feature of interest for dating. The data show us how confident we are in obtaining the true age for a feature or landform when applying luminescence dating on buried cobbles. Recommendations are provided regarding applying rock surface luminescence dating in environments where conditions mean that not all cobbles will have had any previous luminescence signals (including records of previous bleaching events) removed prior to formation of a feature that is subsequently sampled for dating. In such environments, different levels of low sub-surface age plateau recorded in different cobbles from the same feature demonstrate the potential of tracking the pre-depositional history of these sediments by dating multiple cobbles.

Keywords: Rock luminescence burial dating, luminescence-depth profile, heterogeneous bleaching, glacial environments, Tibetan Plateau

Towards the determination of an absolute chronology by rock surface and sediment OSL dating of the pre-ceramic Tumshukaiko monumental site in the north-central Andes of Perù.

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Tumshukayko is a pre-ceramic, monumental site located in the north-central Andes of Perù (Caraz, Ancash), dating back, approximately, to the 3500 B.C., with a long occupation that arrives to the present days. The complex includes a principal mound (Tumshukayko A) and some dispersed sectors in the nearby areas. Fieldworks at Tumshukayko started in 2021 with a topographic campaign, during which we collected one terrain sample for the OSL (Optically Stimulated Luminescence, [1]) dating analysis in an open gallery located in the south sector of the principal mound. In 2022, we excavated seven test pits in order to understand the morphology of the site, its chronology and construction sequence; all of the tests were sampled from the principal mound, with the exception of one test pit which was located in an ancillary mound south of Tumshukayko A, called Tumshukayko B. In this case both terrains and rocks were collected.

The aim of the present work is to reconstruct the absolute chronology of the monumental site by determining the burial age of i) sediments and ii) rocks. For the sediments the multigrain sand-sized quartz dating was used, whereas for the rock surface dating [2] both fine-grain and coarse- grain techniques were applied. The SAR (Single Aliquot regenerative, [3]) protocol was used to determine the Equivalent Dose. For the rock surface dating the luminescence profiles from the surface of the rocks to ~1cm depth were investigated to understand if there were a single or multiple burial event. The ages obtained on the terrains were compared with the ones derived from the rocks' surface. The results of the dating analyses were statistically matched to reconstruct the building phases of the monumental site.

Keywords: OSL, surface dating, sediments, rocks

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Extended range dating: how to choose the right signal?

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In the past years much research has gone into developing luminescence methods that can reliably date samples older than what is possible with quartz OSL, into the Middle and Early Pleistocene. Quartz OSL is limited by signal saturation in the range of 100-200 Gy. The benefits of later signal saturation of the extended range dating (ERD) signals are often hindered by slow bleaching in nature or by thermal instability, rendering these signals less useful in some sedimentological settings. Selecting the appropriate mineral and signal depends on the expected age, available minerals, their signal intensity and depositional environments.

We explored the most commonly used extended range dating signals in fluvial and aeolian sediments from Israel. In aeolian sediments, prehistoric sites and sequences of paleosols provided rough age constrains, and in fluvial sediments – terrace staircases with age estimates based on elevation above current channel and reg soil maturity.

The thermally transferred OSL (TT-OSL) signal of quartz, the post IR-IR signal at elevated temperatures (250°C or 290°C) of alkali feldspar, and violet-stimulated luminescence (VSL) on quartz were compared one to another in different depositional setting, allowing insights and conclusions about their suitability. We also tested these signals on late Holocene samples that appear to have been well bleached at the time of deposition, as attested by the small errors on the OSL ages, to estimate the residuals of the ERD signals under common depositional conditions.

For coastal sands and fossilized sand sheets and dunes, the alkali feldspar pIR-IR_{250} signal provides ages that are about 30% lower than the pIR-IR_{290} ages. Correcting to fading does not bring the two sets of ages in line. However, there is a very good agreement between the quartz TT-OSL and pIR-IR_{290} ages, supporting their reliability. With low dose rates, ages of up to 1 Ma can be achieved with both signals. As for fluvial sediments, comparison of the OSL ages with the pIR-IR_{250} ages shows that, within the reliable range for quartz OSL, pIR-IR_{250} provides useful if somewhat older ages, most likely due to slower bleaching. On the other hand, the TT-OSL ages are as much as 200 ka older than the OSL ages, attesting to the poor bleachability of that signal in fluvial environments. The VSL signal proved to saturate as early as the OSL signal, and at least for the studied samples, is not suitable for ERD.

In late Holocene fluvial samples, the TT-OSL signal overestimates the OSL ages by tens of thousands of years, however in aeolian settings the pIR-IR ages are in fairly good agreement with the OSL ages. Thus, it is advisable to test different ERD signals in modern sediment samples before choosing the most appropriate signal.

Keywords (max. 5): Extended-range-dating, TT-OSL, pIR-IR

Study of Holocene Soil Erosion on Agricultural Loess Slope using luminescence in conjunction with fallout radioisotopes ^{137}Cs and ^{210}Pbex

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Soil erosion and associated sediment accumulation could be a serious problem, especially in agricultural loess areas. Polish loess areas have been used for agriculture since the beginning of the Neolithic era and are particularly vulnerable to soil erosion that began during that period due to deforestation for agricultural purposes. Mechanical denudation increased in the Middle Ages and was intensive for a period of up to 200 years.

The main problem in interpreting the effects of agricultural use on the environment is the precise determination of the age of the sediments corresponding to the phases of increased anthropogenic soil erosion. The answer to the question of the intensity of soil erosion and land use change during periods of prehistoric and historic settlements is a key environmental problem in the archaeology and paleogeography of the Holocene.

In this work, to study soil erosion and accumulation and to determine the age of colluvial sediments and the rate of soil erosion, we have used optically stimulated luminescence (OSL) in conjunction with fallout radionuclides ^{137}Cs and $^{210}Pb_{ex}$ which are often used to study soil erosion. Their use overcomes many of the limitations associated with traditional methods.

We present a study of the intensity of soil erosion and sediment accumulation during the last 100 years. For this purpose, 30 field soil cores were collected from an agricultural field. This was supplemented by 10 soil cores from undisturbed sites to obtain reference values of the radionuclide fallout. In addition to these soil cores, three soil cores from the top, middle, and base of the soil were collected for OSL dating. In addition, five sediment traps were located on the slope to collect moving sediments and investigate the fractionation of fallout radionuclides, as well as residual luminescence. For detailed sediment characterisation, detailed soil physicochemical properties, i.e., pH, OM, N-tot, Fedith, Feox, and grain size, were studied.

The results obtained from the isotope and luminescence analysis confirmed that the soil cover in this area has strongly eroded. The intensity of modern soil erosion is high and clearly increased after World War II. This is probably related to the establishment of a state-owned farm in this area. It is also visible that the OSL ages of the mobilised sediments are almost independent of the distance travelled on the slope. Almost all previous luminescence signals from sediment samples are bleached before the quartz grains start to be transported down the slope and are bleached again before burial at the deposition site.

Keywords: sediment dating, Holocene soil erosion, loess, fallout radionuclides, OSL

Finding Quaternary Seismogenic Activity via Trapped Charge Dating Methods on Fault Gouges: A Case Study of the Periadriatic Fault System

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Trapped charges in minerals can be released either during periods of increased temperature due to shear heating or breaking of atomic bonds due to frictional wear. Therefore, electron spin resonance (ESR) and optically stimulated luminescence (OSL) dating of fault gouges potentially allow finding the timing of seismotectonic deformation in fault zones at near-surface conditions. Since the saturation dose of the quartz ESR signals is larger than quartz and feldspar OSL, ESR enables establishing a maximum age of the events (assuming the resetting at the events was at least partial), while OSL would allow finding their minimum age when the signal is in saturation.

The Periadriatic Fault System (PAF) is among the largest and most important post-collisional structures of the Alps. Recent GNSS data suggest that Adria-Europe convergence is still partially being accommodated in the Eastern Alps. However, according to instrumental and historical seismicity records, seismotectonic deformation is mostly concentrated in the adjacent Southern Alps. Hence, trapped charge dating methods could be applied to constrain the timing of the last activity along the structure.

In this contribution we present our first results for dating earthquakes along the easternmost segment of the PAF during the Quaternary by applying both methods. Sand-sized quartz and potassium feldspar grains (100-150 μm) were extracted from fault gouges along the different segments of the PAF and used for ESR and OSL measurements, respectively. For ESR, we measured the signals from the Al center in quartz aliquots, following the single aliquot additive (SAAD) and single aliquot regenerative (SAR) protocols. For OSL, we measured the IRSL signal at 50°C (IR_{50}) and the post-IR IRSL signal at 225°C ($pIRIR_{225}$) on potassium feldspar aliquots. Our ESR results indicate that the PAF system accommodated seismotectonic deformation during the last 1 Ma, while the OSL signals for all samples were in saturation. This suggests that the events are likely not younger than 0.4 Ma.

Keywords (max. 5): Quartz ESR, feldspar OSL, fault gouge, Periadriatic Fault System, seismotectonic deformation.

Quartz luminescence sensitivity applied as a provenance tool of fluvial sediments from cratonic sources

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Understanding the sediment routing systems is crucial because they affect geological, biological, and socioeconomic dimensions on Earth. For that, provenance tools are needed to track sediment sources, which sheds light on sediment routes over time and space. The optically stimulated luminescence (OSL) and thermoluminescence (TL) sensitivities (light emitted per unit mass and radiation dose) of quartz have been successfully used to discriminate sediments from contrasting source areas, such as cratonic and orogenic terrains in the Amazon River basin. Additionally, the infrared stimulated luminescence (IRSL) has allowed us to estimate the concentration of feldspar relative to quartz, which also discriminates between orogenic (high feldspar content) and cratonic (low feldspar content) sources. However, little is known about the ability of luminescent-based techniques to distinguish sediments from less-contrasting cratonic sources. Here, we measured OSL and TL sensitivities of quartz and IRSL in surface sediments from rivers that drain the highlands of the Upper Paraguay River Basin (UPRB), a cratonic area in central South America. The 49 sampled rivers drain over metamorphic (Proterozoic) and sedimentary rocks (Paleo-Mesozoic), both covered by highly weathering soils. Luminescence measurements were performed on polymineralic aliquots (180-250 μm), where IRSL was used to bleach feldspar grains and measure OSL sensitivity afterward. OSL sensitivity (%BOSLF) was calculated as a fraction of the first second of light emission to the total stimulation curve. Similarly, the sensitivity of the TL 110ºC peak (%TL110) was calculated by dividing the integral of the TL glow curve between 80°C and 120°C by the total TL glow curve. The background was accounted for in all cases by subtracting it from the integrals. The ratio between the initial IRSL signal to the initial OSL signal (IRSL[1s]/BOSL[1s]), which shows the relative contribution from feldspar grains, was also calculated. Our data yielded relatively high %BOSLF and %TL110, ranging from 44 to 100% and 63 to 80%, respectively. The IRSL[1s]/BOSL[1s] values ranged from 0 to 10% without a clear pattern of spatial variability. Despite the overall prevalence of quartz with high luminescence sensitivity, higher values of %BOSLF and %TL110 appears to be related to sediments from settings dominated by metamorphic rocks. This trend is more pronounced in the %BOSLF, in which values higher than 75% are characteristics of sediments sourced from metamorphic rock terrains. However, it is essential to highlight that %BOSLF values lower than 75% can be found in both source rock contexts. In general terms, higher %BOSLF values in sediments supplied by metamorphic rocks than in sediments from sedimentary rocks suggest that sedimentary recycling is not the main process driving sensitization in the temporal scale we are looking at. We suggest that quartz luminescence sensitization in the UPRB can be related to soil residence time (or denudation rates) since soil mixing processes can produce a significant number of cycles of solar exposure (bleaching) and burial (dose). Thus, quartz OSL sensitivity is higher in terrains with long soil residence time (as our metamorphic rocks), while terrains with high denudation rates (as our sedimentary rocks) may provide relatively lower quartz OSL sensitivity. This pattern could be related to the lower erosion resistance of the sedimentary rocks in the UPRB. Our findings show that quartz luminescence-based tools can discriminate between sediment source areas even within cratonic settings, especially the %BOSLF. (FAPESP grant #2020/11047-1)

Keywords: sediment provenance; luminescence sensitivity; quartz natural sensitization; Pantanal

Luminescence and mineralogy characteristics of fault-associated carbonates features of Western Sichuan Plateau

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Carbonates, precipitated by either biogenic or chemical processes, emit luminescence signals under both thermal and optical stimulations [1,2,3]. Although these signals are promising for dating, the case studies are still sparse, which poses difficulties in targeting appropriate material for dating, with respect to the great generic diversity of carbonates. Developed geothermal activities of Western Sichuan Plateau (WSP) facilitate the formation of various carbonates closed to the fault fissures, e.g., banded carbonates along the fault surface, domed carbonates near hot springs, travertine deposits as well as carbonate dominated detrital. Besides these morphological diversity, the mineralogy and geochemical signatures of these carbonates are also different, e.g., calcite, aragonite and dolomite. Carbonate luminescence dating would allow us to constrain the tectonic activity across temporal scales of four orders of magnitude (10^3-10^6 years) with no potential systematic bias. In this study, we collected carbonate rocks and detrital from WSP to systematically investigate their luminescence characteristics and evaluate their suitability for dating accordingly.

Thermoluminescence (TL and Isothermal TL in UV, blue and UV to yellow), blue light stimulated luminescence (BLSL in UV), infrared stimulated luminescence (IRSL in UV and blue) and radiofluorescence (RL in IR) signals of the aforementioned samples are measured. The kinetics of corresponding trapped electrons are constrained under sunlight bleaching, laboratory heating and laboratory storage to evaluate their optical bleachability, thermal and athermal stabilities for dating. We tentatively relate the observed diverse characteristics of these luminescence signals to the mineralogy and geochemical context of the samples. The mineral composition, crystallization index, trace and main elements concentration of these samples will be analyzed to characterize the samples in mineralogy space. Finally, the luminescence characteristics and the mineralogy features will be compared to identify the best-possible mineral for luminescence dating.

Keywords (max. 5): TL, OSL, kinetics, mineralogy

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Dating the Neanderthal environment: Detailed luminescence chronology of a palaeochannel sediment core at the palaeolithic site of Lichtenberg in the Lower Saxony, northern Germany

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Lower Saxony in northern Germany is famous for its rich record of Lower and Middle Palaeolithic sites and palaeoclimate archives of the last 300 ka that record the advance- and retreat of Pleistocene glaciers, as well as periglacial and interglacial conditions. Numerous high-resolution palaeoenvironmental archives and associated Palaeolithic assemblages have been found in this region (e.g., Schöningen, Lehringen, Einhornhöle, Lichtenberg), and therefore offer a means to understand the behaviour of Early humans in relation to climate shifts and their adaptations to changing environments. Establishing a precise and reliable chronostratigraphic framework of Neanderthal occupation, their extinction, and replacement by early modern human is a fundamental research desideratum that can be achieved by applying numerical dating methods.

This study aims to establish a robust luminescence chronology at the late Middle Palaeolithic open-air site of Lichtenberg, northern Germany. Lichtenberg is one of the northernmost Neanderthal occupations on the European Plain, where different levels of Neanderthal occupation are preserved in deposits of the Eemian and Early Weichselian, with temperate, cold and moderately cold climatic conditions [1]. A total of thirty-nine samples were collected from a twenty-metre sediment core that was drilled adjacent to the site and spans the last interglacial-glacial cycle. We present and compare luminescence data and ages derived from feldspar using different signals (e.g., post-IR IRSL and pulsed IRSL). Where possible, the fast component quartz OSL ages are also determined as additional supporting chronological data to assess the accuracy of feldspar dating. Comparison of these dating results enables to assess potential methodological biases, while the resulting chronologies help refine the chronostratigraphic constraints of this Middle-Palaeolithic site and establish a high-resolution chronological model for the sediment core. The latter intends to yield more detailed insights into the timing of palaeoclimatic shifts in northern central Europe during the last glacial-interglacial cycle. Our preliminary measurements show that the fading uncorrected $pIRIR_{290}$ ages spanning ~25-180 ka, with a relatively steady age increase beyond ~110 ka below seven-metre. The dating results will provide a high-resolution age-depth model for multi-proxy analyses, such as XRF, pollen, and granulometric data.

Keywords (max. 5): Luminescence dating, Neanderthals, Middle Palaeolithic site, Northern Germany

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Investigating the Utility of Optically Stimulated Luminescence to Access Residual Contamination of Pre-treated Diatom Silica

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Isotope analysis of diatoms (photosynthesising algae with amorphous silica skeletons) is widely used in palaeoenvironmental studies to infer past changes in climate and productivity in lacustrine and oceanic settings [1]. Measurements of $\delta^{18}O$ and $\delta^{30}Si$ can be made on preserved diatom skeletons (frustules), to infer changes in composition of past waters and thus changes on a local and regional scale. However, to ensure that any isotopic measurements are accurate, the frustules intended for analysis must first be rigorously cleaned to remove any contamination (including, but not limited to, mineral fractions, organic matter, and volcanic ash) [2].

Currently, cleaned samples are assessed for contamination using a combination of light microscopy, which is time consuming; Scanning Electron Microscopy, which is cost prohibitive; and X-ray Fluorescence Spectroscopy (XRF), which only provides quantification of clay contamination. Given the different optical properties of the potential contaminants and the diatoms, measuring the net optically stimulated luminescence (OSL) signal of samples could offer a faster and cheaper alternative, especially by employing a portable OSL (POSL) reader, with non-destructive analysis possible in a few minutes per sample [3].

In this study, we discuss the application of rapid luminescence measurements using a POSL reader for detecting and quantifying various contaminants in samples of diatom frustules for isotope analysis. In the first experiment, we employed partially contaminated diatom samples from three contrasting sites (Lake Suigetsu, Japan [4]; Lake Nar, Turkey [5]; and Lake Baikal, Russia [6]) to appraise the practice of POSL analysis for detecting different contaminants. In the second experiment, a sample of pure diatom material was artificially spiked with an assortment of potential contaminants to determine the limit of feasible quantification. The results of our experiments will be presented here and contribute to the broader application of POSL to the preparation of pure sample material for isotope analysis.

Keywords (max. 5): diatom; Portable Optically Stimulated Luminescence (POSL); sediments; contamination; isotope analysis

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Quantifying ancient bleaching and storage for feldspar single grains

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Single grain IRSL signals have been used to track sediment transport in fluvial systems in several different contexts [1, 2, 3]. However, the determination of virtual velocity, the rate at which grains are transported down a fluvial system, remains a challenge; different approaches have been developed that suit varying environmental and geological situations, each with advantages and limitations. Multiple Elevated Temperature IRSL (MET-IRSL) measurements provide a high volume of information for single alkali feldspar grains, and recent work illustrates their potential for providing an assessment of the timing and duration of past bleaching events of grains with suitable signals, along with an indication of longer term burial and light exposure histories for an expanded population of grains [4].

We have applied MET-IRSL to a number of different fluvial systems, including small rivers from the UK, medium sized rivers from California, and a large river from Brazil, the Solimões River, which represents the main trunk of the Amazon. Our aim is to discover information about the range and chronological distribution of sediment storage in these fluvial systems, the sediment transport rates (virtual velocities), and improve our understanding of the sediment dynamics and landscape evolution of these catchments.

We discuss the advantages and limitations of some new concepts such as the burial-bleach ratio, and its relationship to sediment transport histories, along with measurements of bleaching patterns and modelling of different transport scenarios.

Keywords (max. 5): MET-IRSL, feldspar, sediment transport, Amazon

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The Lower to Middle Paleolithic transition at Tabun Cave (Mount Carmel, Israel): some insights into diagenesis and dose rate variation using IRSL ($pIRIR_{290}$) dating and infrared spectroscopy

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The Levant is a hotspot for studying past human behaviour and evolution during the Pleistocene. In particular, Tabun Cave, located in Mount Carmel, Israel, is one of the most famous sites in the area, with an exceptional sequence that spans the late Lower and Middle Palaeolithic. Human remains were found in the Middle Palaeolithic layers, including a Neanderthal skeleton (C1), and a mandible (C2), commonly classified as *Homo sapiens*, but whose attribution is still debated.

Electron spin resonance (ESR) of tooth enamel (e.g., [1, 2]) and thermoluminescence (TL) of burnt flint (e.g., [3, 4]) have been applied in the past to date the sequence of industries that became a reference for the Palaeolithic of the Levant, but the sedimentary matrix has never been dated. However, it has been shown that dose rate variation due to diagenesis in cave sites may impact the dose rate [5], making difficult to date such context. The characterisation of the mineral composition of the sediment will thus provide useful insights to select the best-preserved samples for luminescence dating [6].

We present here the first dates obtained using infrared stimulated luminescence (IRSL) of polymineral fine grains with the $pIRIR_{290}$ protocol, interpreted in combination with the data obtained from the characterisation of the sediment, i.e. the mineral composition determined using Fourier transform infrared (FTIR) spectroscopy.

Our new age results are in agreement with previous TL dating and indicate that the sediments from Unit X of the Lower to Middle Paleolithic transition, Units II-IX of the early Middle Paleolithic, and Unit I of the middle Middle Paleolithic were deposited between 280 ± 33 ka (Unit X, where the Levallois technology is first documented in the sequence) and 146 ± 11 ka (Unit I). Evidence of authigenic minerals such as phosphates were observed using FTIR, and their implications regarding dose rate variation are discussed here.

