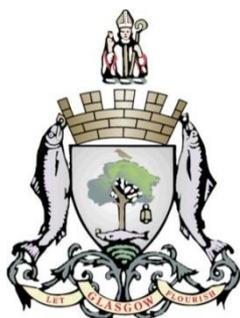


**UK LUMINESCENCE AND ESR
MEETING July 2015
SUERC, University of Glasgow**

Acknowledgements

The organisers are pleased to acknowledge the generous support offered to the meeting. In particular to Stewart McKillop, Sharon Riach, Chefs Theo and Auchie, and the Professional Cookery and Hospitality students of South Lanarkshire College for providing lunch for the Gamma Dosimetry workshop at SUERC on the 7th July; to the Lord Provost of Glasgow for providing a Civic reception for the UK Luminescence and ESR meeting in the City Chambers Glasgow on 9th July; to Lucinda Hay and colleagues in University of Glasgow Conference and Visitor Services Office, and to the Halls of Residence for help with coordinating and organising the meeting; to the School of Geographical and Earth Sciences and SUERC for support for the evening reception on 8th July; to the Risoe Campus of the Danish Technical University, and to Freiberg Instruments for sponsorship of support and prizes for student presentations at the meeting; and to SUERC support staff, particularly Nicole Doran