Keywords (max. 5): $pIRIR_{290}$, FTIR, diagenesis, Palaeolithic, Levant

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*R*ecent developments from *Freiberg Instrument*s

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The lexsyg family of luminescence readers [1, 2] is continuously receiving updates with new technical and software features added. The larger lexsygresearch [2], intended for developmental research and wherever versatility is required, can accommodate up to four detectors of varying PMTs, EMCCDs and spectrometers. Luminescence stimulation can be achieved by heat, radiation (beta or x-ray), LEDs or lasers. In addition to spatially resolved luminescence measurements [e.g. 3], where many single grains can be measured with a CCD simultaneously, a laser system is developed for PMT detection of individual mineral grains. For cwOSL the consecutive measurement of up to three stimulation light sources with data acquisition in a single set is possible. This allows e.g. consecutive stimulation with orange-red followed by blue light, which specifically targets the fast component for thermally modulated (TM-) OSL of quartz [4]. Experimental work with e.g. yellow stimulation [5] is also possible, as well as measurement of the IRPL signal from feldspar following [6]. A standard feature included in all recent lexsyg devices, whether equipped with LEDs or lasers, is the possibility to pulse OSL stimulation at a resolution of 10µs. All luminescence measurements can be performed at temperatures between -50°C and 710°C [7], while maintaining full automation.

The LexStudio2 software, which is used for operating lexsyg devices, includes a SAR plugin to quickly and conveniently create SAR measurements sequences with a few clicks only. It is now expanded to include the multiple elevated temperature pIrIr protocol and thus provides a less error prone and quicker way to create such long measurement sequences. Improvements in the analytical software LexEva2, which includes a GUI for the open source and community driven package R-LUM [8] will also be presented.

Keywords: luminescence reader; lexsyg; LexStudio2; LexEva2; dosimetry

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Linking feldspar luminescence phenomena and mineralogy using spatially resolved techniques

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Feldspars are routinely used in retrospective dosimetry to date geomorphological and archaeological events and processes. Continuous advances in luminescence research in recent years enabled the development of novel feldspar luminescence signals for dating applications. However, feldspars are a complex group of minerals, presenting its user with new challenges for each luminescence signal investigated. The diversity in feldspar mineralogy and associated variations in luminescence emission wavelengths and intensity means that not all luminescence signals are present in each sample. Since the crystal defects giving rise to various luminescence emissions are still largely unknown, it is difficult to properly assess and evaluate the drivers of variations in feldspar luminescence. We use a spatially resolved approach to link different feldspar luminescence emissions with mineralogical characteristics. We aim at identifying mineralogical and crystallographic sources of variation in luminescence emission wavelengths and intensity to help in choosing appropriate samples and measurement conditions for luminescence dating of feldspars.

We use a Sensitive InfraRed Instrument for phOto Luminescence measurements of feldspar (SIRIOL) [1] attached to a Risø luminescence reader equipped with an EMCCD camera to investigate spatial variations in blue (~410 nm) and yellow-green (~550 nm) thermoluminescence (TL) and infrared stimulated luminescence (IRSL) signals and in infrared photoluminescence (IRPL, ~900 and ~950 nm). We combine these spatially resolved luminescence measurements with electron back-scatter images and wavelength-dispersive x-ray spectroscopy (WDS) using an electron microprobe. Based on specific luminescence features identified using SIRIOL we select regions of interests for back-scatter image analysis and WDS to identify mineralogical sources of luminescence phenomena. Multivariate statistics are applied to luminescence data and oxide concentrations to objectively determine relationships between sample chemistry and luminescence emissions.

Our results collected on 15 chemically and structurally different alkali feldspars and plagioclases show that luminescence emissions in feldspars are dictated by the sample's major element chemistry, the presence of water in the melt, as well as by structural features, such as perthite lamellae or cracks. Whilst perthites generally show the most intense luminescence for all three emissions investigated, not all emissions occur in the same parts of the crystal, indicating different distributions of crystal defects responsible for the emissions.

Keywords (max. 5): Feldspar, spatially resolved luminescence, electron microprobe, mineralogy

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Wildfire exposure recorded in quartz luminescence sensitivity

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Luminescence sensitivity of quartz has been shown to vary between geologic terrains and rock types [1-3] and may be enhanced by weathering and sediment-transport history [3-5]. Observations from laboratory thermal treatments [6-7] and dating of archaeological hearths and pottery [8-9] have illustrated increased quartz luminescence sensitivity in annealed and fire-exposed sediments. We use these observations to test if there is a relationship between burn severity and luminescence sensitivity of soil samples from recent burn areas in the southwestern US. Sample from depth and outside the burn areas are used to determine the background (geologic) signature of the source-rock luminescence properties.

Results indicate enhanced quartz sensitivity of the surface soils in comparison to samples from depth and outside of the burn perimeter. The relationship between sensitivity change and mapped soil burn severity parameters are examined to determine if burn intensity is recorded in the magnitude of quartz sensitivity change. Results from 110 C TL sensitivity and thermal activation characteristics of surface soils and burned rocks at a high-severity fire in northern Arizona [10] are compared to the OSL sensitivity data collected in this study.

Keywords: quartz sensitivity, fire exposure, soil burn severity

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Exploring the multi-faceted potential of luminescence profiling via the portable reader in various fluvial landscapes and depositional environments (NE France)

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Portable luminescence readers have been increasingly employed in a wide breadth of geomorphological settings over the last decade (Munyikwa et al., 2020). Measurements of bulk samples along depth profiles yield infra-red and optically stimulated luminescence net intensities (IRSL/OSL). The signal build-up depends on (i) the burial duration of the sediment, (ii) the dose rate, (iii) the inherited dose at time of burial, (iv) the mineral composition and (v) the luminescence sensitivity of the minerals. In fluvial landscapes, however, the handful of existing case studies mostly focused on the sole identification of alluvium's unconformities via luminescence profiling. We argue here that this approach shall go beyond the mere one- (or sometimes two-) dimensional sedimentary screening and steer towards the production of three-dimensional chronostratigraphical information.

This study presents the outcomes of a luminescence-profiling approach performed in a wide array of fluvial landscapes and depositional environments located in the Upper Rhine Graben and the adjacent Vosges Mountains (NE France). They include:

- modern and historical overbank fines from the main stem (Rhine) and its tributaries (Sauer/Seltzbach Rivers, Upper Rhine Graben);
- modern and historical swale-and-ridge topography along with palaeomeanders (Bruche, Upper Rhine Graben);
- Holocene terrace deposits (Bruche);
- fluvio-glacial deposits (probably) from the Last Glacial Maximum (Cleurie Valley, Vosges Mountains).

We thus explore the ability of the reader to measure signals of varying intensities in different morpho-sedimentary units of clearly distinct ages. The results globally show:

- a consistent pattern of downward increasing OSL/IRSL signal intensities, although some sharp contrasts (i.e., shifts of one order of magnitude in signal intensities) in some sequences could be identified (e.g., Rhine);
- a larger scatter of OSL/IRSL signal intensities in the sandy fraction than in the silty fraction, probably reflecting the influence of grain size on the signal accumulation (requiring further investigation);
- the potential of the portable reader as a rapid and efficient tool for tracing (i) historical overbank fine deposition in floodplains thanks to increasing burial durations and (ii) sediment provenance due to differential bleaching between distinct sedimentary sources.

Keywords (max. 5): portable reader, depth profiles, fluvial landscapes/environments, geomorphology, tracing

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Revisiting a proof of concept in spatial and temporal bleaching processes by measuring OSL residual doses in surficial sands.

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Analysis of modern alluvial sands reveal that in many cases there is a lack of complete reset in the luminescence signal, indicating that the grains retain a residual dose prior to burial. This partial resetting (bleaching) phenomenon is still very poorly understood and remains a methodological lock for luminescence dating methods, potentially significantly affecting the accurate dating of alluvial sediment depositions and leading to an age overestimation. In this study, we aim at investigating the problem of *in situ* partial bleaching by conducting measurements in present-day beds of alluvial braided rivers and quantify the distribution of apparent OSL bleaching as a function of sediment trajectories (erosion, deposition, transport) and grain sizes. This study proposes, via an innovative approach, UAV-based surveys coupled with measurements of residual *in situ* OSL doses in modern sediments from a river located in the southern Alps (Séveraisse, France).

While most studies dealing with this bleaching issue are collecting buried sands, we mainly collected surficial sands (0-2 cm deep) along modern river bars and exposed to sunlight for at least a week to investigate quartz OSL residual doses and signals. We tested this general screening of residual OSL signal variation in modern sediments by collecting surficial sands in areas as small as 1m² in addition to random samples from braided alluvial beds. Our study led to starting a combined approach using the portable OSL reader (POSL) complemented with conventional OSL measurements on different granulometric fractions, which show that surficial sands are rarely totally bleached, with measured residual doses up to 90 Gy. We also note strong correlations between POSL on bulk sediment and conventional quartz OSL measurements.

We also explore our understanding of the effects of morphodynamic processes associated with the formation of alluvial deposits, and our ability to target the most appropriate bleached deposits. To answer this question, we use differential DEMs derived from drone SfM-photogrammetry (resolution of ~ 5-10 cm) to document morphological changes over space and time in the riverbed. Our sampling strategy shows that the OSL and POSL signals vary according to the position in the riverbed but that there are no preferred areas (deposition or erosion) for better bleaching processes.

Keywords (max. 5): quartz, bleaching processes, POSL, fluvial sands.

Maximising reproducibility in luminescence measurements of rock slices

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Rock luminescence dating has grown in popularity in recent years, and potentially offers several advantages over traditional sediment luminescence dating. One key advantage when determining burial ages is the potential for an individual rock surface or clast to preserve clear evidence for bleaching prior to the burial event of interest and the subsequent accumulation of dose, and in some circumstances these materials may even preserve a history of multiple exposure and burial events. This previous exposure and burial history is inferred from the study of variation in age with increasing depth away from the rock surface. But such patterns in age-depth profiles in rock may also potentially be influenced by inhomogeneous radionuclide distributions causing spatial variations in the dose rate [1, 2]. In unconsolidated sediment dating it is recognised that various factors such as accuracy and reproducibility of heating [3] and grain size [4] can also influence the assessment of equivalent dose, and the same is anticipated to be true of rock slices. Minimising sources of variability within and between rock slices is important if rock age-depth profiles are to be interpreted appropriately.

This study investigates the influence of various parameters on the reproducibility of assessments of equivalent dose from rock slices. The factors explored include the thickness of the materials being measured, beta source calibration, the reproducibility and efficacy of heating rock slices, and variations in optical attenuation.

The ability to cut reproducibly thin and flat rock slices minimises the likelihood of variability within and between rock slices for many parameters, and gives greater confidence in the equivalent dose values determined and in their interpretation as part of a rock age-depth profile describing the bleaching and burial history. A method to achieve this routine preparation of uniformly thin and flat rock slices is described. Working with thin rock slices also means that the number of slices that can be prepared over a given depth into rock is obviously greater than can be achieved using thicker slices, which can be particularly advantageous for rock types which permit limited penetration of light, improving their potential to provide information on prior bleaching and burial events.

Keywords: rock burial dating, cobble, beta calibration, grain size, reproducibility

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Uncovering the dynamics of construction, use and abandonment of Roman military camps in Northwest Iberia through luminescence dating and geochemistry

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Roman military camps are temporary defensive enclosures, usually rectangular-like with rounded corners and defended by an external ditch and earthen embankment or stonewall. The use of remote sensing techniques has contributed to the identification of several new Roman military sites in northern Portugal and Galicia [1]. In the present work, two of those enclosures located in Northwest Iberia are considered: Lomba do Mouro (Castro Laboreiro, Melgaço and Verea, Ourense) and Alto da Raia (Tourém, Montalegre and Calvos de Randín, Ourense). Despite the increase in archaeological data concerning this type of enclosures, aspects related to the definition of the dynamics of construction, occupation and post-abandonment remain to be clarified. The Roman camps, being of temporary use, have a very limited associated material culture. Added to this constraint are signs of abrasion (acidic soils) and post-depositional taphonomic processes that make it difficult to establish the dynamics and chronology of the enclosures, constituting a challenging case study. In this sense, a multidisciplinary approach has been applied combining archaeological data, luminescence dating, and chemical and mineralogical compositional studies of the accumulated materials. The results of luminescence dating of the materials sealed by the stonewalls at Lomba do Mouro point to a Roman Late-Republican chronology. Concerning the materials accumulated in ditches and earthen embankment at Alto da Raia, the mineralogical composition points to the anthropogenic intention/selection of materials. Both studies, dosimetry by luminescence and compositional ones, are in accordance with an inversion of the stratigraphy related to the earthen embankment construction and with the hypothesis of reusing the nearby pre-existing prehistorical materials to infill the ditch.

Keywords: Roman military camps, Northwest Iberia, dynamics of accumulation, Luminescence dating, Geochemistry,

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New luminescence age estimates for the Soda Lake maar eruption (Nevada, USA)

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Soda Lake is a basaltic Holocene maar located in northwestern Nevada, USA. A maximum age of ~10 ka is currently the best age constraint for the eruption given that the eruptive deposits cover lake sediments of pluvial Lake Lahontan. We apply optically stimulated luminescence (OSL) dating to feldspar and quartz of xenocrystic origin to define the eruption age for Soda Lake. Fading corrected IR_{50} and non-fading corrected post-$IRIR_{225}$ ages from xenocrystic feldspar are statistically indistinguishable, yielding an average age of ~5.5 ka for the Soda Lake maar eruption. The quartz OSL signal was dominated by medium and slow components leading to significant age underestimation relative to the feldspar extracts. This new eruption age provides valuable information for risk assessment and hazard mitigation in northern Nevada. We also present some preliminary results on an exploratory application of luminescence dating to xenoliths extracted from juvenile basaltic bombs and the potential for luminescence to provide constraints on magma thermal dynamics and ascent history.

Keywords: xenocryst, xenolith, maar eruption

A unique case of vitrified forts from Italy: TL dating with "Pre-bleach with blue LEDs" protocol

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Since the 1700s, vitrified forts in Europe have been known, but archaeological interpretations of their construction process are still subject to debate. In the Late Bronze Age and to follow during the Iron Age civilization, it was not uncommon to find fortifications towering over the hills. These kinds of construc-tions were first discovered in Scotland, where they are prevalent [1]. Moreover, some significant studies were recently concluded on Swedish vitrified forts [2]. It is interesting to note that these fortifications are primarily found in insular Europe and are only occasionally found on the continent. Apart from a few rare instances in Portugal, the presence of these structures has not yet been consistently observed in Mediter-ranean European countries. A unique case was found in Italy, on the top of the Serravuda Hill near Acri, in the region of Calabria (Southern Italy) in 1970 [3,4].

The first systematic study campaigns conducted advanced different hypotheses about the origin of these stones. Early studies excluded that the heating event was correlated to forest fire, smelting ovens or lighting fulguration and hypothesized impact-shock event by the fall of extraterrestrial bodies or, alterna-tively, the effect of unknown anthropic activities (prehistoric or protohistoric rituals). A preliminary chem-ical study did not furnish incontrovertible evidence of geochemical anomalies correlates to impact events or archeometallurgical human activities.

The present study, based on a series of new mineralogical and chemical data, aims to raise the level of confidence to the origin of these enigmatic rocks [4]. Indeed, thermoluminescence (TL) dating could support the hypothesis that the glassy rocks of Serravuda are related to anthropogenic activities.

More than twelve samples of different geological nature, including heated or partially vitrified rock fragments and several vitreous cements, were dated.

The measurement protocol chosen was proposed by Woda and Discher and called "Pre-bleach with blue LEDs" [5], originally, it was developed only for accidental dosimetry evaluation purpose and for measuring doses in the display glasses of mobile phones, but it has been already adapted and successfully tested on historical material (mosaic tesserae) [6].

As for these glasses, the TL signal from vitrified forts samples presents anomalous fading and is light sensitive. The experimental protocol circumvents these problems by isolating the thermally more stable TL signal with an optical pretreatment and by determining a fading curve for each analyzed sample. By integrating over the time, the given function, it is possible to estimate the fading correction. The measured ages, calculated starting from the measured archaeological absorbed doses, along with the technological indications provided by recent geological investigations [4], suggest that Serravuda Hill's vitrified forts are related to the hillforts that are found throughout vast areas of northern, mainland Europe and the is-lands. Such dating suggests that the Serravuda finds had various backgrounds, extending from the Late Bronze Age through the Iron Age.

Keywords: Archeological glass, Thermoluminescence, Dating

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OSL dating of very young aeolian sediments of NW Spain to assess dune erosion due to sea level changes

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Optically stimulated luminescence (OSL) ages of young sediments (<1 ka) have been reported in the last years to study late-Holocene events [1]. Such studies are helpful to understand contemporary sedimentary processes and rates, being applied on aeolian, fluvial, lacustrine, marine and other sedimentary environments. Young coastal dunes have been dated to understand the recent behavoiur of such dunes due to the present sea level rising in several regional or local areas [2,3]. Dating these sediments is challenging due to the low signal-to-noise ratio of the natural OSL signal and because young samples are very sensitive to thermal transfer or partial bleaching of the luminescence signal during transport.

The study and dating of fossil dunes in the Galician Rias (fluvial valleys flooded during the last marine transgression) of NW Spain have allowed the reconstruction of the coastal evolution of this area from the Marine Isotopic Stage (MIS 8, [4]), with a well understanding of the erosive and sedimentary processes occurred in the last glacial cycle (MIS 5 to MIS 1, [5,6,7]). However, there is still a poor knowledge of sea level rising effects during the late Holocene. In this work, we have studied and dated six samples from a current coastal dune field and climbing due in Playa de Trece (Galicia, NW Spain). The obtained equivalent doses were very low, ranging from ~130 to ~30 mGy. The obtained ages are very recent, being <300 ka. The ages fit some late-Holocene sea level fluctuations, indicating that the dune dynamics are strongly influenced by small changes of the sea level.

Keywords (max. 5): young sediments, quartz, OSL dating, coastal dunes, sea level

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What surface processes are encoded in the luminescence sensitivity of quartz sediment grains?

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The sensitivities of the 110ºC thermoluminescence peak (TL_{110}) and the fast optically stimulated luminescence component (OSL_F) of quartz have been increasingly used in sediment provenance analysis. This application relies on the four to five orders of magnitude variation of quartz TL_{110} and OSL_F sensitivities, which allow a clear discrimination between sediments of different geological origins. Laboratory measurements demonstrated that both the TL_{110} and OSL_F are sensitized by either heat treatment or irradiation-illumination cycles. In nature, however, sensitization is mainly attributed to irradiation-illumination cycles occurring when quartz grains are buried and sequentially exposed to sunlight. Natural cycles of burial irradiation and sunlight exposure can occur in soil profiles due to the upward and downward movement of grains (soil mixing processes) and in source-to-sink sedimentary systems due to erosion, transport, and deposition events (sedimentary recycling). Additionally, heating could sensitize quartz grains laying near the surface in settings with frequent wildfires. Rates of soil mixing and sediment recycling as well as the frequency and intensity of wildfires depend on several variables acting on diverse scales over time and across space, such as soil biotic activity, vegetation cover, uplift or subsidence rates, and precipitation regime. These relationships open the possibility of translating TL_{110} and OSL_F sensitivities into Earth surface processes and rates. However, decoding and quantifying surface processes from the luminescence sensitivity of quartz sediment grains are still challenging. As a step toward this goal, we performed: i) a literature review to update views about TL_{110} and OSL_F sensitization; ii) experiments to appraise the laboratory sensitization range and build sensitization curves of quartz single grain and multi-grain aliquots for different irradiation-illumination cycles to emulate different conditions of burial, irradiation and sunlight exposure and; iii) characterization of TL_{110} and OSL_F sensitivities of quartz sediment grains produced in well-known geological contexts. Results are integrated and discussed to shed light on how quartz is sensitized in nature and to appraise the use of quartz TL_{110} and OSL_F sensitivities for the quantification of specific past surface processes.

Keywords (max. 5): surface processes; sedimentary deposits; quartz luminescence

Constraining extreme fluvial discharge events using a combination of classical and EMCCD-based rock surface dating - techniques.

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Gravel-bed rivers transport large quantities of sediment from alpine sources to foreland sinks and are a key element in the sediment transport system of mountain regions. Generating a quantitative comprehension of the morphodynamics and sedimentary processes operating in gravel-bed rivers is a long-standing research goal in fluvial geomorphology. This constitutes the base for understanding fluvial sediment cascades, valley floor incision and mountain denudation as well as for managing flood and sediment hazard risks. The prediction of how riverbed texture, sediment load and channel morphology respond to changes in governing conditions (discharge, sediment supply, valley slope) remain complex and thus are still largely elusive.

We systematically sampled the granitic fluvial lag deposits that are preserved in the river bed channel of the Solenzara in southern Corsica. We target the grain size range > 250 mm (gravels to boulders) and explore the capabilities of an EMCCD camera set-up for 2D rock surface dating. In this study the IRSL, post-IR-IRSL as well as the IRPL signals of these samples are investigated and compared with each other. In addition to generating 2D EMCCD images of rock luminescence, we also use a classic “drilling and slicing” approach to generate 1D luminescence-depth profiles by measuring individual rock slices under the photo multiplier tube. Advantages and disadvantages of the 1D versus 2D luminescence data for the Solenzara samples are discussed and initial rock surface burial ages for different grain sizes and sections of the fluvial lag deposit presented. The ultimate goal of this rock surface dating study is to better constrain the spatio-temporal pattern of bed load transport and formation of lag deposits on the scale of a fluvial channel.

Keywords: rock surface dating, EMCCD, Corsica, gravel-bed rivers, fluvial lag deposits

Zircon luminescence as a geochronological tool for (sub-) recent sediments

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Constraining the depositional history of sediments in geomorphological and (geo-)archaeological studies over the past 1,000-2,000 years remains challenging, particularly in arid environments and in the absence of organic material for radiocarbon dating and dendrochronology. Detrital zircons occur commonly in sediments (albeit at low concentrations). Their ability to accumulate a luminescence signal over time offers a new opportunity to develop a geochronometer for recent to sub-recent timescales. The date corresponds to the time of last exposure to light of zircon grains, corresponding to the burial time following (re-)mobilisation. Unlike quartz and feldspar, zircon minerals contain high U and Th concentrations, exceeding the radionuclide concentrations from the surrounding sediment matrix. This intense 'self-irradiation' facilitates the 'auto-regeneration' technique, in which the zircon grains, after the readout of the natural signal, are stored in the dark for several months, followed by measuring their auto-regenerated signal. The age is then obtained by dividing the natural signal by the auto-regenerated signal multiplied by the storage time [1, 2]. This methodology has the potential to achieve a dating precision on the order of a few years.

Our contribution presents initial results from a new project on reconstructing droughts in the Great Plains (USA) within the past 1,500 years using the zircon luminescence chronometer. We share our experiences in extracting zircons from sediments using a range of methodologies. Laboratory experiments using green laser stimulation and detection of the UV signal of one zircon sample indicate signal resetting rates under sunlight exposure almost as high as those of quartz. This characteristic facilitates accurate dating, even of events associated with short sunlight exposure. Measured rates of athermal signal loss are high but irrelevant for the auto-regeneration technique. The decomposition of CW-OSL signals of single zircon grains suggests two exponentially decaying components with photoionisation cross-sections varying by factors of ~20–30. Finally, we present preliminary results from a storage experiment to assess the minimum storage time required to induce a detectable auto-regenerated signal.

Keywords (max. 5): zircon, OSL, single-grain, auto-regeneration, bleaching

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Assessing the timing of the extent of the Laurentide Ice Sheet using optical dating of quartz, Hudson Bay Lowland, Manitoba, Canada

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The Laurentide ice sheet (LIS) repeatedly waxed and waned over the North American continent during the Quaternary period. Its existence had a profound effect on the local terrestrial environment, and on global sea level and climate. Evidence of the presence and extent of the LIS is preserved in the depositional record. In places, this depositional record contains nonglacial sediments buried beneath glacial sediments, but ascertaining the timing of nonglacial periods is difficult. This is because organic material found within the sediments is commonly near or beyond the ~50 ka limit of radiocarbon dating, it is poorly preserved, or it is suspected of contamination. Optical dating of quartz, which can be used to date the burial time of sediments, provides an alternate geochronological method and its upper age limit is usually about 100 ka. We have applied optical dating of quartz using a standard single-aliquot regenerative-dose protocol to several key stratigraphic beds in the Hudson Bay Lowland region of northeastern Manitoba. We found that most sample aliquots contain a bright, quickly-decaying luminescence signal that has a saturating exponential plus linear (SEPL) dose response, that allows age values over 150 ka to be determined. However, previous studies undertaken by others working in various regions of the world have shown mixed results when using the linear part of SEPL growth curves for dating. This presentation will review some previous studies that have applied SEPL luminescence signals, and then discuss the utility of using this signal to date sediments in the Hudson Bay Lowland. We will also compare our optical dating results with information inferred from paleoenvironmental reconstructions.

Testing the timing of loess accumulation in western Greenland using joint radiocarbon and luminescence methods

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Loess–palaeosol sequences formed by dust accumulation often provide an excellent record for understanding climate change and the deposition of atmospheric mineral dust. Holocene age loess deposits in the Arctic have to date received little attention, yet potentially can be used for past dust and climate reconstruction in this highly sensitive region. However, one of the prerequisites for utilizing the potential of these deposits is accurate, detailed, and independent chronologies. Here we sample loess and peat-loess sections for combined detailed luminescence and bulk organic radiocarbon dating, as well as testing possible climate proxies around the ice-free area of western Greenland near Kangerlussuaq. While the OSL quartz signal from loess in western Greenland was insensitive or weak, the low-temperature $pIRIR_{180}$ and IR50 signals yielded reproducible ages. However, although luminescence ages show stratigraphic age consistency with depth, a large age offset of c. 2 thousand years is observed between luminescence ages and bulk organic matter radiocarbon ages, with the latter giving younger ages. This may result from incomplete bleaching of the IR and pIR signals, or from younger carbon contamination of bulk organic matter in the loess, which is generally low (<1%).

Here we present further results of tests for the causes of these offsets between different age-dating techniques. It is well known that pIRIR ages are susceptible to overestimates due to 'partial bleaching', where solar exposure is insufficient to completely zero the signal, but rarely has this phenomenon been reported for airborne dust deposits. High-resolution sampling of loess deposits (each 2 cm) from the present field surface to 20 cm depth was performed, and analysis of variation of luminescence dose with depth reveals a consistent natural residual dose of ~ 5 Gy for $pIRIR_{180}$ and 0.70 Gy for $IR_{50.}$ This yields an age of ~2.28 ka and 0.79 ka respectively, for surface deposits, which we suggest is a result of incomplete bleaching. Assuming that a similar residual dose occurs throughout the section, the ages were corrected and showed better agreement with bulk radiocarbon results. Final corrected ages reveal that most of loess accumulation occurred in Greenland during the Holocene over the last 4-6 ka**.** However, the possibility that the radiocarbon ages are too young remains and is also being investigated. Should the natural modern equivalent dose in these sediments be due to partial bleaching, this may be a consequence of dust accumulation occurring during the polar night season, combined with short transport distances (10s to 100s of m) and rapid burial at the surface.

Keywords : pIRIR, polymineral finegrains, Radiocarbon, Arctic, dust

Middle Loire Valley settlement: first chronology using ESR on quartz grains

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Stepped-terraces systems of several tributaries of the Loire River basin were during the two last decades particular objects of multidisciplinary study, involving Quaternary geology, prehistory and geochronology. The Loire River itself, the longest stream of France, and its fossil stepped terraces system have remained little studied until now from the geochronological point of view, particularly in its middle section, near Orléans. This section is however considered for some fifty years as a key area evidencing the existence in the past of the connection of two older rivers leading to the formation of the current Loire valley. Several researchers have hence proposed the hypothesis of the existence of a Plio-Pleistocene Loire paleo-river flowing northward from the Massif Central to the Seine valley and the English Channel. This Loire River was then disconnected from this one and its flowing was orientated to the west from the Blois area until the Atlantic Ocean.

The lack of alluvial deposits in the area between the present-day Loire valley and the Seine one, in relation to significant erosion, means that it is not possible to work directly on ancient evidence of the south-north paleo-river. According to the hypothesis that the alluvial terraces preserved in the intermediate sector were put in place after the connection of the two former rivers (capture), the dating of these sedimentary formations would make it possible to determine when this capture took place. Thus, a series of ESR quartz dates have made it possible to establish a chronological model for this Middle Loire. Five different phases in the evolution of the Middle Loire system can now be described, between 800ka and the present day. These phases seem to indicate a gradual capture, beginning between 900 and 800 ka, with changes in fluvial dynamics, leading to the current course of the river around 250 ka ago.

Keywords: Loire Valley, alluvial terraces, ESR, quartz

Late Quaternary sedimentation history of the alpine Damqu Wetland in the Yangtze River headwater in Tibetan Plateau by luminescence dating

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The Southern swamp of the Yangtze River, Damqu Wetland, covering an area of 8548 km^2, is one of the highest alpine wetlands in the world. and has great significance in terms of water resources, ecosystems, paleoclimate, geomorphology, and biodiversity. However, due to tough traffic conditions and harsh environments (arid, strong ultraviolet, and hypoxia), the Damqu Wetland is poorly researched at present. Chronology is the basis for these studies. Here we investigated the SE Damqu Wetland and examined two natural sections (DQ1 and DQ2) exposed by the Damqu River, a main tributary of the Yangtze River. We combined quartz OSL (optically stimulated luminescence), feldspar pIRIR (post-infrared infrared stimulated luminescence), and radiocarbon (^{14}C) dating techniques to establish the chronology. The dating results demonstrated consistency between OSL, pIRIR, and ^{14}C ages (peat). Depositional hiatuses were identified in both sections. Below the hiatus, the sediments were dated to marine isotope stage (MIS) 3 in Section DQ1, and >200 ka in Section DQ2. Above the hiatus, sedimentation resumed since the Late Holocene in both sections. We assume that the hiatuses were probably caused by fluvial erosion. Sedimentary resumption during the Late Holocene might result from decreased stream power due to weakened East Asian summer monsoon and ameliorated vegetation due to elevated temperature. Besides, the sediment colors, which partly reflect the contents of organic matter, showed two periods of climatic optimums at 4 ka and 2 ka in the Dangqu Wetland.

Keywords: Tibetan Plateau; Yangtze River headwater; Damqu Wetland; OSL dating; climate changes

Quartz OSL of a Category 5 hurricane washover deposits sufficiently bleached

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Washover deposits are the most important archive for studying the strong tropical cyclones predating instrumental and historical records, but they are rarely directly dated successfully except for a few attempts with OSL. Because overwash transports sediment by highly turbulent flow over a short distance during cloudy storm weather, there are major concerns that the inherited OSL of washover deposits may not be sufficiently bleached. In this study, we measured quartz OSL with multi-grain aliquots of samples collected from two washover fans in St Vincent Island, Florida, formed by a ~3 m storm surge of Hurricane Michele (2018), the Category 5 hurricane strongest to hit the Florida Gulf Coast since record-keeping began in 1851. The equivalent dose (D_E) distributions of the samples are closely clustered near 0 Gy and produce unlogged central doses falling between 0.04 to 0.05 ± 0.02 Gy (1σ) and unlogged minimum doses of about 0.02±0.01 Gy (1σ). These data suggest that quartz OSL of the washover deposits for the strongest hurricanes can be sufficiently bleached, presumably because the washover deposits originated from shallow foreshore and dune sands that were sufficiently bleached before the storm. This finding lends strong support for direct dating washover deposits with quartz OSL.

Keywords: washover deposits, OSL bleaching

OSL and TL sensitivity measured in marine and fluvial sediments from the São Francisco River basin, eastern Brazil

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The São Francisco River watershed is one of the most important in eastern South America and covers an extensive latitudinal range (20º S to 7º S). The São Francisco watershed was segmented into four sectors (I-IV), according to downstream changes in its geomorphological characteristics. It is being influenced by the South American Monsoon System in its sectors I and part of II (upper and middle river courses), and by the Northeast Low, in its sectors III and IV (sub-middle and lower courses). This study explores variations in optically stimulated luminescence (OSL), thermoluminescence (TL) and infrared stimulated luminescence (IRSL) signals in the silt fraction of modern sediments from the São Francisco River watershed and in a marine core offshore the São Francisco River mouth (i.e., M125-115- 4, collected at 46.6 m water depth, 7.76 km from the coastline), which records most of the Holocene. Our aim is to investigate possible changes in sediment provenance within the São Francisco River watershed through downcore variations in quartz OSL and TL sensitivity and feldspar IRSL intensity. Moreover, we also assess quartz OSL and TL sensitivity across the basin linked Holocene variations in precipitation. All luminescence signals were measured in polymineral aliquots and recorded in the ultraviolet band. Quartz OSL sensitivity was calculated for the fast component by using blue light stimulation ($BOSL_F$) after IRSL to bleach feldspar luminescence. The TL sensitivity was determined through the relative intensity of the 110ºC TL peak (TL_{110}). $BOSL_F$ and TL_{110} sensitivity are reported as relative to the total BOSL (1-100s) and TL (up to 250ºC) emissions, respectively.

Our results from the modern fluvial sediments indicate higher $BOSL_F$ and TL_{110} sensitivity values for sectors I and II and lower values of both variables for sectors III and IV. On the other hand, the proportion between feldspar (IRSL intensity) and quartz ($BOSL_F$ intensity) was relatively low for sectors I and II and higher for sectors III and IV. In the downcore record, $BOSL_F$ and TL_{110} increase from the early to the late Holocene, while the ratio between feldspar and quartz decreases. Sectors I and II are covered by Cerrado (Savanna) and Atlantic Forest. Hence, the higher sensitivity of quartz sediment grains from these sectors may be related to the higher frequency of fires (in the case of Cerrado), more bioturbation, and the long-lasting permanence of quartz grains in the soil profile since the vegetation of these biomes tends to inhibit erosion. On the other hand, sectors III and IV are covered by Caatinga (Dry Forest; semi-arid conditions), and its sparse vegetation does not guarantee the stabilization of the soil profile. Thus, quartz grains are more swiftly transported to the river channel during episodic events of torrential rains, for example.

The increase in sensitivity in the downcore record, mainly from 3.8 ka onwards, suggests an increase in sediment supplied from sector I and part of II from the early to the late Holocene. This is in line with an early to late Holocene strengthening of the South American Monsoon System.

Keywords (max. 5): quartz; source area; precipitation; Holocene; eastern Brazil.

Climate and Neo-Tectonics Imprints on the Evolution of Late Quaternary Terraces in the Tista River Basin, Darjeeling Sikkim Himalaya

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Fluvial terraces are important geomorphic archive preserving information about past fluctuations in climate and tectonics. In tectonically active regions such as Himalayas which are also the drivers of Indian Summer Monsoon (ISM) and are also influenced by the past climatic changes. To understand the impact of two processes, different sections of fluvial terraces were studied along the Tista River in the Darjeeling Sikkim Himalayas over a stretch of ~65 km.

An attempt has been made to reconstruct the geomorphic history of the region using Optically Stimulated Luminescence (OSL) dating and geochemistry. Four level of terraces were identified in the region as T4, T3, T2 and T1, in decreasing order of their ages. T3 terrace is nested into T4 and could only be differentiated on the basis of chronology. The upper age limit of T4 is ~72 ka and this period was followed by a glaciation phase. We do not get any deposits during this phase showing that this was a period of no active sedimentation. The T3 has an age range of ~ 50-30 ka and is regional in nature, whereas all other terraces are fragmentary in space. This time period was also an interglacial phase with similar precipitation conditions as of today. However, the Chemical Index of Alteration (CIA) values indicate that the chemical weathering was not intense during this period indicative of relatively dry condition. The T2 formed during ~ 24-11 ka which was period of Last Glacial Maxima (LGM) followed by interglacial period and Younger Dryas event. The striking difference between T4, T3 and T2, T1 is its terrace material. The T4 and T3 are composed of laminated sand with few intercalations of cobble-pebble layers whereas, the T2, T1 and present day channel are composed of pebble, cobble and boulder beds with few thin sand units. The river dynamics during formation of T4 and T3 was such that it could only transport sand sized particles while during formation of T2 and T1 it changed drastically. It is important to understand that this change was either induced due to climatic fluctuations or due to the tectonics. We observed in two of the studied sections the T 3 terrace was deformed indicating that this deformation event took place after its formation, i.e. 30 ka. This was followed by the formation of T2 terrace, pointing towards a tectonic activity between 30 ka and 24 ka which drastically changed the dynamics of the Tista River. Even the younger terraces viz. T2 and T1, also show warping indicating that the region is tectonically active in present day scenario, posing a serious problem for the local inhabitants. The climate and tectonics are working hand in hand in shaping the geomorphology of the region.

Keywords: Himalayas, Fluvial terraces, neo-tectonics, climate change

Spatial and temporal differences of quartz luminescence sensitivity in the fine grain fraction of loess and fluvial deposits in the Danube Basin

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Loess profiles provide the opportunity to apply several proxy records to reconstruct Quaternary environmental conditions at a high resolution. Nevertheless, luminescence properties and variation of dose rate may also have a palaeo-environmental relevance, e.g. the luminescence sensitivity of the quartz fraction can refer to the provenance of the dust [1]. The sensitivity difference of Danube- and Tisza-related quartz extracts has recently been shown [2], but has not been tested on Danubian profiles, however, it has a great potential to provide valuable information on provenance, especially concerning sections in the southern part of the Danube Basin.

In the present study, we investigate and compare the sensitivity of fine-grain quartz extracts from three loess profiles of the Danube Basin along a north-to-south axis, from Moravia, Czech Republic to Vojvodina, Serbia. Besides, the luminescence properties of fluvial sediments of the Danube and Tisza Rivers, transporting and depositing sediments of Alpine and Carpathian origin, were also tested. OSL sensitivity was determined using the procedures outlined by Bartyik et al. [2]. After bleaching the aliquots, the same artificial dose was administered to each sample. First, mass-normalized CW OSL base sensitivity values were measured, and then by using repeated cycles of irradiation, the degree was sensitivity change was also determined. At certain samples, LM OSL measurements were also made.

The spatial comparison of values was made using MIS 2 samples from each profile to identify differences at similar atmospheric circulation patterns. Results were also compared to the OSL sensitivity of fluvial quartz extracts obtained both from MIS 2 and modern sediments. At one of the profiles (Novo Orahovo, Vojvodina) high resolution temporal changes were also assessed.

Keywords: quartz, fine grain, OSL sensitivity, provenance, loess

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Ages of Central Asian loess and their implications for dust sedimentation

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Independent and reliable timescales are prerequisites for Quaternary climate and environmental reconstructions. Since the 1980s, many researchers from Russia, China, UK and Germany have carried out studies on geochronological studies of Central Asia (CA) loess, including paleomagnetism and thermoluminescence dating. Recently, Infrared Stimulated Luminescence (IRSL), Optically Stimulated Luminescence (OSL) and Accelerator Mass Spectrometry (AMS) ^{14}C have been widely used to date the Middle-Late Quaternary sediments in Central Asia[1-3], although controversy remains regarding the reliability of results because of their age inconsistencies and discrepancies. Here, we collected dating results over 30 loess sections or drilling cores from CA and analyses their temporal-spatial distribution characteristics.

Previous chronostratigraphic data of CA loess and our field investigations indicated that most of loess outcrops have developed since the last interglacial-glacial period, although CA loess sediments can span the entire Quaternary, and back to Pliocene. AMS ^{14}C can provide reliable ages for the last 25–30 kyr. Both Quartz OSL and K-feldspar pIRIR dating techniques based on well-bleached natural environmental materials can provide reliable ages for younger samples, less than 80–100 ka. Based on the ages, we summarized the dust sedimentary processes as the following three points. 1) Rapid accumulations: Steep age-depths plots imply extremely high sedimentation rates. 2) Discontinuity or sedimentary hiatus. These non-conformities are often hard to be recognized by untrained observers, but obvious age gaps can be observed in age statistics and depth-age plots of loess sections in the Caspian Lowland of northern Iran, and in the piedmont of the Tianshan. 3) The upper Holocene sediments, especially in Northern CA, are frequently eroded away. Their absence may be caused by an arid climate and wind/fluvial erosion. Spatial-temporal distributions of CA loess luminescence ages indicated that there are different clusters in different loess subregions, but generally, the strong dust activities occurred during cold glacial periods or stadials. New dating techniques should be developed in future research to meet the high-resolution and older (>100kyr) paleoclimate reconstruction in CA.

Keywords: Quartz OSL, K-feldspar pIRIR, AMS ^{14}C, dust sedimentation

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Effect of sample composition on the infrared-radiofluorescence (IR-RF) of polymineral and K-rich feldspar samples

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K-rich feldspar sediment samples are often heterogeneous even after mineralogical enrichment through, e.g., density separation. This is partly due to feldspar's solid-solution nature, but contamination by other minerals can also be an issue, especially when the sample is not etched with HF. Despite a sample's mineralogical heterogeneity, IRSL or postIR-IRSL results can be reliable if other factors such as internal dose rate and anomalous fading are accounted for. Indeed, even polymineral samples (i.e., without any attempt at mineralogical enrichment) have been shown to yield reliable pIRIR ages [e.g., 1].

An alternative dating method currently in development is the radiofluorescence (RF) of K-rich feldspar, in particular the infra-red (IR) RF emission. This is a promising method to obtain relatively high equivalent doses of up to 1000–1500 Gy with no or only small corrections for anomalous fading. In the case of IR-RF dating, the possible effect of signal contamination by other minerals is not yet clear. In particular, an interfering unstable red-RF emission has been described, whose tail overlaps with the wavelength range targeted for IR-RF dating [e.g., 2]. Previous work has suggested a negligible contribution of this interfering component for two relatively pure K-rich feldspar samples [3], but the emission proportions must still be systematically tested on a more diverse set of samples.

Here, we will investigate how sample composition might affect RF behavior and possible unwanted RF signal contributions. We will compare PMT measurements and emission spectra of coarse-grain K-rich feldspar and fine-grain polymineral fractions to discuss the effects on equivalent dose estimation. The samples contain between 7–96% K-rich feldspar, with the remainder dominated by quartz, albite, Fe-aluminosilicates and muscovite, as characterized by energy dispersive spectroscopy (QEMSCAN). Such an investigation is crucial to assess the reliability of IR-RF dating of polymineral fine-grains and, more broadly, to further our aim of reliably dating deposits of Middle Pleistocene (Chibanian) age or older.

Keywords: IR-RF, emission spectroscopy, deconvolution, K-feldspar, polymineral fine-grains

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Investigating the quartz relative fast OSL component sensitivity from test- and regenerative-dose signals over SAR cycles

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Quartz optically stimulated luminescence (OSL) sensitivity, i.e. the OSL intensity to a given radiation dose, is varied and related to sediment source. It may be altered (enhanced) as quartz is subjected to repetitive cycles of light exposure and/or irradiation. Such property has been shown to be a useful tool for sediment provenance investigations. Recently, Souza et al. [1] have successfully used OSL dating data to calculate the quartz relative fast OSL component sensitivity ($\%BOSL_F$) for sediment provenance analysis based on the OSL signal derived from the first test dose (T_n) of the single-aliquot regenerative-dose (SAR) dating protocol. In fact, they have shown that any test dose signal (e.g. T_n, T_1, T_2, etc.), and even any signal from regenerative-dose (L_x), from their dataset could be potentially used to characterize the sample OSL sensitivity [1]. Here, we expand their tests using SAR signals from more OSL dating data in order to calculate the $\%BOSL_F$ for several sediment samples that represent the most diverse depositional contexts. The main objective was to assess whether the conservative behaviour of $\%BOSL_F$, observed by Souza et al. [1], could be considered a universal property (i.e. sample independent). Preliminary results show that for several samples $\%BSOL_F$ does not vary throughout SAR cycles; other samples, however, $\%BOSL_F$ varies significantly. Possible reasons underlining these differences are being investigated. All calculations were performed using *.binx* files from samples that have been previously measured for equivalent dose estimation. Therefore, our approach dismisses the need of additional luminescence measurements and shows that the extensive database luminescence laboratories already have can be repurposed and yield new and useful information. (FAPESP grant #2021/14022-2)

Keywords: sediment provenance; quartz sensitivity; test dose signals

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Luminescence chronology and thermometry studies of plant opal phytoliths

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In this work we have been investigating the luminescence properties of plant opal phytoliths to assess their suitability for determination of age and/or thermometric information from soil and sediment sequences. Opal phytoliths, or bio-opal, form when monosilicic acid from soil-waters is taken up by plants and chemically altered to silica, producing intra- or extra- cellular structures that give grasses and stems their strength. Opal phytoliths are usually considered to be non-crystalline and referred to as silica mineraloid structures, with ~4-9% water, <5% other elements, and specific gravity ranging from ~1.5-2.3. They are known to be resistant to degradation and hence preserved in soil or sediment even after decomposition of organic matter. Our earlier work examined a <2.37 g/cm^3 density fraction in parallel with quartz grains from samples collected from fluvial terraces and soil pits on Konza Prairie Biological Station native tall grass prairie a few km from Kansas State University. We observed generally similar luminescence characteristics from the phytolith fractions to quartz, with bright blue OSL signals and good SAR characteristics. In two hours the OSL signal is ~90% bleached by white light, whereas red fluorescence lab lighting has a negligible effect over the same exposure time. TL data suggested the presence of feldspatic-like minerals or perhaps thermal degradation of the phytoliths during TL measurement; the phytolith fractions were also stimulated by $IRSL_{50}$ perhaps also indicating presence of contaminant minerals. Initial SEM analyses identify what appear to be weathered silica grains, but also highly weathered, pitted concretions with silicate-like structures according to element mapping but actual mineral identification is presently unclear.

Most recently we have begun analyzing samples collected from a suite of stratified paleosols from the mid-continent stream type-site of Claussen, Mill Creek, Wabaunsee County, Kansas. This site has documented phytolith examples and a radiocarbon framework. We are developing phytolith preparation methodologies, continuing luminescence characterization studies, incorporating screening of prepared fractions with SEM and IRSL evaluation, and pulsed time domain analysis measurements and micro-dosimetric shape characterization are being explored.

We think luminescence from opal phytoliths shows great promise as an alternative target to quartz or feldspar, but moreover as a sensitive recorder of climatic change or wildfire/anthropogenic-fire exposure on plant communities. This presentation will review our earlier work on phytoliths and discuss most recent findings from the Claussen site.

Keywords (max. 5): opal phytoliths, biogenic silica, luminescence properties

An optically-stimulated luminescence (OSL)-derived cryptostratigraphy from the Lake Suigetsu sedimentary profile, Japan: 30,000 – 50,000 cal BP

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The luminescence characteristics of sediments are affected by a variety of environmental factors, reflecting both local and broader regional influences. If seeking to apply optically-stimulated luminescence (OSL) as a 'pure' dating technique, variability in these external variables needs to be controlled for, involving, *inter alia*, lengthy pretreatment procedures and complex dose rate corrections. However, in so doing, a lot of potentially valuable palaeoenvironmental information is lost.

Instead, in the present study, we explicitly analysed raw, non-pretreated sediment that preserves this wealth of contributory environmental influence. Using a SUERC portable optically-stimulated luminescence (POSL) reader [1], we have performed rapid profiling across a 20,000 year interval of the annually laminated (varved) Lake Suigetsu sedimentary profile, central Japan (i.e., 30,000 to 50,000 cal BP) [2], producing 443 contiguous measurements with a mean sampling resolution of 45 years. To facilitate our understanding of this dataset, follow-up, more targeted laboratory profiling techniques were applied.

The 'cryptostratigraphy' ('hidden stratigraphy') revealed by our data includes the identification of a step-change in luminescence parameters circa 39,200 cal BP, which we attribute to a major earthquake that resulted in re-routing of inflow to the lake. Further variability in the derived luminescence signals are compared with supporting palynological, palaeomagnetic [3], μXRF [4], and thin-section microscopy data

[5] from Lake Suigetsu. A potential correlation between the luminescence profile and geomagnetic field intensity is tantalising [6], and will be the focus of discussion.

Keywords (max. 5): portable optically-stimulated luminescence (POSL), laboratory profiling, lacustrine sediment, palaeomagnetism, cryptostratigraphy

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OSL and radiocarbon-based chronology of sand-drift events on Beniguet island (W France)

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Sand dunes are an essential component of coastal landscapes. The understanding of their long-term mobility is crucial to design appropriate management methods, especially in a context of global sea level rise and associated coastal erosion. Along the coasts of Western Europe, the morphological evolution of coastal dunes has been characterized by several periods of stability and remobilization of aeolian sands during the last millennia of the Holocene. Well-constrained chronologies of dune mobility periods have been reconstructed in Ireland, UK, Portugal based on radiocarbon dating of palaeosols interbedded in aeolian sand deposits[1]. In western France, the absence of palaeosols has limited such approaches. Recently, archaeological and historical remains have been used but such an approach has many methodological limitations[2].

The objective of this study is to provide robust chronological evidence for the Holocene mobility of coastal dunes in western France. It focuses on the chrono-stratigraphic analysis of the sandy cover of Béniguet Island, located at the western tip of the Brittany peninsula (W France). The geometry of the coastal sedimentary deposits was reconstructed about 40 vibro-cores taken from aeolian sands covering the central part of Béniguet Island over a thickness between 2 and 4 m, near an archaeological site currently being excavated.

Four archaeological levels were identified and dated to the Bell Beaker, Early Bronze Age, High Middle Ages and Late Middle Ages periods.The chronology of the Holocene deposits is based on a dozen radiocarbon dates obtained on the anthropogenic levels and on 8 Optically Stimulated Luminescence (OSL[3]) ages obtained on the aeolian sand layers.

Equivalent doses were mesured from multi-grain aliquots and the dose rate was obtained from high resolution gamma spectrometry. The chronology of the sequence was modeled by combining OSL ages and radiocarbon dates in a Bayesian framework using the R package BayLum[4].

The anthropogenic levels are overlain by a series of aeolian sand layers dated by OSL to ca. 4000 BP, 2700 BP, 1000 BP. These results are consistent with the regional chronology established for western France and clarify the timing of coastal sand-drift events[2].

Keywords (max. 5): coastal dunes, Holocene, OSL, archaeology, France

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Exploring dryland dynamics with portable luminescence readers: the good, the bad and the ugly.

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Luminescence signals using portable luminescence readers (port-OSL) are insightful tools for exploring sample relative age and casting additional light on sediment characteristics, used back in the laboratory or in the field. Sand-rich dryland environments are a useful testing ground for using port-OSL, owing to the likelihood of complete signal bleaching before burial. We have been exploring the extent to which it is possible to produce generalized chronologies that approximate sediment burial age in different locations and geomorphic settings. Our approach compares port-OSL signals with ages established using standard luminescence dating protocols for quartz, as a form of port-OSL first-order 'calibration' (e.g. Stone et al., 2015; 2019; Nitundil et al., 2022). The rationale for this work is to provide landscape-scale assessments of Quaternary environmental change in a cost-effective and time-effective manner.

In this study we present samples from dunes in four regions within southern African dunes (re-measured in 2022 to provide a consistent analytical sequence and data processing approach) and from the Thar Desert in western India. This represents n=26 for the Namib Sand Sea, n=32 for the western Kalahari, n=22 for the southern Kalahari, and n=44 for the Thar (and may include further regions, if samples are available before June 2023). We also present samples from palaoelake shorelines in the former megalake Makgadikgadi sequence (n=73 from Lake Ngami, n=40 from Lake Mababe and n=36 from Makgadigadi).

We find the port-OSL calibrations are region specific with coherent regional groupings, and strong coefficients of correlations for the dune datasets. However, those from the lake shorelines define a weaker correlation with sample age. We explore the influence of sample composition data (such as quartz to feldspar rations and particle size distribution) and inherent port-OSL signal brightness (using a subset of southern African dune and lake shoreline samples).

Keywords: Portable Luminescence Readers, Quartz OSL, Dryland dunes, Dryland lake shorelines, Sediment characteristics

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Increasing the reliability of luminescence dating through the internal dose rate determination

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Improving the techniques for determining the dose rate is crucial from the point of view of luminescence age assessment. The internal dose rate determination can be widely used in assessing the age of low radioactivity sediment samples. In our earlier work [1] the ratio of internal dose rate to total dose rate exceeded 10% for sedimentary samples. Neglecting internal dose rate would lead to a significant overestimation of the luminescence age.

Our results demonstrated for two independent dune profiles (Kowalewo and Baranówka, Poland) confirm that sediments with a low natural concentration of radionuclides can frequently have a significant internal dose rate. If we ignored the internal input, we would not obtain comprehensive chronostratigraphy. Internal dose rates for pure quartz grains were obtained using the μDOSE system [2].

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Keywords: luminescence dating, internal dose rate, dose rate, quartz, aeolian deposits

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Sensitivity changes and fading behaviors of luminescence signals from various geological materials

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Understanding sensitivity changes and fading phenomena of luminescence signals is important for TL and OSL dating. In the estimation of relatively young ages by the TL predose method, the sensitivity change of the luminescence signal from quartz grains around 110°C is used [1]. In OSL dating, the luminescence signal intensity is measured when different radiation doses are given and is corrected by the one when the test dose is given [2]. In IRSL and post IR-IR dating methods, age values are sometimes obtained after correcting the fading of the luminescence signal due to aging [3]. Thus, sensitivity change and fading phenomena are important factors in luminescence dating.

In addition to the research described above, another direction of studies for Quaternary earth science has been conducted by using luminescence signals as indicator of the sediment provenance. Ganzawa et al. (1997) indicated that quartz of aeolian origin transported from China can be distinguished from volcanic quartz originated in Japanese tephra by looking at TL colour [4]. Takada (2010) showed that there are large differences among sensitivity changes of the 110 °C TL signals from various geological samples and suggested the possibility that they can be used to estimate the sediments provenance [5]. Furthermore, we indicated that the dose-saturated Al and Ti-Li center ESR intensities and TL colour can be used to quantitatively estimate the provenance of the sediments [6]. Recently Sawakuchi et al. (2018) reconstructed past drainage configurations within the Amazon basin using luminescence sensitivity as a proxy in the stratigraphic record [7]. Thus, luminescence signals are also important clues in sediments provenance analysis.

In this study, we measure the sensitivity change and fading behavior of luminescence signals for various geological materials in sediments such as quartz, feldspar, zircon, etc. and discuss how they can be applied for a new technique for dating and estimating the sediments provenance.

Keywords: sensitivity change, fading behavior, luminescence signal, dating, sediments provenance

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Potential for ESR Signal Zeroing of the E_1' center by Experimental Fault Slips

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Electron spin resonance (ESR) dating of a fault is a developing technology with the potential to di- rectly determine the age of the last seismic fault slip. This method assumes that charge trapping centers in quartz in a fault material have been completely annihilated by the seismic fault slip (ESR signal zeroing) [1]. To date, there is very little understanding of the relationship between the signal zeroing and seismic slip parameters of faults. The previous high-velocity friction (HVF) experiments have implied that the E1' center (an unpaired electron trapped in an oxygen vacancy [2]) in quartz detected by ESR measurement could be correlated with frictional power density and begin to decrease due to frictional heating at a power density of 0.6–0.9 MW/m^2 [3]. However, the data was lacking to confirm the signal zeroing at higher power density corresponding to the seismic slips of large earthquakes. This study aims to quantitatively assess the relationship between the E1' center and larger frictional power density by HVF experiments.

We performed HVF experiments for simulated quartz gouges with an equivalent slip rate of 1 m/s, an equivalent displacement of 10 m, and normal stresses of 1.0–2.5 MPa. The temperature during the expe-riment was measured with thermocouples installed in the stationary cylinder, less than a few millimeters from the sliding surface. For gouges before and after experiments, ESR measurements to detect the E1' center were conducted. The peak-to-peak height at g value ≈ 2.001 of the E1' center calibrated by that of the standard material was calculated as the ESR intensity (ESR intensity ratio) of the E1' center.

In the HVF experiments, the ESR intensity ratio of the E1' center decreased with increasing frictional power density of 0.96–1.4 MW/m^2 at normal stresses of 1.0–2.5 MPa. The observed maximum tempera- tures were 260℃ at 0.96 MW/m^2 (1.0 MPa), 600℃ at 1.0 MW/m^2 (1.5 MPa), and 480℃ at 1.6 MW/m^2 (2.5 MPa). The E1' center is thermally unstable at ≳300℃ and more unstable at higher temperatures [4]. Hence, the ESR intensity ratio might decrease due to larger frictional heating with increasing frictional power density. Comparing our results with those in the previous study, the ESR intensity ratio clearly decreased with increasing frictional power densities of 0.6–1.4 MW/m^2. It suggests that the ESR intensity ratio of the E1' center turns to decrease from a frictional power density at about 0.6 MW/m^2 and can drop to zero at a larger frictional power density. The HVF experiments in this study mimic seismic fault slips induced by earthquakes with a moment magnitude of 8–9 at shallow depths of ≲100 m. Seismic fault slip associated with an earthquake at a depth of at least one hundred meters beneath the earth's surface can be required for ESR signal zeroing of charge trapping centers, particularly the E1' center.

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Keywords: electron spin resonance, high-velocity friction, quartz, frictional heating, frictional power density

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Linking provenance and surface processes to quartz luminescence sensitivity of modern and Pleistocene alluvium in a small catchment

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The application of OSL dating requires quartz that is dominated by the fast-decay component. However, the geologic processes that lead to quartz sensitization remain uncertain. Source-rock geochemistry, pressure, and temperature can affect luminescence behavior. Quartz sourced directly from bedrock commonly has low sensitivity compared to transported sediment suggesting that luminescence sensitivity can be enhanced by exposure to surface processes of transport and mechanisms of erosion and weathering. We investigate these controls on the luminescence properties of quartz sand in modern and Pleistocene alluvium in a small catchment where we can account for lithologic changes. We compare the quartz luminescence properties with sand-grain provenance via petrographic analyses and surface processes via ^{10}Be-derived erosion rates, in-situ sediment weathering indicators, magnetic susceptibility, and topographic metrics of the catchment. These datasets are used to test the of the effects of lithologic changes and surface processes on luminescence sensitivity.

The High Creek catchment, in northern Utah, USA (52 km^2; max elevation: 3.5 km; relief: 1.6 km) contains folded and faulted Paleozoic limestones and quartzites within the core of the Bear River Range and Plio-Pleistocene basin sediments on the flank, abutting the East Cache normal fault. The drainage system has little sediment storage and two main tributaries, the North and South Forks. During the Late Pleistocene, High Creek flowed into pluvial Lake Bonneville, creating a delta at the mouth of the catchment, and the South Fork hosted a small cirque glacier. Samples were collected from modern alluvium along the river and both tributaries and from the Pleistocene delta. Luminescence sensitivity of the delta is consistently low, and the modern samples show a multi-modal and higher spread of sensitivity values. LM-OSL analyses indicate that the modern alluvium is dominated by the fast component which is generally lacking in the Pleistocene deltaic deposits. Although contributing geology varies slightly between samples there is no clear pattern between contributing bedrock and luminescence sensitivity. This temporal change in the quartz sensitivity suggests modification by surface processes between the Late Pleistocene and today.

We compare our luminescence results to other metrics that link to catchment geomorphology and chemical and physical weathering. Concentrations of major mobile cations (K, Na, Ca, Mg) of the samples suggest a slight increase in chemical weathering of the source sediment in the modern samples. With higher weathering rates, we might expect that the erosion rates derived from in-situ ^{10}Be would be lower. Patterns in erosion rate do not follow this assumption. Instead, the largest change in erosion rates is between the North (58 m/Myr) and South Forks (97 m/Myr) of the modern alluvium, suggesting that erosion rate is influenced by glacial versus fluvial dominated erosion over Pleistocene timescales. Initial findings imply that an increase in chemical weathering since the Pleistocene may be influencing the sensitization of quartz. We discuss the results of these datasets and the potential processes that control quartz luminescence sensitivity.

Keywords (max. 5): luminescence sensitivity, quartz, LM-OSL

Chronology of Late Quaternary permafrost events in the Lower Volga region (Northern Caspian Lowland)

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Areas of periglacial permafrost are widespread Late Pleistocene phenomena on the East European Plain. Numerous cryogenic structures, often forming cryogenic horizons demonstrating the existence of permafrost, have been described in this region. Geological evidence of cryogenesis is important not only for palaeogeographic reconstructions but also as a chronostratigraphic marker and benchmark of palaeotopography.

Here we present the results of a study in the Lower Volga region (Caspian Lowland) of sections containing numerous traces of cryogenesis in Late Pleistocene deposits. These traces include thin vertical wedges in loess and palaeosols, and involutions and pseudomorphs in alluvial and estuary-marine sediments. In order to identify the stages of cryogenic development and the boundaries of the permafrost zone in the southeast of the East European Plain, we characterized the morphology of cryogenic structures and undertook OSL dating.

In the Lower Volga area we identified cryogenic horizons (CH) in 6 sections. In the northern part of the Lower Volga wedges are found in loess units. Luminescence dating results for Srednyaya Akhtuba, Raygorod and Leninsk have been presented earlier, providing a chronological framework for those locations. We identified an additional loess site, Batayevka, with evidence of cryogenesis and collected 4 OSL samples. In the southern part the most characteristic forms of cryogenesis were described in the Chernyy Yar section. To determine the timing of the cryogenic processes we took 8 OSL samples from units above and below the wedges and the infilling.

In total we have obtained 12 new OSL ages from both quartz and feldspar grains. Samples were processed using standard procedures. The quartz OSL signal of sand-sized grains from all samples is sensitive, and dominated by a fast component. Quartz and feldspar measurement protocols have both been shown to perform well in laboratory tests. There is generally good agreement between feldspar $pIRIR_{50,290}$ ages and quartz OSL ages.

By considering the new and published dates for 6 sections together, we identify seven stages in the development of cryogenesis in the Late Pleistocene of the Lower Volga region: stage I (~115-105 ka); stage II (95-90 ka); stage III (~90-82 ka); stage IV (~75-70 ka); stage V (~52-45 ka); stage VI (37-35 ka); stage VII (~23-22 ka). These results contribute new understanding of the extent of the distribution of the permafrost zone in the south of the East European Plain in the Late Pleistocene.

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Keywords: luminescence dating, Volga River; cryogenic structures, alluvium, marine sediments

Direct dating of an ancient stone causeway at Bjæverskov, Sjælland, Denmark: A combined approach using rock surface burial luminescence dating of granitic cobbles and coarse grains from disaggregated heated rocks.

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In 2017 part of an ancient stone causeway was uncovered at Bjæverskov on the island of Sjælland, Denmark. Previous approaches to dating such ancient stone structures have almost always been relative, or by association, with methodologies relying upon interpretation of temporally diagnostic artifacts, radiometric dating of organic remains (^{14}C AMS), or surrounding sediments (optically stimulated luminescence dating). Such techniques can fail to conclusively address whether these materials are actually associated with construction of the ancient structure itself. With no artifacts found at the site, optically stimulated luminescence dating of sedimentary coarse grains, grains derived from crushed rock cores, and surficial rock chips obtained directly from granitic road cobbles were used to determine the time of construction. Some granitic road cobbles were visibly disaggregating at the time of excavation, and lab measurements revealed surprising fast-component dominated quartz sensitivity from these samples. It was concluded that at least some of the rocks used in the causeway had been heated, presumably prior to/or during incorporation in the structure. Dose recovery plateau experiments using quartz grains recovered by crushing apparently heated rocks suggested the use of a 220/180°C preheat/cut-heat combination (DR ratio 0.99±0.01; n=40); the low pretreatment temperatures were preferred to reduce the risk of thermal transfer in these young samples. IRSL signals were used with 4 rocks that could not be disaggregated. All yielded L/T burial profiles that indicated prior light exposure, and of these 4, two (1 granite, 1 felsic gneiss) had apparently been exposed for sufficient time for us to be confident of obtaining accurate IRSL ages. IR_{50} fading corrections were undertaken by determining L/T at field saturation (from deep within the rock), giving the same aliquots a 2kGy dose in a ^{60}Co gamma cell, and remeasuring the laboratory saturated L/T. The post-IR $IRSL_{180}$ signals were also measured in these two cobbles; the bleaching front was shallow and the signal was only sufficiently reset to allow accurate determination of D_e on one rock. In total 8 ages were accepted; 4 quartz ages from coarse grained sediment, 2 fading corrected IR_{50} ages from surface slices from non- disaggregated cobbles, and 2 quartz ages from disaggregated (apparently heated) cobbles. IRSL signals from the sedimentary and heated samples were used primarily to assess the degree of resetting of the quartz blue-stimulated OSL. In all the sedimentary samples, both the post-IR IRSL and IR_{50} signals significantly over-estimated the quartz age. However, the quartz ages, the heated cobbles and the fading corrected IR_{50} ages from the unheated road cobbles, are consistent and likely reflect the construction age. Quartz from the overlying sediments appears to be mainly well bleached, but is younger than the construction age. We conclude that the stone causeway was constructed ~2ka ago.

Preliminary optically stimulated luminescence ages for the archeological site of Gatzarria, France

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Located in the mountain range of the Pyrenees, ~100 km from the current coastline, the archaeological site of Gatzarria – in and around a karstic cave – has yielded an important Palaeolithic sequence, spanning from the Middle to the Upper Palaeolitic. The lithic industries identified correspond to several Middle Paleolithic technocomplexes, based either on the Levallois, the Discoid or the Quina technology, and a few Châtelperronian elements have also been identified. Several chronological variants of Aurignacian superpose the Middle Palaeolithic sequence, and the Gravettian completes the Upper Palaeolithic sequence [1]. Whereas both the Aquitaine Basin (SW France) and the Cantabrian region (North of Spain) are very rich in archaeological sites from these periods, the northwestern foothill of the Pyrenees, where Gatzarria is located, is less well known, despite a non-negligible number of sites. Similarities do however exist with the archaeological record of all three areas and raw material sourcing supports long distance movements, of objects and/or people, between them. Obtaining a numerical chronology at Gatzarria cave will thus enable us to describe population dynamics and interactions in a key region of SW Europe, the "Basque crossroads", during several key moments of the Upper Pleistocene.

Here we present OSL ages obtained from 34 sediment samples collected for OSL dating and processed in the usual manner using sand-sized (180-250 µm) quartz and feldspar grains. Preliminary multi-grain quartz measurements using the single-aliquot regenerative-dose (SAR) protocol show that quartz is fast-component dominated, has satisfactory luminescence characteristics and dose response curves have an average characteristic dose (D_c value) of ~70 Gy. Single-grain quartz measurement show that only about 2% of the grains give detectable luminescence signals and a significant fraction of these are in saturation on the laboratory dose response curve. Only very little K-rich feldspar is present in these samples, but comparison with quartz age will be made where possible. Age modelling will be undertaken using both the commonly applied frequentist approach as well as Bayesian modelling using the specifically designed software tool BayLum [2].

Keywords: Luminescence sediment dating, Middle- and Upper Paleolithic, age modelling

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Holocene lake formation, Yellow River migration and neolithic human activity revealed by OSL and radiocarbon ages of cores from the North China Plain

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Two layers of lacustrine deposits within Holocene exist widely in the North China Plain, representing two dramatic environmental transition events, which has significant implications for both Yellow River migration and neolithic human activity in the flooding plain. However, the ages, distribution, and environmental significance of these two layers are still unclear. In particular, previous chronological data are mostly by a few sparse radiocarbon ages, and systematic chronology investigation and luminescence ages are very limited. In this study, three boreholes were obtained from Anyang (core HX05), Puyang (core NC02), and Jinan (core ZK1), respectively. Core NC02 is about 60 km away from Core HX05 to the south, and is about 234 km away from core ZK1 to the east. The two layers of lacustrine deposits are observed in all three cores and in similar depths. Quartz optically stimulated luminescence (OSL) and radiocarbon dating are applied to determine the age of the two lacustrine sediment layers. The dating results indicate that the age of the lower lacustrine layer is about 10 ka, and that the upper lacustrine layer is about 3 ka. The implications of the dating results for paleoenvironmental change, Yellow River migration, and neolithic human activity in the flooding plain will be discussed.

Keywords: quartz OSL, radiocarbon dating, drilling Cores, Yellow River Plain, lacustrine deposits and neolithic sites

Reconstructing dust provenance from quartz OSL and ESR signals: pre- liminary results on loess from around the world

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It is well known that optically stimulated luminescence (OSL) sensitivity of quartz can vary orders of magnitude across different samples. However, it is debated whether quartz OSL sensitisation is induced by Earth surface processes or driven by the intrinsic properties of crystals in the source rock. Moreover, the defects responsible for this variability are not yet identified. On the other hand, oxygen related defects in quartz that can be quantified by electron spin resonance (ESR), such as the concentration of paramagnetic oxygen vacancies in the form of the E_1`native defect [1,2] or the heat-treated $E_1$` (thought to reflect the total number of oxygen vacancies [3]), and the so-called peroxy radicals [1,2] have been shown to correlate with the age of rocks and have been proposed as provenance indicators.

Here, we work towards obtaining a better understanding on the relationship between point defects in quartz and luminescence properties such as the OSL sensitivity, with the final aim of establishing a trapped charge quartz-based provenance method. We analyse quartz extracted from loess sites in different locations worldwide, on which detrital zircon U-Pb age distributions have been previously presented. The advantage of using loess is that it is windblown and transported over long distances. Thus, it can be assumed that the intrinsic characteristics of the source rocks dominate over the effect of transport in the variability of the luminescence and ESR properties of sedimentary grains.

For a signal to be an accurate indicator of provenance one needs to show that it is either dose independent or reaches a quantifiable steady state. By using samples collected from Luochuan site, we show that the laboratory and natural dose response curves of E_1` and peroxy ESR signals of quartz overlap and reach a steady state for doses over about 1000 Gy, that we attribute to reaching a dynamic equilibrium between diamagnetic and paramagnetic oxygen vacancies. For this dose range we show a strong linear relationship with nil intercept between $E_1$` and peroxy signals for samples worldwide, supporting the hypothesis that these defects are Frenkel pairs. Further, we show significant correlations between the OSL sensitivity and the above two mentioned ESR signals. The very strong correlations (Pearson`s $r > 0.85$) remain valid after the samples have been heated for 15 min to 150 ˚C in order for $E_1$` to reach its maximum value, clearly suggesting a relationship between OSL sensitivity and oxygen vacancies in general. All the above-mentioned properties are clearly distinguishable for samples collected from different locations, hence have potential to be used as provenance indicators. A clear empirical increase in OSL sensitivity as well as oxygen related defect concentrations is observed in areas where the source material has components with older ages. It does seem that OSL sensitivity and intensity of E_1` and peroxy defect signals are governed by the age of the source rock from which the loess is derived.

Keywords: quartz, oxygen-related point defects, ESR, OSL, provenance

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ESR and OSL variability in quartz extracted from magmatic, metamorphic or sedimentary rock

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Sediment routing systems in fluvial catchments are primarily governed by intertwined climatic, tectonic and man-induced drivers at the centennial/millennial timescales. Among the various geomorphological and geochemical approaches developed to trace sediment dynamics, the scientific community has recently explored the potential of (palaeo-)dosimetric methods, which are extensively used to date e.g. Quaternary alluvial environments. Recently, Optically Stimulated Luminescence (OSL) and Electron Spin Resonance (ESR) signals have been successfully transposed to decipher sediment provenance and transport in fluvial catchments.

In this context, the French ANR QUARTZ research project aims at using quartz grains as an ubiquitous marker of sediment dynamics to understand (i) how each quartz grain holds a source-specific signature, and (ii) how this signature evolves along sediment routing systems. This contribution specifically focuses on the first research topic.

Quartz-bearing rocks located upstream in catchments deliver the material that is usually dated by OSL and/or ESR in fluvial sequences/deposits for geological or archaeological purposes. Here, we analyzed with ESR and OSL methods quartz grains originating from different source rocks in the Strengbach and Séveraisse catchments (France), draining a low mountain range (Vosges Mountains) and the Alps (Ecrins Massif), respectively. These rocks comprise magmatic, metamorphic and sedimentary lithologies of distinct age and composition, and provide quartz minerals present in the transposed and deposited sediments. The quartz grains were analyzed with ESR and OSL methods on the quartz minerals from different quartz-bearing rock formations in both catchments, i.e. mostly granites, gneisses and sandstones of distinct ages and/or compositions. The source-specific signature of the different ESR signals (Ti/Al ratio, signal shape, non-optically bleachable intensity of the Al centre) was investigated. The bleaching kinetics of the different ESR centres used in dating and present in these quartz from different rock types were also investigated. Depending on the history of the quartz-bearing rock and therefore of the quartz nature (magmatic, metamorphic or sedimentary), we suggest that the ESR response varies in terms of signal shapes and intensity ratios of the different centres measured. Similarly, quartz OSL characteristics have been investigated (OSL signal intensities, contributions of fast/medium/slow OSL components, dose-response curves and saturation behavior) between rocks of different origins, as well as the bleaching potential (residual doses) between different quartz origins.

These analyses are currently complemented in a near future by quantified trace element analyses on quartz samples from the same sources. This will allow us not only to provide encouraging results in terms of tracing quartz in fluvial deposits, but also a better understanding of the processes at the origin of ESR and OSL signals variability. This will constitute a first step towards understanding the dosimetric behaviour of the sediments to be dated, and towards even more reliable dating techniques.

Keywords (max. 5): quartz, ESR, OSL , rocks, variability

Investigating the accuracy and relevance of the pIT protocol

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In 2020, Lamothe et al. [1] proposed a new protocol for determining the equivalent dose (De) of potassium feldspar grains (.). The Post-Isothermal IRSL (pIT) relies on an artificial mimic of the fading by applying an annealing temperature before each measurement of both IR50 and IR225 signals, avoiding to measure the fading rate, and avoiding the bleaching issues of the PIR290 protocol. Here we compare the De or ages obtained with the pIT protocol, with those obtained with other protocols, including PIR290 on feldspar grains, SAR on quartz grains and independent age controls. We discuss the significance of a correlation between the pIT De and annealing times, and the relevance of using a third signal (e.g. IR150).

Keywords: post-isothermal IRSL, PIR290, feldspar, Equivalent Dose, fading.

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Resetting of quartz OSL signal from fault gouges by the 1891 Nobi Earthquake

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The Nobi Earthquake in 1891 [1] with an estimated magnitude of 8 is the largest historical intraplate earthquake in Japan. This earthquake caused ruptures along the Neodani Fault, a left lateral strike-slip fault north of Nagoya. Maximum horizontal and vertical offsets of ~8 m and ~6 m, respectively, were recorded [2].

Direct dating of fault gouges has been conducted by many authors using both luminescence and electron spin resonance (ESR) dating [3]. Although fully resetting of the signals was observed experimentally in shear experiments, comparisons of apparent luminescence/ESR ages with known historical earthquakes typically yielded overestimated ages by 2-3 orders of magnitude [4].

This study investigates quartz optically stimulated luminescence (OSL) signal resetting of fault gouge samples obtained from two cores (R3NDFP-1 and R3NDFD-1) [5,6] drilled at the central part of the Neodani Fault to estimate the degree of the OSL signal resetting by the Nobi Earthquake. The samples were taken every 2-4 mm from the most recent active fault slip plane in the cores. The silt-sized quartz samples with a grain size fraction of 2-11 μm were prepared for OSL measurements. The natural signal intensity and dose response curve of the samples were obtained using the single aliquot regenerative dose (SAR) protocol with pulsed OSL stimulations to remove any contaminated signals from feldspar. The apparent age, thermal stability parameters of the OSL signal and the reported recurrence interval of the fault were used to simulate the history of accumulation and resetting of the OSL signal at different distances from the fault plane. The results will be used to discuss the sampling strategy of fault gouge as well as the method of fault activity evaluation by direct dating of faults.

Keywords (max. 5): fault gouge, Nobi Earthquake, active fault, quartz OSL, signal resetting

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μDOSE^{+}: Dose rate measurement system with active shielding boosted by machine learning

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μDOSE^{+} is an enhanced dose rate measurement system dedicated for small and/or very low radioac - tivity samples. System extends the capabilities of the μDOSE system by implementing major improvements. For example, a unique and patented active shielding (UPRP Pat. 242191) that reduces the number of false pulses originating from cosmic radiation which would be classified as α or β particles. This is done using the state-of-the-art Uniform Manifold Approximation and Projection (UMAP) [2] and Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN*) [3] machine learning algorithms which are used for pulse classification.

In addition, the improved counting chamber allows to measure samples from a wider mass range, provides higher β counting efficiency and offers effortless maintenance μDOSE^{+} system.

130 000 pulses classified with UMAP and HDBSCAN*. Clusters are formed by α particles, β particles and background events.

Keywords: dose rate, alpha beta counting, machine learning, UMAP, HDBSCAN*

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Bleaching in river valley sediments from the eastern margin of the Last Scandinavian ice sheet

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One of the major unresolved paleogeographical issues of the East European Plain concerns the evolution of its major river systems. According to a popular model, some of the systems on the MIS2 Scandinavian Ice Sheet (SIS) margin were occupied by proglacial lakes – one example is the Upper Volga River [1]. Published luminescence ages of what were thought to be limno/fluvioglacial sediments [1] showed that quartz is in saturation and the feldspar $pIRIR_{50,290}$ signal gives much older ages than expected (~300 to ~600 ka). These ages contradict the geological interpretation: since the valley lies inside the MIS6 ice limit, it must have been completely reworked by the MIS6 glaciation, and so no sediments can be older than MIS6. This apparent age overestimation could be attributed to poor bleaching, but there is no evidence for this. Investigating the degree of bleaching of fluvio/limnoglacial and alluvial sediments from similar valleys located near previous ice fronts could help us resolve this inconsistency.

LGM proglacial lakes have been reconstructed in the Severnaya Dvina drainage basin; this system drains part of northwest Russia to the Arctic Ocean. The basin was partly occupied by the eastern margin of the SIS, and debate about the existence of a proglacial lake is still ongoing. We have investigated the luminescence behaviour of various valley sediments sites and the LGM proglacial lake history.

We studied 10 sections in Severnaya Dvina basin, collecting 34 OSL samples. Most of the samples are alluvial, but there are also 5 limnoglacial and 2 fluvioglacial samples. Almost all have ages estimated using both quartz and feldspar signals from sand-sized grains, so we were able to investigate the degree of bleaching of the quartz by comparing quartz OSL ages with feldspar IR_{50} and $pIRIR_{50,290}$ ages. For both OSL and pIRIR dose recovery tests are satisfactory. For twenty-two samples, both IR_{50} and $pIRIR_{290}$ ages agree with OSL ages, indicating that the quartz OSL signals were very likely sufficiently well-bleached at deposition. This applies to one out of 5 limnoglacial samples; for the other four, IR_{50} ages agree with OSL ages, indicating that the quartz signals were probably well-bleached, and indeed these quartz ages are stratigraphically consistent. We can conclude that any $pIRIR_{50,290}$ unbleached signals in these samples at the time of deposition must have recoded apparent doses of <15Gy. These results show that both quartz and very likely feldspar signals in limnoglacial sediments are expected to be well-bleached in these proglacial environments, and we conclude that a proglacial lake indeed existed here during MIS2, partly filling the Severnaya Dvina valley. However, the two fluvioglacial samples underlying the lake sediments both have quartz in saturation and only one has a finite $pIRIR_{290}$ feldspar age (~350 ka). But their stratigraphical position suggests accumulation in MIS6 and so poor bleaching should not be ruled out, even although the one datable sample has an $IR_{50}/pIRIR_{50,290}$ ratio consistent with the younger well-bleached samples (as in the Volga [1]). Hence, further investigations are needed.

Keywords (max. 5): signal bleaching, quartz, feldspar, proglacial lake, LGM

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The Brabant Member at Romont quarry (East Belgium): new luminescence ages based on quartz and feldspar

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The stratotype for Middle and Upper Pleistocene loess deposits in Belgium is exposed in the Romont quarry at Eben-Emael. Previous luminescence dating studies have generated a broad chronostratigraphic framework for the Upper Pleistocene part of this sequence. However, these ages were not obtained using samples that were collected at systematic, closely-spaced vertical intervals. As such, the available dataset does not allow, for instance, calculation of detailed dust mass accumulation rates, recognition of short phases of enhanced dust deposition, and hiatuses. This considerably hampers interpreting the record in terms of its broader significance and relevance for understanding past dust-dynamics and their relation to climatic change in an ice-marginal region. In addition, little or no work has been undertaken on the Middle Pleistocene (i.e. MIS 6 and older) deposits, implying that their chronostratigraphic position is uncertain. These gaps in our understanding led us to revisit the site for further luminescence analyses.

Here, we present the first luminescence-dating results for samples that were collected at vertical intervals of 10 cm from the top 5 m of a sequence preserved in the NW limit of the Romont quarry (i.e. some 50 samples in total). The sequence essentially covers the Upper Pleistocene. In terms of lithostratigraphy, it corresponds to the Brabant Member, which comprises a cryoturbated horizon (Nagelbeek Tongued Horizon; NTH) that is covered by a unit of homogeneous silt, which lacks distinct sedimentary structures. The NTH is an important marker horizon that is found across all the Belgian loess belt. The top of the member is strongly decalcified and weathered, forming a Holocene luvisol.

To establish the chronology, we use OSL, IR_{50} and $pIRIR_{290}$ signals from very fine sand-sized (63-125 μm) quartz and K-feldspar; the dose rate is derived through high-resolution gamma-ray spectrometry. These analyses are currently ongoing – the results we have obtained so far indicate that "the Brabant loess" contains well-bleached material. The final age results will be presented at the meeting. The ages will also be related to our finds for the Brabant Member as exposed at other localities, such as Lixhe/Visé (B) and Maastricht (NL), which were reported during the UK Luminescence and ESR meeting in 2015 in Glasgow (for that particular abstract, see: https://www.gla.ac.uk/media/Media_409842_smxx.pdf, p. 76).

Keywords (max. 5): loess, Romont quarry, quartz, K-feldspar

Dating the terraces of the Lena River using luminescence

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The Lena River is one of the largest rivers in the world; it determines the geomorphology and controls the exogenous processes of Northeastern Siberia. The Lena River is a remarkable case of palaeogeographic inheritance, traceable throughout the Quaternary period. As a result, the history of the river is complicated and can be divided into several epochs.

The stages of channel evolution, the influence of the Verkhoyansk Ridge glaciation on channel position and the number, and the age and origin of river terraces have all been a matter of debate for more than half a century. Large-scale geological investigations of bank exposures conducted during the Soviet period provided important stratigraphic data which have been used by various authors to reconstruct the geological history of the Lena River. However, these interpretations vary widely with no consensus on the number, age or genesis of the terraces. This complicates palaeogeographic reconstruction of the Lena valley, especially because of the debates around position and age of various Quaternary terraces. Many researchers have remarked that the absence of absolute dating is a major barrier to improved understanding.

To address this problem, in 2019-2021 we investigated the Ust-Buotama outcrop in the middle reaches of Lena River (61.232091 °N., 128.602046 ° E.). This section is the best exposure of the Bestyakh terrace, the most distinctive of the accumulation terraces of the Lena River. The outcrop, located on the right bank of the river 130 km upstream the city of Yakutsk, has a maximum height of ~120 m, including an aeolian dune. The terrace contains 3 recognised main geological units: Bestyakh, Mavrinka and Dolkuma, the genesis and age of which are debated.

We sampled 9 tubes from the Mavrinka and Dolkuma units. Using optically stimulated luminescence and post-infrared stimulated luminescence we obtained 8 finite ages, while the lowermost sample was in full saturation. Our chronology is based on sand-sized multi-grain quartz and feldspar aliquots. Luminescence measurements were carried out for quartz and feldspar to determine whether the signals were sufficiently bleached prior to sedimentation. The quartz OSL signals are fast-component dominated and dose recovery ratios are satisfactory (1.04±0.03; n=20). Quartz/feldspar age ratios (1.06±0.12) demonstrate that quartz OSL signals were very likely sufficiently bleached. Independent age control (radiocarbon dating results from the aeolian dune) supports our luminescence ages.

Our results indicate that: (i) the base of the section (Mavrinka alluvial formation) was deposited before 300 ka; (ii) the middle part, represented by Dolkuma aeolian unit formed during MIS 2, and (iii) the final stages are marked by a palaeosol formed 15.1±2.6 ka ago. For the first time we identified a stage of strong aeolian activity in the middle reaches of the Lena River during MIS 2, forming a 55-60 m thick aeolian field. This aeolian reworking of the Lena alluvial sediments may be the source of the large sand deserts in the Lena valley, and the large area of dust sedimentation in the Beringia region (Yedoma formation).

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Keywords: North-Eastern Siberia, Yakutia, fluvial terraces, sand dunes, OSL dating

Landscape dynamics enlightened by feldspar single-grain luminescence

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Luminescence dating is widely used to determine the time of deposition and burial of sediments. The optically stimulated luminescence (OSL) signal of quartz is most often used, as it is very light-sensitive and thus likely to be reset upon deposition. In recent years we have explored what additional information luminescence signals may yield about sediment provenance, transport and mixing processes. For such applications luminescence measurements are best made on individual grains. Moreover, less light-sensitive signals may have a better 'memory'. Hence we focus on post-infrared infrared stimulated (pIRIR) luminescence signals from sand-sized K-feldspar grains.

Our investigations have shown that up to half of the feldspar grains from most samples yield suitable pIRIR properties to determine an equivalent dose (D_e). Information on provenance, transport and mixing is interpreted from the single-grain D_e distributions. We suggest that the percentage of grains with near-saturated signals, the percentage of well-bleached grains, the mean and overdispersion of the distribution may all provide useful insights.

In a range of studies, partly already published[1-4], we have used these novel approaches to quantify soil mixing and fluvial sediment transport rates. Moreover, we have shown that the De distributions inform on changes in provenance and sediment transport over time, and that catchment-wide denudation rates are reflected in the distributions. We presently explore how the method can provide insight in the pathways of nourishment sand along the Dutch coast.

Keywords (max. 5): Sediment transport, provenance, single-grain, K-feldspar

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The D_e underestimation caused by recuperation of heated quartz extracted from volcanically-baked clay and correction strategies

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Accurate luminescence ages of volcanically-baked clay are important for studying the eruptive history of young quaternary volcanoes. However, some unusual luminescence properties were found in some heated quartz extracted from volcanically-baked clay, i.e., slow decay rate, strong recuperation, etc., whose effects on equivalent dose have not been well studied. In this study, baked clay collected from Dayingshan volcano, Yunnan Province, southwest of China, were collected to investigate the effect of these special luminescence characteristics on equivalent dose. It was shown that the initial OSL signal of heated quartz was dominated by medium component with small Fast Ratio values (< 10), and pulse-annealing tests indicated that the medium component was thermally stable. The negative correlation between D_e and recuperation indicated that strong recuperation would lead to the underestimation of D_e when using the SAR-OSL method. Therefore, three different correction strategies were used to suppress or eliminate the effect of recuperation on D_e, namely: I) correction by the D_e-recuperation relation[1]; II) early background subtraction[2]; and III) increasing the excitation temperature. The corrected luminescence ages fitted well with independent ^{14}C ages obtained by carbon chips. The accurate eruption history of Dayingshan volcano during the Quaternary was finally obtained at about 41-43 ka.

Keywords: heated quartz, OSL, recuperation, medium component, volcanically-baked clay

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The single grain K-feldspar luminescence dating of paleolake shorelines of Manas Lake reveals the Late Quaternary glacial melting water forced highstand lake level in arid Central Asia

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In Westerlies-dominated Central Asia, the spatial-temporal pattern of lake evolution on the scale of glacial-interglacial cycle remains unclear, primarily due to the lack of robust lake level records compared to monsoonal East Asia. In this study, five well-preserved paleolake shoreline sequences with 12−24 m above modern basin of dried Manas Lake, a representative terminal lake in the Junggar Basin of arid Central Asia, were investigated. Single-grain K-feldspar pIRIR dating is used to 29 shoreline samples for chronology determination. Combining the previously reported ages of beach ridges at Manas Lake basin, An integrated lake level history for Manas Lake during past 80 ka is reconstructed. Results showed that lake-levels were at highstands of ~25 m above modern lake basin (a.m.l.) during MIS 5a (~80−70 ka) and 23 m a.m.l. during MIS3 (48−27 ka). Holocene high-lake-level occurred in the last deglaciation-early Holocene (14−10 ka) and in the late-Holocene (3.5−0.2 ka) at ~20 m a.m.l., which then shrunk dramatically within a few decades. The possible mechanism of lake level evolution is discussed through comprehensive analysis with regional modern hydrological characteristics and reliable paleoclimatic records. The alpine glaciers in Central Asia, driven by Northern Hemisphere summer insolation, plays a more dominant role relative to Westerlies precipitation in the basin lake level changes recharged by glacial meltwater on both orbital and suborbital timescales.

Keywords: single-grain K-feldspar pIRIR dating, paleolake shorelines, lake level changes, Glacier meltwater

Quartz OSL and K-feldspar pIRIR dating of young nebkhas from semi-arid dune fields in northern China

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Nebkhas are a unique biogeomorphological aeolian landform, and widely distributed in arid and semi-arid regions. Previous studies have shown that nebkhas have great potential to act as an available record of the regional climate and environmental change during the Anthropocene. However, to establish a high-resolution chronological framework for the nebkhas sediments, which might be deposited recently and thus have relatively young ages, is challenging. In this study, quartz SAR-OSL and K-feldspar $pIRIR_{150}$ dating methods were applied to date the nebkhas sediments from different sites in the Mu Us and Otindag dune fields in northern China. A set of tests, such as the dose recovery, anomalous fading and residual tests, were carried out to explore the applicability and reliability of the K-feldspar $pIRIR_{150}$ dating protocol in this area. We also analyzed OSL signals of quartz grains with annealing step of different temperatures, to test the sensitivity of luminescence signals. The results show that pIRIR signals have relatively low residual doses and satisfaction of dose recovery ratio around 1, indicating the applicable of K-feldspar $pIRIR_{150}$ protocol. Meanwhile, quartz SAR-OSL and K-feldspar pIRIR ages are generally comparable, both of which are coincided with the stratum sequences, indicates the reliability of ages. The new luminescence dating results revealed that the nebkhas in different sites of the Mu Us and Otindag dune fields are most likely formed in the past few hundreds of years, and they have probably undergone multiple phases of sand accumulation and erosion, linking with regional environmental changes as well as local disturbances.

Keywords: nebkhas; quartz SAR-OSL dating; K-feldspar $pIRIR_{150}$ dating; environmental reconstruction; Anthropocene

OSL and radiocarbon dating of a borehole from the East China Sea shelf and implications for regional stratigraphic correlation

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The East China Sea (ECS) is featured by a broad continental shelf, huge terrigenous sediment input, and striking river-sea interaction during the Quaternary. Despite previous studies, mostly on the littoral areas and inner shelf, the late Quaternary stratigraphy and sedimentary environment on the mid-outer ECS shelf were poorly documented. In particular, it is still controversial in critical issues such as the recognition of marine transgression deposits in the interglacial period and the occurrence and ages of deposits in the glacial period [1, 2, 3, 4], mainly due to the limited robust chronological data.

This study presents new data on geochronology and lithology of a borehole on the outer shelf of the ECS, aiming to revisit the sedimentary stratigraphic evolution since the Marine Isotopic Stage 5 (MIS5). A comprehensive analysis of 19 luminescence and 17 AMS ^{14}C ages provides a strong constraint for the chronostratigraphy since MIS5. The marine regression/transgression cycles were identified using sedimentological analysis, which primarily constrained the environmental change over the past 100 kyrs, including tidal sand ridge, tidal flat, tidal estuary, fluvial channel, shallow sea. Although the borehole was characterized by the strong river-sea interaction accompanied with sea level fluctuations, this study clearly identified the stratigraphic boundaries between MIS1 and MIS 5 by luminescence dating, as well as by lithology. The data confirmed the tide-influenced fluvial deposition formed during the Last Glacial Maximum on the outer shelf. We infer that tidal forcing significantly superimposed its influence on sea level change and thus formed the most striking feature on the late Quaternary stratigraphy of the open ECS shelf. The major findings of this study may allow better understanding of the Quaternary sedimentary evolution and river-sea interaction on open shelves dominated by siliciclastic sedimentation, as well as for regional stratigraphic correlation.

Keywords: Luminescence dating, AMS ^{14}C dating, chronostratigraphy, borehole, the East China Sea shelf

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Combined ^{14}C, OSL and ESR dating of representative loess-paleosol sequence from Songnen Plain, Northeast China

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The expansion of Asian inland aridification not only resulting in the desert and Gobi development in the mid-high latitudes of the northern hemisphere, but also become the main source of the global aeolian dust, which even today profoundly affect billions of people. Consequently, understanding the origination, development and expansion history of those aeolian deposits have been a hot research topic around the world, which could provide essential information for assessing future regional and global trends of climate and environmental conditions and social-economic activities organizing in this area. However, previous studies were mainly focus on central Asia; the Northeast China as the eastmost Eurasia boundary of the aeolian dust transportation and expansion, has been rarely studied.

The loess-paleosol sequences, as the typical surface aeolian deposit in late Cenozoic, have been confirmed as the classic recording archives of the Asian aridification history and contain a direct indicator of past atmospheric circulation. Especially, the loess-paleosol accumulation located at the sand-desert downwind area, has an excellent coupling relationship with the formation and evolution of Asian aridification expansion, which can well constrain the evolution process of Asian aridification expansion. Songnen Plain is located at the easternmost Eurasian arid-semi-arid zone, which is the final inland area for aeolian dust accumulation, and is sensitive to the climate fluctuations and could provide the earliest timing record of the Asian aridification eastward-expansion.

After late Quaternary mammal fossils and paleolithic investigations at the 1970s, the systematic lithostratigraphic division studies of the Songnen plain are started from 1980s. Based on the magnetostratigraphy, ^{14}C and OSL dating results, combined with excavation of Mammuthus primigenius Blumenbach and Coelodonta antiquitatis Blumenbach, Sun et al. (1982) and Wu et al. (1984) divided the stratum of Songnen plain into Huangshan formation (early Pleistocene), Dongfeng formation (middle Pleistocene), Harbin formation (late Pleistocene), and Tantu formation (Holocene) from bottom to top, respectively. However, because of the unknown of exactly location at which the fossils were found, the stratigraphic division of Songnen plain remains debate.

In this study, we present an iconic ~55 sediment section (including ~29.9m loess-paleosol sequences) deposited at north Songnen Plain, Northeast China. On the basis of magnetostratigraphy, the chronostratigraphy of the ^{14}C, OSL and ESR dating were performed on this section, which could provide a better absolute dating constrain on the evolution history of the Asian aridification expansion and climate change.

Keywords: OSL dating, ESR dating, Asian inland aridification, loess-paleosol sequences, the Northeast China

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ESR and OSL-thermochronometry in the Western European Alps

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The western European Alps are characterised by deeply incised valleys, however the timing of their formation and the impact of Quaternary glaciation on rates of erosion remains disputed. This is mainly due to a lack of geochronological methods that cover the timespan of 10^3-10^6 years. Electron spin resonance (ESR) thermochronometry using both the Al and Ti centres in quartz has high potential to fill this temporal gap because of its low closure temperature (<100 °C), potentially allowing changes in erosion rates to be related to glacial advance and retreat.

We took surface rock samples for ESR and OSL-thermochronometry from two elevation transects in the Rhône valley, Switzerland near to the towns of Sion and Visp. Before applying the ESR thermochronometry method, a series of ESR protocol validation experiments were conducted using the Sion samples. A single aliquot regenerative additive measurement protocol was used that involves an annealing step at 400°C following the measurement of the natural signal. The suitability of this protocol was tested by using preheat plateau, dose recovery and recycling ratio tests, as well as through comparison with single aliquot additive dose response. To estimate the thermal kinetic parameters, both isochronal and isothermal decay experiments were performed. OSL-thermochronometry measurements were done following Bouscary and King (2022)[1].

The preheat plateau experiment showed that 170°C is the appropriate preheat temperature whilst sensitivity changes are not significant. ESR thermochronometric ages of seven samples from Sion range between 240 kyr and 650 kyr, while Ti centre ESR signals of samples from Visp are saturated. Although the lithology of the two sites is similar, the D0 values of samples from Visp are 2-3 times smaller than those measured at Sion. The frequency factors were >8 orders of magnitude smaller for the isochronal experiment relative to the isothermal experiment, with the latter experiment yielding the most plausible parameters. For most samples the Al-centre has higher thermal stability than the Ti-centre, although the thermal stability of the different samples investigated is highly variable (e.g., *s* ranges from $7.5*10^9$ – $4.5*10^{12}$ s^{-1} and *Et* from 1.3-2 eV for the Ti-centre).

Preliminary inversion of the Sion ESR data yield consistent cooling histories, with the exception of the valley bottom sample that suggests more rapid rock cooling. These data show that the low closure temperatures of the Al and Ti signals in quartz allow the Late Quaternary exhumation of the Alpine valleys to be resolved. In contrast, first luminescence measurements on the samples from Sion yielded saturated values (e.g., D0 values of the IR50 signals are between 130 and 200 Gy), demonstrating the additional potential of ESR-thermochronometry in these kinds of settings.

Keywords: ESR thermochronometry; SARA protocol; thermal stability; European Alps

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Challenges in US-ESR dating: From irradiation sources to age modelling

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In the past decade, the ESR signal of fossil tooth enamel powder has been shown to be a compound spectrum of several radicals with distinctive kinetics [1,2,3]. This led to developing new methodological protocols working with enamel fragments, such as radical intensity separation and angular variation calculation. Furthermore, the identification of radical distribution heterogeneity in enamel layers has pushed to further investigate radiation impact on the ESR signal [4,5].

In this paper, we will present on overview of the challenges arising when dating fossils remains with the coupled dating techniques Uranium-series and Electron Spin Resonance dating.

Our presentation will review recent advances in understanding the impact of different irradiation sources to the ESR signal and the distribution and concentration of stable and unstable radicals [6]. We will also discuss the importance of Uranium uptake mapping of dental tissues and the heterogenous influence on the ESR intensity. We will place this new knowledge in perspective to discuss our latest age modelling attempt of early Pleistocene fossils [7].

Keywords (max. 5): US-ESR, direct dating, tooth enamel, fragment, powder, irradiation source, x-ray, uranium mapping

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Dating fault rocks using optically stimulated luminescence and ESR signals: Can OSL and ESR signals be reset by faulting ?

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Faulting that caused surface ruptures in the past, particularly during the Quaternary, is of significant importance for the assessment of potential earthquake hazards. Thus, considerable efforts have been made to infer the timing of last fault movement and the recurrence intervals of age-unknown faults. Previous works have mainly relied on OSL dating of unconsolidated sediments cut by faults. However, this can provide only indirect chronological information on the timing of last faulting. Further, any attempt to directly date faulting event using radiogenic isotopes or ESR signals of constituent minerals in fault rocks has not been successful because of the limitations of each dating scheme. Recently, by several authors, the possibility of applying OSL dating method to fault rocks was investigated. However, these were mostly carried out using simulated fault gouge [1] with a few case studies on natural samples [2].

In the northern segment of the Yangsan fault in the southeastern part of the Korean peninsula, a well-preserved PSZ (Principal Slip Zone) is observed in a fault core outcrop with the thickness of ~ 1–2 cm. As the PSZ is considered to have been exposed to intense frictional heat and stress during faulting event, we expect that luminescence and ESR signals of quartz or K-feldspar grains in this particular part of the fault rock would have been effectively bleached during fault slip. To test our hypothesis, we collected samples from PSZ, together with those from CZ (Cataclasite Zone) and BZ (Brown gouge Zone), which are located on the west and east sides of the PSZ, respectively [3]. Then, we characterise and compare the optically stimulated luminescence and ESR signals of minerals extracted from each fault core zone, and examine the equivalent dose values obtained using different luminescence signals. Finally, we discuss the potential importance of PSZ for directly dating the timing of last earthquake faulting events using OSL or ESR dating methods.

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Keywords: optically stimulated luminescence, ESR, fault rock dating, signal resetting

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Using luminescence dating to establish a window of extinction; the demise of the greatest ape - *Gigantopithecus blacki*

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Luminescence dating, in all its different forms, provides a robust sedimentary context for cave deposition[1] and has the potential to form the backbone of cave chronologies in Asia[2]. In this region, the evidence for the mysterious giant ape *Gigantopithecus blacki*, the king of all Asian megafauna and the only ape to go extinct in the Quaternary, is only found in cave sediments[3]. This creates a premium for accurately constraining *G. blacki* burial sediments and establishing a 'window of extinction', which represents a vital tipping point at which palaoenvironmental and palaeobehavioural evidence is interpreted. As the reason for its demise is intimately connected to timing, determining the exact window of extinction represents the first step towards identifying the cause/s.

In this talk, we will outline a Bayesian modelling approach[4] to establishing the extinction window of *G. blacki* using 55 OSL single grain, pIR-IRSL single aliquot and single grain techniques applied to 22 cave sites in southern China. These provide a vital sedimentary context for cave sedimentary and fossil deposition and form the backbone of the cave chronologies. They are supported by 102 independent age estimates from U-series, US-ESR and ESR quartz, which provide a useful regional data set to test the performance of luminescence dating in this region. By sampling both *G.blacki*-bearing and non-*G.blacki* bearing caves and modelling a fossil and sedimentary context we have reconstructed a point in time when giants ceased to roam in this region.

Keywords (max. 5): Extinction window, *Gigantopithecus blacki*, Bayesian modelling, pIR-IRSL, OSL single-grain

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Spatially-resolved luminescence behaviour in museum specimens of feldspar: implications for dating rocks and sediments

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Feldspars occur with a range of major element chemistry and mineral structure. When dating sediments using coarse-grained feldspars, samples are prepared using density separation to make a crude distinction between potassium-rich and potassium-poor feldspar grains and other minerals. When applying luminescence dating techniques to rocks, even such relatively crude physical separation of minerals is not possible where intact rock slices are used. However, for both sediment and rock dating of feldspars, use of imaging detectors such as Electron-Multiplying Charge Coupled Devices (EMCCD) presents the opportunity to spatially resolve different mineral grains, offering potential advantages over the more conventional photomultiplier tubes that are typically used. Furthermore, scanning micro X-ray Fluorescence (μXRF) devices offer the opportunity to resolve major element chemistry at a similar resolution (~20μm) to EMCCD data, revealing different feldspar types and enabling these to be linked to luminescence behaviour. Such an approach would allow us to assess whether some feldspar types are better suited to dating than others.

This study explores spatially-resolved optical resetting, dose response and fading properties for IRSL and IRPL signals in a selection of chemically and structurally characterized museum specimens of alkali and plagioclase feldspar. These feldspars were prepared as ~300 μm thick slices, and exposure to a SOL-2 solar simulator was used to test optical resetting of the various luminescence signals examined. Spatially-resolved detection of each luminescence signal was achieved using sensitive EMCCD detectors on SIRIOL [1] and DASH [2] heads mounted on a TL/OSL DA20 Risø reader. Maps of major element distributions for each feldspar slice were produced with a Bruker M4 Tornado Plus μXRF spectrometer. EMCCD and μXRF data were processed and analyzed using various packages in the Fiji distribution of the ImageJ software [3]. Bulk mineral structure was characterized for the feldspar samples by X-ray Diffraction (XRD) on powdered sample using a PANalytical X'Pert PRO Materials Powder Diffractometer, and bulk chemistry by XRF on pressed pellets of sample and cellulose binder using a Rigaku Primus IV XRF spectrometer.

Spatial variability was observed in the luminescence properties across the signals and feldspars investigated. Relationships between the behaviour of these luminescence properties and major element chemistry are explored. The benefits of high spatial resolution measurements, and different feldspar types, are discussed in terms of luminescence dating of rocks and sediments.

Keywords: feldspar, luminescence behaviour, major element chemistry, spatially-resolved detection

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Violet stimulated luminescence based new ages of loess and hominin occupation in Lushi Basin, Eastern Qinling Mountains, central China

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The Qinling Mountains (QLM) in Central China with numerous Paleolithic localities is an important area for hominin occupation and settlement during the early to middle Pleistocene. Paleolithic archaeological survey was carried out in the Lushi Basin in the middle of South Luohe River, central China, Hundreds of paleolithic artifacts were collected and in situ lithic artifacts have been found buried in loess deposits. To establish the reliably chronological framework of the loess sediments and find the age of human occupation, luminescence dating is investigated to obtain age controls. Preliminary dating results using quartz SAR-OSL, TT-OSL and feldspar $pIRIR_{290}$ show that the samples are beyond the age limitation because of signal saturation. Here we investigated the post-blue violet stimulated luminescence (VSL) using a single aliquot regenerative dose (SAR) protocol and a multiple aliquot additive dose (MAAD) protocol. The SAR VSL signal are not saturated but have $2D_0$ values < 800 Gy, indicating underestimated D_es compared to the $2D_0$ values of saturated quartz TT-OSL and feldspar $pIRIR_{290}$ signals. The original VSL decay curve can separate into two components with distinct bleaching characteristics. Under violet laser bleaching, component A, derived from early signal integration, have a lifetime of 66 s, whereas component B, derived from later signal integration, have a lifetime of 281 s. Under sunlight bleaching, component A and B have lifetime of 7.2 hours and 18.3 hours, respectively. Then component A signals were selected to establish the dose response curve (DRC) and determine the D_es using MAAD protocol. The established DRCs have $2D_0$ values >2500 Gy and equivalent dose of a Luochuan S1 layer loess sample (~120 ka) was successfully determined. Based on our resultant luminescence ages, the Lushi Basin loess samples are buried between ~400−700 ka which are in agreement with the pedostratigraphic and magnetic susceptibility correlation with the well-dated loessepaleosol sequences of the North Qinling Mountain and central Chinese Loess Plateau. Our VSL ages in combination with magnetostratigraphic analyses and pedostratigraphic analysis suggest that the the Paleolithic layer dates back to ~1500 ka, offering a poential understanding of early human dispersal and migration route between southern and northern China.

Keywords: Violet stimulated luminescence; Bleachability; Signal integration limits; early Pleistocene; Paleolithic;

Luminescence chronology of aeolian sands in east Guangdong of the coastal South China Sea

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Coastal sand dunes are critical sedimentary archives in coastal South and Southeast China for the study of regional climate and environmental change and landscape evolution. Lufeng area in East Guangdong Province preserves one of the most complete sequences of late Quaternary sand dunes with aeolian characteristics in the coastal South China Sea, including the so-called Old Red Sand (pre-Holocene sand tunes, also known as Lufeng Formation). However, the age, distribution, formation, and sea-land interaction implications are still poorly known due to the limited chronological data. A survey project was established to sort out these issues during which a number of drilling cores were obtained. In this study, detailed chronological study has been performed on core LFZK07 (50 m in depth) and three natural outcrops of aeolian sands (LFMY2~4) from Lufeng area. Results of Quartz OSL and AMS ^{14}C dating indicated the existence of three episodes of aeolian sand deposition. The dark brown Old Red Sand (up to 5.6 m thick) in outcrops LFMY 2 and 3, directly overlayed the weathering crust of the granitic bedrock, is dated to older than ~80 ka, most likely formed in MIS 5. A layer of light brown sand at the depth of 8-15.5 m in the core was dated to 2-3 ka. This layer directly overlayed the MIS 5 marine unit, suggesting a depositional hiatus between MIS 5 and late Holocene at the coring site. The 2-3 ka sandy layer was then covered by yellowish sands with a thickness of 9.7 m (8 m in the core plus 1.7 m in natural outcrop LFMY4), the bottom of which was dated to 0.07±0.01 ka. The dating results showed that the coastal sand dunes in Lufeng area were deposited in MIS 5 and MIS 1 during high sea levels, and no MIS 3 sand dune was observed. The two episodes of Holocene sand dunes in Lufeng may correspond to intense centurial scale climatic events during 2-3 ka and < 0.7 ka.

Keywords (max. 5): coastal sand dunes, South China Sea, luminescence dating, late Quaternary, paleoenvironmental change.

Testing the upper limit of luminescence dating based on single-grain (SG) standardised growth curve (SGC) for pIRIR signals of K-feldspar grains from Nihewan Basin, northern China

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As one of the most important regions for early human occupation in East Asia, the Nihewan Basin in north China is well-known for an abundance of archaeological sites with ages spanning the last 2 Ma. Because of many sites have no reliable ages, there are a lot of demands on luminescence dating to provide independent age estimation for them. To reduce the demand machine time for luminescence dating, Single-grain (SG) Standardised Growth Curve (SGC) has been developed for samples from Nihewan Basin [1,2] and applied for sediments from Yuxian basin (sub-basin of Nihewan) [3]. In this study, we tested this procedure on samples from the Dadaopo section in the Nihewan Basin, including materials from the Brunhes/Matuyama (B/M) boundary (~780 ka). The results show that (1) negligible fading component can be achieved using the pIRIR procedure; (2) by interpolating the central re-normalised L_n/T_n ratios onto the SG SGC, the pIRIR signals yielded ages in stratigraphic order; (3) for the sample from the B/M boundary, the obtained D_e value ($1931 \pm \frac{279}{209}$ Gy) is broadly consistent with expected De (2145 Gy). Our study suggests that the pIRIR SG SGC procedure has the potential to date samples up to 700~800 ka in this region.

Keywords: K-feldspar, Single-grain dating, Standardised growth curve, Nihewan Basin

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Luminescence dating of glacial sediments of penultimate glaciation in SE Tibetan Plateau using single grains of K-feldspar

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Luminescence dating is a useful chronological tool for glaciogenic sediments, especially when the targeted sediments lack organic materials or are too old for radiocarbon dating. However, problems like partial bleaching make its application on glaciogenic sediments challenging. Poor luminescence characteristics and low saturation level of quartz limit its application in glacial environments, especially dating old glacial sediments. Developments of the single-grain technique and post-infrared infrared stimulated luminescence (post-IR IRSL) protocols offer opportunities for mitigating or overcoming these problems. Here we test the use of single grains of K-feldspar for luminescence dating of glacial sediments of penultimate glaciation: Guxiang glaciation, the largest known Quaternary glacier advance in SE Tibetan Plateau and was previously constrained to marine isotope stage 6 (MIS-6) by cosmogenic nuclide ^{10}Be exposure dating [1].

We took 6 samples (GX601 to GX606) from glaciofluvial sand lens within the lateral moraines of Guxiang glaciation and 2 samples (GX607 and GX608) from overlying loess and paleosol. Dose recovery tests show that the two-step post-IR_{50} $IRSL_{225}$ protocol was able to recover the given dose and assumed suitable for this study. The equivalent doses (D_es) of each sample show large scatter, suggesting partial bleaching of these samples. It is therefore unsurprising that D_es derived from the minimum age model (MAM) are smaller than those derived from the central age model (CAM). Measurement of the fading rates show that, g-values of the IR_{50} signal range between 3–6%, whereas those of the pIR_{50} $IRSL_{225}$ signal are all less than 3%. After correction of the fading rates, the final ages derived from the pIR_{50} $IRSL_{225}$ signal fall into MIS-6 if the CAM is used, and fall into MIS-5 if the MAM is used. In addition, we compared the single-grain K-feldspar and quartz ages of the younger overlying loess and paleosol samples. For both minerals, the MAM ages are smaller than the CAM ages. Moreover, the MAM ages of feldspar (~4 ka for GX607 and ~20 ka for GX608) are similar to the CAM ages of quartz, and thus larger than the MAM ages of quartz (~2 ka for GX607 and ~10 ka for GX608). This seems indicate the residual doses of feldspar are probably larger than those of quartz. For most of these samples, there is a trend that the brighter the grains, the lower their D_es. The discrepancies between those results of CAM and MAM age models, quartz and feldspar, dim and bright feldspar grains, and comparation between luminescence and ^{10}Be exposure ages, will be investigated and discussed.

Keywords (max. 5): glaciofluvial sediments, luminescence dating, feldspar, single grain, Tibetan Plateau

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Application of OSL dating to trace the origin of the megaflood(s) of the Yarlung Tsangpo River

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The failure of natural dams formed by landslide and glacier in mountain area have triggered the most destructive flood events on Earth and other planets. It has been evoked that outburst flood is a very effective agent to modify landscape, such as curving bedrock gorge, and transport surface mass, which may impose long-lasting imprint on fluvial geomorphology. Recently, it is widely debated that the focused incision given risen by high-magnitude outburst floods has contributed to the rapid uplift of Eastern Himalayan Syntaxis. Previous studies have identified three dammed lakes in the valley of Yurlung Tsangpo, namely, Gaga Lake, Dazhuka–Yueju Lake and Jiedexiu Lake. However, the causal relationship between these dammed lake and outburst floods is unclear due to the lack of a robust chronology. Especially, the sediment formed by cataclysmic process may experience short bleaching history which result in unfavorable luminescence characteristic to obtain reliable ages. This problem hinders the estimation of the expected repetition time for the events of such magnitude which can be key input for quantitative geomorphic evolution model. Here, we presented 15 optically stimulated luminescence (OSL) ages in the middle reach of the Yarlung Tsangpo River, primary from lacustrine , colluvial , and eolian sediments associated with river blocking, to reconstructed the evolution of the Zhaba dammed lake. A combination of the single-aliquot regenerative-dose (SAR) protocol and the standard growth curve (SGC) method was applied to determine the equivalent dose of 38–63μm quartz grains. Utilizing luminescence characteristics analysis of quartz OSL ages, the reliability of quartz OSL ages was tested. The findings of the study suggested that the Zhaba dammed lake formed before 44.68±3.64 ka, but the quartz OSL signal show saturation trend which is a common phenomenon in OSL dating. Younger sediments formed between 16.89±1.40 ka and 15.10±1.20 ka, which illustrates that the Zhaba dammed lake at least continue until 20 ka. Furthermore, continuous clay varve also implies the lake maintain stable for a long period of time. Hence, during the Holocene altithermal period, the Zhaba dammed lake likely to have collapsed and caused a catastrophic outburst flood events in the Yarlung Tsangpo river.

Keywords: quartz, SAR-SGC, megafloods, Tibet

OSL dating millennium volcanic eruption and baked sediments from Changbaishan, China

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Accurate ages of Quaternary eruptions are crucial for reliable delineation of volcanic histories and associated time scales, with implications for geodynamics and volcanic hazards, as well as the development and evolution of magmatic systems. Widespread tephra deposits are also important chronostratigraphic markers and thus accurate eruption ages are crucial for constraining Quaternary stratigraphy (Bo pan et al.,2022). However, it is challenging to direct dating ages for young volcano. optically stimulated luminescence （OSL） dating may be used as an alternative method for dating baking materials.

In this study, the application of OSL dating to millennium volcanic eruption and baked sediments are tested to investigate the suitability of OSL dating for baking materials directly associated with volcano.

The fine-grained quartz were very bright and had enough luminescence signals for OSL dating of the volcanic eruption and baked sediments. Coarse quartz and potassium feldspar were very dim. Fine-grained quartz ages were about 2.2 ka overestimated millennium. But it may be potential to date ten thousand years volcanic eruption and baked sediment.

Keywords: OSL dating, volcano, quartz, potassium feldspar

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Single grain pIRIR dating of glacial sediments in the Yuzhu Peak area of Kunlun Mountains of Tibetan Plateau revealed the transgression and regression of glaciers during Holocene period

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The variation of glaciers at Kunlun Mountains of Tibetan Plateau is influenced by interaction of Asia summer monsoon and Westerlies, as well as human activity during Holocene period, thus the evolution of glaciers and its driving forcing is still hotly debated. The lack of reliable chronology for moraines and glacial landforms formed by glaciation has seriously hiatus the reconstruction of the glaciers evolution at these regions. In this study, 12 glacial sediments samples were collected from 6 marines sequence from southern and northern slopes of Yuzhu Peak glaciers of Kunlun Mountains. The single-grain quartz OSL and K-feldspar pIRIR dating was used to date these poorly bleached marine samples. None of the 600-1200 single-grains in most quartz samples produced a bright enough signal for the measurement of quartz OSL D_e, which indicate single grain quartz OSL dating cannot be used to date Holocene marine samples from Kunlun Mountain regions. The reliability of K-feldspar $pIR_{50}IR_{170}$ dating was confirmed by anomalous fading tests, dose recovery, and residual dose tests. Using the minimum age mode (MAM) of single-grain K-feldspar $pIR_{50}IR_{170}$ dating, the residual ages of a modern glacial sediment sample and a modern ice water sediment sample are 0.23±0.06 and 0.44±0.04 ka, indicating that there are well-bleached grains in the glacial sediments. On the south slope, the single grain pIRIR ages of the marine 246m, 790m and 566 m away from the modern glacier are 4.9-2.2 ka, ~7.5 ka and ~13 ka, respectively. On the north slope, The single grain pIRIR ages of the marine 398m, 453 m and 980 m away from the modern glacier are 4-2 ka, ~6.9 ka, and 9.6 ka, respectively. These results shows that at least three times glaciers transgressions occurred in the Yuzhu Peak region during the Holocene periods. The cold event of Younger Dryas, and another two low temperature events in the early Holocene is likely responsible for this glaciers transgression at both slopes of Yuzhu Peak at Kunlun Mountains.

Keywords: Glacial sediments, K-feldspar pIRIR dating, Single grain, Northeast of the Tibetan Plateau, Yuzhu Peak

Luminescence dating of cobbles buried in moraine deposits from the source area of Litang River, eastern Tibetan Plateau

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Numerous, distinct moraines are well preserved in the eastern Tibetan Plateau, and these record the last deglaciation of this area precisely. Most luminescence studies have targeted glaciofluvial sand lenses in exposed outcrops of moraines. However, very rare moraine outcrops with sand lens could be found in this area of Tibet. Cobbles, on the contrary, are ubiquitous within moraine outcrops. A 'rock surface luminescence dating technique' has already been applied to moraine cobbles in the Austrian Alps and has showed great potential for dating moraines and investigating transport processes in glacial environments [1].

In this study, we apply rock luminescence burial dating on moraines with independent age control in the eastern Tibetan Plateau. Forty-two cobbles were collected from three moraines in the source area of the Litang River, which were formed between ~19 - 15 ka according to cosmogenic radionuclide ^{10}Be exposure dating of boulders from the same or adjacent moraines. Cores from the top and bottom sides of cobbles were extracted and subsequently sliced. L_n/T_n signals from rock slices were measured using a post-IR_{50} $IRSL_{225}$ protocol [2]. Luminescence-depth profiles indicate that a portion of the cobbles show evidences of exposure to daylight before burial, with low signal plateau from ~2 mm to more than 10 mm in depths. These cobbles were considered well-bleached and we determined equivalent dose (D_e), anomalous fading, and dose rates for these samples. A number of luminescence-depth profiles show more than one plateaus in the upper portions which potentially reveal multiple exposure events. The burial ages of these cobbles will be compared to ^{10}Be exposure ages. The wider applicability of luminescence dating of cobbles buried in moraine deposits will be discussed.

Keywords: rock surface luminescence burial dating, buried cobbles, glacial deposit, cosmogenic radionuclide ^{10}Be exposure dating, Tibetan Plateau

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Luminescence chronology of the Jinchuan loess-paleosol sequence at the Western Sichuan Plateau, China

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The extensive loess deposits in the eastern Tibetan Plateau are direct evidence for studying past dust activity and environmental records of the Tibetan Plateau. However, the aeolian dust history and deposition processes in the Tibetan Plateau are still poorly understood due to the lack of detailed numerical chronology studies of the loess-paleosol sequence. The rapid development and application of optically stimulated luminescence (OSL) technology provides a good opportunity for investigating the chronology of the loess in the eastern Tibetan Plateau. In this study, we conducted the quartz single aliquot regenerative dose (SAR) OSL and post-IR IRSL (pIRIR) dating of K-feldspar on a typical loess sequence at Jinchuan in the eastern Tibetan Plateau, and discussed the applicability and reliability of OSL dating technology of the Tibetan loess for establishing a reliable numerical age framework. Both the quartz OSL and post-IR IRSL properties are satisfactory. The quartz OSL signal in this region saturated at about 180 Gy, while the upper limit of equivalent dose of the $pIR_{200}IR_{290}$ protocol can reach ~600 Gy. Our results showed that a reliable chronological framework since marine isotopic stage 5 (S1 paleosol) can be established by luminescence dating for the Jinchuan loess sequence.

Keywords: Quartz SAR-OSL, K-feldspar Post-IR IRSL, Loess, Tibetan Plateau

OSL dating of fluvial and lacustrine sediment in Ranwu Lake, Southeastern Tibet

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As glaciers recede in response to the significant warming on the Qinghai-Tibetan Plateau (TP) since the 1950s (0.16℃ per decade [1]), the number and size of glacial lakes increase rapidly and cause more Glacial Lake Outburst Floods (GLOFs) in the Himalayas, aggravating risks to people and towns in downstream regions. To better understand this geo-hazard, it is necessary to evaluate the evolutionary history of large glacial lakes on the TP. Glacial lakes often expand/shrink in accordance with the changes of controlling glaciers and lake level is generally regulated by a combination of monsoonal precipitation and glacial meltwater, providing a record to study the history of glacial meltwater and regional paleo-climate change. However, for glacial lakes, geomorphic features like the paleo-shorelines are rarely preserved due to the frequent glacial movement, therefore it is hard to reveal past lake levels.

In this study, we investigated the Ranwu glacial lake in the southeastern edge of the Tibetan Plateau, at the north slope of the Himalayas. Based on OSL dating of a series of fluvial and lacustrine sediment profiles, using both quartz OSL and K-feldspar pIRIR signals, we attribute that the ages and elevations of these outwash sediments can be used to provide a conservative estimation for past lake levels of the Ranwu Lake. The results suggest the following: (1) The recent highest lake level for Ranwu Lake should has an elevation exceeding 4,380 m (+460 m above the modern lake). The pIRIR (50, 225) age from K-feldspar is about ~50-70 ka, implying a large glacial lake with high water level once existed; (2) After that, the lake level gradually dropped until ~30 ka, then followed by a rapid drop of ~300 m during ~30 to ~20 ka, possibly linked to the arid climate in the last glacial maximum. (3) Then, the lake level remained relatively stable after 20 ka. Other factors including regional neo-tectonics, basin topography and water outlet have also been discussed.

Keywords: Ranwu glacial lake, lake level, OSL dating, Tibetan Plateau

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New chronological results of Paleolithic in the Chaohu Lake Region and its implications for the early Hominin occupation in south China

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Systematic field investigations and excavations documented hundreds of open-air Paleolithic localities in the middle and lower reaches of the Yangtze River, the abundant stone artifacts recovered from these sites provides critical materials to explore lithic technologies and hominins adaptive behaviors in south China. However, the age of early human occupation remained largely unknown, and the adaptive strategy of early human is still ambiguous as lacking of reliably chronological framework. In this work, multiple luminescence dating techniques, including the quartz SAR-OSL, TT-OSL and K-feldspar pIRIR ($pIR_{50}IR_{225}$ and $pIR_{200}IR_{290}$) procedures were applied to date three Paleolithic localities in Chaohu Lake Region (CLR), where more than three hundreds of stone artifacts include large cutting tools (such as handaxes) has been found, implying a key area which bears Mode 2 technocomplex present in southeast China. The quartz SAR-OSL and K-feldspar pIRIR ages are in good agreement with each other, whereas the quartz TT-OSL shows obvious systematic overestimation. Based on our resultant luminescence ages, the three study sites range from 30 ka to >200 ka. Of which, the main cultural layer of Paleolithic localities which contained the knives and handaxes dates back from 78 to >200 ka, representing the pre-existing Middle Pleistocene Large Cutting Tool (LCT) techno-complex. While in contrast, abundant small flakes and flake tool productions dated from the 70 to 30 ka, indicating the local small flaking system became prominent and continued to develop, which similar to those found in south China. Our findings thus offer a potential approach to understanding the early human dispersals and adapted strategies in south China during the Middle to Late Pleistocene.

Keywords: Chaohu Lake Region; Paleolithic; luminescence chronology, Hominins dispersal, South China

Preliminary ESR dating results for fault barite: Insights into the history of faulting recorded by barite in basalt bedrock of the Li-jiang–Xiaojinhe Fault, southeastern Tibetan Plateau

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The chronology of fault activity in bedrock is critical to constraining and understanding periods of active faulting, assessing seismic hazards, and mitigating the effects of earthquakes. However, because of the lack of suitable materials for dating, the temporal reconstruction of faulting in bedrock remains highly challenging for geologists. In the present study, we determine for the first time the electron spin resonance (ESR) ages of fault barite ($BaSO_4$), which is produced by episodes of intense faulting on basalt bedrock fault surfaces. Three barite samples were obtained from a basalt fault section (27°5′23″N, 100°25′45″E, 1.8 km above sea level) of the Lijiang–Xiaojinhe Fault (LXF), southeastern Tibetan Plateau, for ESR measurements. Similar to marine barite, the ESR spectrum of fault barite shows an electron-type center with g = 2.0034, 2.0022, and 1.9995 attributed to SO_3^-. The signal intensity systematically increased with increasing gamma-ray dose. Dose rates were calculated using a model based on the location and burial depth of the barite samples, as well as their surrounding bedrock. The three barite samples yield ESR ages of 131 ± 26, 503 ± 61, and 1416 ± 246 ka, resp ectively, which indicate that the LXF was active during the Early and Middle Pleistocene. The three ESR ages for fault barite from basalt extend the time range of activity of the LXF compared with previous carbonate ESR and radiocarbon dating results. Consequently, we propose that ESR dating of barite is valuable for reconstructing the history of bedrock fault activity. However, given that this investigation represents a preliminary application of the fault-barite ESR method, further study is needed to confirm its usefulness and the accuracy and precision of dating results.

Keywords: basalt, bedrock fault activity, barite ($BaSO_4$), electron spin resonance (ESR) dating, Tibetan Plateau

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A chronology of Holocene barriers in the East Sea of Korea: Luminescense dating of sandy sediments

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Optically-stimulated luminescence dating has become an alternative to radiocarbon dating for constraining the chronology in coastal environments that allow for sufficient sunlight bleaching of sediments during the transport. We reconstructs the Holocene history of the beach-shoreface, barrier in east coast of Korea using luminescence dating. A core was collected the present shoreline and show a 60-m-thick succession of coarsening-upward mud to sand deposits. Single aliquot regenerative-dose (SAR) OSL of coarse grains (180–250 μm in diameter) were extracted from a core for multi-grain measurements of quartz OSL to determine burial ages. Due to the poor quartz luminescence characteristics unexpected for beach deposits, only a limited number of samples were suitable for OSL dating. For equivalent dose (De) determination, sand-size quartz and feldspar extracts were used, applying a single grain measurements. A detailed chronology derived from the radiocarbon and paleo-magnetic age were compared with those of OSL. The calculated OSL and IRSL age estimates were generally in good agreement. However, the lack of comparison with an independent age control and less-sensitised luminescence characteristics caused by short transport distance from the source area prevent determination of whether OSL ages are accurate. Nevertheless, consistent age results between OSL and IRSL and consistent ages with stratigraphic order throughout the sequence indicate that the luminescence signal is well bleached by waves and currents, and luminescence dating is applicable to Holocene wave-dominated coastal sediments.

Keywords (max. 5): single grains, OSL, IRSL, less-sensitised, barrier, East Sea of Korea

Luminescence Chronology for DZK01 Core from Shandong peninsula of the coastal Bohai Sea in China

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The Shandong peninsula along the coastal Bohai Sea in China is mainly a vast alluvial plain formed by the Yellow River, and it is an ideal area to study the evolution oflandform in a river-sea interaction area in which chronology is the key. However, the detailed OSL chronology of cores in this area is lacking. In this study 22 OSL samples have been collected from the upper 40 meters of DZK01 core (100m in depth) to establish a chronology using quartz Single Aliquot Regeneration (SAR) + Standard Growth Curve (SGC) methods. Preheat plateau test and laboratory dose recovery test showed that the SAR protocol was applicable to these samples whose recuperation was negligible. Three radiocarbon samples were also dated for cross-checking. Sedimentation rate was calculated based on the dating results. The paper then discussed sedimentology and geomorphic evolution of the lower Yellow River since the late Pleistocene.

Keywords: Shandong peninsula, drilling core, OSL chronology, lower Yellow River

Analysis of time-resolved optically stimulated signals in the presence of overlapping components or under the influence of shallow traps

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Pulsed stimulation with time-correlated photon counting is commonly used in luminescence dating, dosimetry and research to separate signals with different lifetimes or to determine the lifetime of the luminescence components [1]. Nevertheless, the presence of overlapping components or the influence of shallow traps can distort the signal, yielding erroneous luminescence lifetimes when the signal is fitted with simple exponential components [2].

In this presentation, we introduce this issue and show how this can result in incorrect outcomes, if such effects are not taken into account. Numerical simulations were combined with experimental data on Al_2O_3:C, demonstrating the influence of multiple components and shallow traps on the observed luminescence lifetime. In particular, we show that, by ignoring the influence of shallow traps, atypical results can be obtained, where, for example, the luminescence lifetime appears to increase when the sample is readout at an elevated temperature, before decreasing due to thermal quenching [3].

Finally, new equations taking into account both the presence of overlapping components and the influence of shallow traps on the luminescence lifetime are presented. The use of these equations instead of simple exponentials is found to yield more accurate lifetime determination.

Keywords: luminescence lifetime, time-resolved OSL, time-tagged photon counting, photon arrival time distributions

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Testing appropriate quartz OSL and K-feldspar pIR IRSL measurement protocols for dating fluvial sediments from Indonesia

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Fluvial sediments coupled with robust geochronology provide a valuable archive of environmental change. Quaternary landscape evolution in tropical environments, such as Indonesia, remains poorly constrained due to limited prior studies as well as challenging mineral properties for luminescence dating. In this study, we explore the application of luminescence dating for sediments from the Kampar River, Sumatra Island, Indonesia, with the objective of reconstructing its Quaternary fluvial dynamics.

Sediment samples were taken from terrace deposits of different elevations. Initial quartz SAR measurements were made using blue and green stimulation and a double SAR protocol. Neither blue nor green stimulated signals were dominated by a fast component. Most quartz aliquots also failed the IR-depletion test suggesting feldspar contamination. However, SEM analyses indicate that no feldspars were present in the quartz extracts.

As the quartz properties were unsuitable, we tested post-IR_{50} $IRSL_{225}$ of K-feldspar which yielded good signal intensities despite limited feldspar being present in our samples. Residual doses were a few Gys and dose recovery test results were within 10 - 15% of unity, indicating that the protocol is suitable for these samples. Resultant IR_{50} and $pIRIR_{225}$ dose distributions yielded large overdispersion values (between 39 and 80 %) due to partial bleaching. Ages were therefore calculated using the minimum age model. The observed $pIRIR_{225}$ fading rates (mean g2days= 0.94 ± 1.38%/decade) were significantly lower than those measured at 50°C (mean g2days = 4.48 ± 1.63%/decade). Fading uncorrected pIR_{225} ages and fading corrected IR_{50} ages were in agreement, highlighting the potential of using the luminescence of feldspar for dating in Indonesia. Our chronology reveals that since MIS6, the Kampar river has aggraded during glacial periods, these data will be coupled with fluvial dynamics modelling to better understand the fluvial response to a changing climate.

Keywords: pIR-IRSL, Quaternary, fluvial dynamics, Indonesia, Tropics

Luminescence dating reveals glacial paced ancient dammed lakes formation and outburst along the Yarlung Tsangbo

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Fluvial landforms and deposits are valuable terrestrial archives for understanding the surface processes and tectonic activities that shaped the earth. Yarlung Tsangpo, originated from the Gyama Langdzom Glacier on the northern slope of the Himalayan Mountains, is one of the highest and largest rivers around the world. The drainage basin is tectonic active and has been extensively affected by glaciation processes during the Quaternary. In previous studies, lacustrine and outburst deposits have been extensively discovered in the wide valleys along the main stream and tributaries of Yarlung Tsangpo, indicating that many dammed lakes have been formed and burst in the past, such as Dazhuka palaeo-lake [1], Jedexiu palaeo-lake [2] and Gega palaeo-lake [3]. These lakes were generally considered to be the product of glacier and/or glacial moraine advances blocking the narrow gorges mainly during the last glacial and Holocene period, which provided constructive information to study the geomorphic and sedimentologic responses of the river system to climate change. However, due to the complexity of the sedimentology and limitation of different dating techniques, the formation of the dammed palaeo-lakes as well as their connection to the climate forcing remain controversial.

In this study, we report two newly discovered dammed palaeo-lakes, located at the upstream of all previously investigated palaeo-lakes mentioned above, in the middle reach of Yarlung Tsangpo, named Xiaru and Duobai palaeo-lake, respectively. The two sets of lacustrine strata (up to 20 m thick) distribute several tens of kilometers along the main stream of Yarlung Tsangpo and vanished immediately reaching the narrow gorges downstream. Due to the poor performance of the quartz luminescence signal, the post-IR IRSL dating of K-feldspars is applied alternatively to establish the chronological framework of the dammed lakes. Preliminary results demonstrated that the formation of the two palaeo-lakes began probably simultaneously at 21-20 ka, corresponding to the Last Glacial Maximum, while the failure of both lakes occurred no early than 16-15 ka, falling into the last deglaciation period. We conclude that the middle reach of Yarlung Tsangpo might have been dammed for more than 5 ka since the LGM at different places simultaneously. Glacial activities related to the climate changes might have played the predominant role in the geomorphic process of Yarlung Tsangpo dranaige basin since LGM.

Keywords (max. 5): Yarlung Tsangbo, dammed lake, post-IR IRSL dating, geomorphic response, LGM

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Single-grain luminescence as a bioturbation tracer in chernozem

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Krotovinas, the infilled burrows of small mammals, are of great importance for genesis of Chernozems and hold valuable archive of landscape history [1]. The key to revealing this archive involves understanding the origin as well as the age of the filling in the burrow. Conventionally, this could be achieved by comparing substances inside and outside of the burrow. And ages are often determined through radiocarbon dating. Yet suitable materials for ^{14}C dating are not always available.

Alternatively, luminescence dating technique holds great potential of solving problems related to the formation of krotovinas, as it is can illustrate the source of the burrow-filling and provide information about the age of the krotovina [2,3,4]. In this study, we investigated a chernozem profile with conspicuous krotovinas, overlying a fluvial terrace from the black soil region of the northeast China. Systematic sampling was carried out, and three krotovinas with various depths and different colors (two in black and one in yellow) were sampled along with their immediate adjacent counterparts in the undisturbed surroundings. In addition, samples from the black top soil and the yellow bottom fluvial sediment were also collected for comparison. Detailed single-grain luminescence characteristics (e.g. signal sensitivity and partial bleaching) of both quartz and feldspar were initially studied to get a first sight of the profile feature and to ensure reliable measures. Subsequently, luminescence characteristics as well as associated ages were compared between the krotovinas and their adjacent counterparts to investigate the effects of biomixing on luminescence dating, and among samples down the profile to find out possible sources of these fillings.

Results show that the ages of those undisturbed samples coincided well with stratigraphic order, while significant discrepancies were observed between samples inside and outside of the krotovinas. Both black krotovinas were younger than their adjacent counterparts whereas their luminescence characteristics agreed better with those of the top black soil, indicating a surface origin of these fillings. On the contrary, the yellow krotovina yielded older age than that from the undisturbed vicinity while it exhibited similar characteristics as the basal fluvial sediments, suggesting a possible source of the filling from the bottom of the profile. Furthermore, based on single-grain luminescence characteristics and ages of these krotovinas, the extent of soil mixing was evaluated, and its effects on soil formation from black soil region of the northeast China were discussed. This research shows the potential of single-grain luminescence as a key grip for tracing bioturbation in chernozem, shedding light on solving problems related to soil formation.

Keywords : single-grain luminescence, bioturbation, krotovina, chernozem

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Isothermal thermoluminescence (ITL) dating of a speleothem from Bleßberg Cave

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Their amenability to radiometric dating (U-series) makes speleothems (secondary cave carbonate deposits) a key archive of past climatic and environmental changes. However, incorporation of non-radiogenic thorium can hamper U-series dating, and samples older than ca. 600 ka remain out-of-reach for U-Th dating. Our aim is to develop isothermal thermoluminescence (ITL) dating as an alternative approach for otherwise undatable samples.

The calcite thermoluminescence (TL) signal (280 °C peak) saturates at very high doses (saturation dose up to 5000 Gy) [1,2], which shows great potential to extend the dating limit to several millions of years. However, a spurious TL signal occurring in the high temperature range so far hindered its application [3,4]. The conventional multiple-aliquot additive-dose (MAAD) protocol used for TL dating applies extrapolation for equivalent dose (D_e) estimation, which is also associated with large uncertainties. ITL dating with the single-aliquot regenerative-dose (SAR) protocol [5,6] might be a promising way to circumvent these issues as it reduces the influence of the spurious TL signal and it applies interpolation to obtain the D_e. However, this protocol has not been tested yet on samples with independent age control.

Here we test the ITL SAR dating protocol on a speleothem sample from Bleßberg cave, Germany, which has been accurately dated by the ^{230}Th/U-method (425.6±3.9 ka to 321.6±2.0 ka, based on 17 dates). An ITL measurement at 235 °C for 200 s can remove the 280 °C TL peak completely without TL contribution from the higher temperature range. The ITL D_e shows a plateau in the ITL temperature range between 230 °C and 240 °C. Peak shifting and isothermal annealing tests indicate that the 280 °C TL peak and the ITL signal at 235 °C have lifetimes of tens of millions of years at 10 °C, which is sufficiently stable considering the age range of this speleothem sample. The accurate alpha efficiency (*a*-value) and the U and Th distribution within the sample are measured to estimate the dose rate. The time-dependent dose rate variation due to U-series disequilibrium is corrected for. The ITL ages are compared with the ^{230}Th/U ages to evaluate the performance of the ITL SAR dating protocol.

Keywords: calcite, speleothem, isothermal TL, SAR, ^{230}Th/U

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Luminescence dating of paleo-shorelines reveals Holocene lake shrinkage mainly modulated by the Indian summer monsoon on the northwestern Tibetan Plateau

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As an important component of the "Asian Water Tower", lakes on the Tibetan Plateau (TP) significantly affect the regional ecosystems and societies, and they serve as an effective sentinel of climate change. Therefore, a good understanding of the long-term hydrological variations of these lakes is necessary. However, the Holocene lake-level fluctuation on the northwestern TP (NWTP), an important region for the interaction between the Indian summer monsoon (ISM) and the westerlies, remains unclear largely due to the challenge in dating of lake (shore) sediments [1].

Here we present the lake level variations of a non-glacier-fed lake, Longjue Co, on the NWTP based on luminescence dating of the paleo-shorelines. The OSL signals of quartz grains are unsuitable for dating due to high contributions of the medium component. The post-infrared infrared stimulated luminescence ($pIR_{50}IR_{170}$) signals of K-feldspar single-aliquots are favorable as indicated by internal checks including dose recovery tests, residual dose tests and measurements of signal stability. However, incomplete bleaching of the signal for part of the samples were found by comparing the IR De/pIRIR De ratios of all the samples [2]. Thus, the pIRIR dating of K-feldspar single-grains (SG) were further performed on the poorly-bleached samples. After rejecting grains with unfavorable signals, the dependence of the De of K-feldspar grains on their brightness were examined and the brightest grains were used for De calculations. The Minimum Age Model and the Central Age Model were used for poorly-bleached and well-bleached samples, respectively. The results show that Longjue Co reached the highest level during the early Holocene (10-8 ka) and then gradually shrank in the middle and late Holocene.

The correlation with paleo-climate records suggests that the Holocene shrinkage of Longjue Co is mainly modulated by the gradual weakening of the ISM, which follows the trend of Northern Hemisphere summer insolation. Our results indicate that the NWTP was significantly influenced by the ISM during the Holocene. In addition, we highlight the necessity of SG luminescence dating for water-lain sediments dating on the TP.

Keywords: pIRIR of K-feldspar single-grain, lake level, Indian summer monsoon, northwestern Tibetan Plateau

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Multi-step post-IR IRSL dating and paleoclimate implications since penultimate interglacial palaeosol in the Central Shandong Mountains, eastern Chinese Loess Plateau

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Knowledge of past climate changes in the Central Shandong Mountains (CSM) obtained during astronomical simulations of the current interglacial period may help us understand future climatic patterns. However, fewer studies have explored the penultimate interglacial (S_2) period compared to the existing research on the Holocene (S_0) and last interglacial (S_1) periods. The absolute ages and palaeoclimatic implications during the penultimate interglacial palaeosol and whether the climate was arid during the time of glaciation in the currently humid and semihumid areas are still unclear. In this work, the luminescence ages and paleoclimate proxies in the Dongheishan (DHS) section were studied. Multi-elevated-temperature post-infrared infrared-stimulated luminescence (MET-pIRIR) dating results were obtained in the DHS section (250-90 ka). The palaeosol ages during S_2 and S_1 were derived almost continuously based on luminescence ages on the orbital scale, indirectly suggesting that the study area was arid during the glacial loess sedimentation periods. The analysed chroma and magnetic susceptibility results suggest that the weathering intensity of the palaeosols in the last interglacial period was stronger than that in the penultimate interglacial period; this finding was also supported by the measured percentages of particles below 2 μm. Furthermore, the median grain sizes and contents of particles larger than 63 μm in the loess-palaeosol deposits located in the lower reaches of the Yellow River indicate variations in the proportions of proximal materials in the total deposition flux. The utilization of luminescence ages and multiple proxies can provide a reference for researching the pattern and evolution of palaeoatmospheric circulation in East Asia.

Keywords: luminescence; Central Shandong Mountains; climatic patterns; penultimate interglacial period

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OSL dating for the oldest aeolian sand in the Otindag sandland, China

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The Otindag sandland, located at the boundary of the East Asian monsoon area, is sensitive to climate change and is therefore an ideal place to investigate past environmental evolution. Due to frequent volcanic eruptions that have occurred since the Cenozoic, numerous interbeds of multi-stage basalt and sand exist in the stratigraphic sequence, which allowed older sand to be preserved due to the protective effect of the overlying rock. Previous studies of climate change in the sandland mainly focused on the time interval since the last glacial period, and information is lacking regarding climate change over longer timescales and younger volcanic activity. The key reason for this is that suitable geological carriers are rare, which prevents the expansion of the desired sediment chronological scale. In order to establish the chronological framework, samples of the sandy paleosoil, aeolian sand, lacustrine sand and volcanic baked layer were collected and dated by the optically stimulated luminescence (OSL) method. The conventional SAR, TT-OSL and pIRIR($_{200,290}$) procedures were used to obtain equivalent doses of quartz and feldspar. To ensure the accuracy of the dating data, the age of the feldspar dating of the oldest aeolian sand sample (TBB) was compared with the quartz result, and the quartz and feldspar ages were found to be consistent with each other within the error range. Considering the error of the age measured by TTOSL (384.2±68.0 ka) exceeded 10%, the age measured by the pIRIR($_{200,290}$) method (321.2±11.5 ka) was adopted to represent the deposition age of the aeolian sand sample. In addition, the age of the oldest sand deposition in the three sections of the Otindag sandland may reach 300 ka, mainly due to the different thermal history and provenance from other areas such as Loess Plateau, resulting in the different saturation dose and dose rate lever of quartz or feldspar. The sedimentary age framework established by OSL dating enabled the reconstruction of the evolution process of the Otindag Sandland. The climate was cold and dry during the periods corresponding to 321.2, 160.3−151.6 and 4.4 ka, and the Aeolian sand material quickly accumulated during these times, as dunes were activated and the sandland expanded. During the periods corresponding to 5.0 ka and 2.4−1.3 ka, sandy soil developed efficiently, implying the dunes were fixed. The oldest lacustrian sand age is 320.4±16.0 ka for quartz dated by the SAR method. Hence, aeolian sand and lacustrine sand developed in the same period, which indicates that there was a landscape where dunes and lakes coexisted around 320.4 ka, such as at present. The Optical Stimulated Luminescence dating results of the volcanic baking layer and the underlying coarse sand layer confirm that volcanic activity occurred around 321.2 and 155.0 ka. Combined with results of previous research, this study indicates that the northeast and northwestward basement faults of the northern margin of the North China Craton and the Central Asian orogenic belt are characterized by extensional tectonic properties in the background setting of plate subduction, and relative uplift and settlement occur in the sandland formation zone.

Keywords: Otindag sandland, OSL dating, volcanic lava, aeolian activity

OSL chronology of fluvial aggradation and incision in the source area of the Mekong River in Tibetan Plateau since Late Pleistocene

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The Qinghai–Tibet Plateau (QTP), often known as the Asia Water Tower, is the source of several continental-scale major rivers. However, due to extremely difficult access and harsh situation in the interior plateau, fluvial processes in the headwaters of these large rivers and their relationship with global climate changes remain unknown. In this study, the optically stimulated luminescence (OSL) dating technique was used to reconstruct the aggradation and incision history of the Zaduo Basin, the first inner-mountain basin and human settlement in the headwater of the Mekong River. The dating results showed that the T4 terrace, the highest terrace in the basin, was deposited before marine isotope stage (MIS) 5. During MIS 5, the Mekong turned to incision and cut into the bedrock by >50 m, possibly as a result of increased precipitation and ameliorated vegetation. During MIS 4, the river began to aggrade again, possibly owing to decreased precipitation and increased sediment supply out of intensive glacial activities. At ~20 ka, the Mekong incised again and formed the T3 terrace which was ~28 m above the present floodplain. Thereafter, with increasing precipitation and vegetation, the Mekong continued to cut down and formed two cut-in-fill terraces at elevations of 22 m and 11m above the present floodplain, at the last deglacial and the early Holocene, respectively.

Overall, orbital-scale climate changes were the most likely driving force of fluvial evolution processes in the Zaduo Basin since the Late Pleistocene. In general, aggradation occurred during the glacial period, whereas incision took place in deglacial and interglacial periods.

Keywords: Tibetan Plateau; Mekong River; OSL dating; fluvial process; climate changes

Towards an optimal protocol for dating lacustrine-aeolian sandy deposits at Jiufangtai Section in the Salawusu River Valley of the Mu Us Desert, China

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We report a luminescence dating study at Jiufangtai Section in the Salawusu River Valley located in the southeastern margin of the Mu Us Desert, Inner Mongolia, China. The section consists of interbedding sandy deposits of aeolian and fluvio-lacustrine facies. As this is where the stratotype section for the Salawusu Stage of the Upper Pleistocene period in China's Quaternary stratigraphy was defined, the chronology of its sedimentary sequence is of paramount importance. In this study, we focus on the upper part of the section. Seven samples were dated with a range of protocols using quartz and potassium feldspars. The SAR equivalent dose of coarse-grained quartz ranges from 16 Gy to 67 Gy and those of $pIR_{100}IR_{225}$ for the feldspars of the same size are between 40 Gy and 125 Gy. The differences up to a factor of two in equivalent dose observed for the two mineral fractions cannot be reconciled by the dose rate effect. The youngest sample gives near zero OSL signal for quartz and an equivalent dose of less than 3 Gy for the feldspar fraction, pointing to an adequate bleaching condition for the recent sedimentary environment. However, there is a relatively large scatter in equivalent dose for all the coarse-grained quartz samples. This poses a major challenge in evaluating the equivalent doses for dating in terms of degree of zeroing at deposition, an aspect that is usually irrelevant in desert areas. As luminescence property may affect the interpretation of the dating results, a series of experiments are designed to examine the stability of luminescence signals and saturation dose. For such sedimentary sequences with highly dynamic shifts in facies as in the Salawusu River Valley, the geological processes involved in solar resetting may be complicated. We will discuss how a variety of factors can be considered when optimizing the protocols for accurate dating of the lacustrine-aeolian deposits.

Keywords: Quaternary stratigraphy, stratotype section, quartz-feldspar comparison, desert, Salawusu

Testing the attenuation of light in evaporite-dominated sediments from the Atacama Desert

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The northern Atacama Desert displays a unique set of geomorphological features, similar to those detected on Mars. One of these features are surface polygonal patterned grounds associated with calcium-sulphate wedges in the subsurface. Vertically laminated subsurface-wedge structures occur in evaporite-bearing deposits of the Aroma alluvial fan situated in the Central Depression of Atacama Desert. The high content of calcium-sulphate phases in the wedges is assumed to lead to haloturbation processes resulting in subsurface wedge growth and polygonal patterned ground formation on the surface.

To resolve wedge-growth phases and episodes of moisture supply in this generally extremely water-limited environment, geochronological data of the calcium-sulphate wedges is crucial to potentially use calcium-sulphate wedges as palaeoclimate archives in the Atacama Desert. First tests of coarse-grain feldspar luminescence dating on two subsamples extracted from the inner part of a calcium-sulphate wedge from the Aroma-fan site showed widespread and clustered equivalent dose (D_e) distributions ranging from ~20 Gy to saturation [1]. The broad post-IR $IRSL_{225}$ D_e distribution was interpreted to reflect different wedge-growth phases. However, these two wedge subsamples are not sufficient to enable an interpretation of wedge stratigraphy.

To further investigate the drivers behind D_e distributions measured and to enable linking luminescence results with geomorphological interpretations, we sampled a second calcium-sulphate wedge in higher resolution. Post-IR $IRSL_{225}$ D_e distributions obtained for five subsamples from the inner part of the second wedge from the Aroma-fan site revealed similar pattern, thus letting us question the validity of the D_e distributions measured. To explore potential sources of the broad and clustered D_e distributions, we conduct light transmission experiments based on the study of Ou et al. [2]. Using calcium-sulphate wedge slices of different thickness we determine the light attenuation of a Xe-lamp and record transmitted wavelengths using a spectrometer. We combine these light transmission experiments with D_e measurements of feldspar grains sampled from a sediment-core-like transect into the wedge. Testing the light attenuation of calcium sulphate-bearing deposits from the Atacama Desert will help in interpreting the widespread D_e distributions recorded in different calcium-sulphate wedges and it will also aid in assessing the applicability of luminescence dating on such evaporite-dominated deposits from the Atacama Desert.

Keywords (max. 5): Calcium-sulphate wedges, Atacama Desert, luminescence dating, light attenuation

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Luminescence dating of kilns pottery quarter at Paykend (Uzbekistan)

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During the excavations of the Paykend site carried out by the French-Uzbek mission in the Bukhara oasis (MAFOUB), a pottery quarter was discovered between the citadel and the canal [1]. This quarter includes sequences of kilns and embankments. In order to understand the chronology of occupation of this sector of the town, about fifteen kilns and fill levels were sampled corresponding to about thirty dates (TL, BL- and IR-OSL). The materials chosen were both elements of the kilns (walls, bricks and pillars) and shards from the fillings after the furnaces were used. The architectural elements allow us to date the last use of the kilns. The dating provided by the shards is more difficult to analyze. While some of them may come from the last batch, or even from previous batches, they may also come from waste levels uncovered during the excavation of new kilns. This is corroborated by the presence of shards corresponding to the earlier phases of occupation of the site. On the other hand, in the fillings, no shard appear to date later than the surrounding architectural elements, indicating that the kilns were filled quickly after the end of their activity. This confirms our analysis of stratified sites as to the difficulty of dating stratigraphic units from movable elements alone. Overall, luminescence dating gives us an occupation between the 8th and 14th century AD. in accordance with C14 and archaeological dating. To go further, we sought to combine our data (palaeodoses and annual doses) with archaeological interpretation. In particular, the stratigraphic relationships between the kilns are modeled in order to establish a chronology of the site and highlight phases of occupation of the district. This is compared with the archaeological analysis carried out in the different sectors of the pottery quarter, in order to evaluate the relevance of our models.

Keywords (max. 5): stratified site, modeling, central asia, middle age

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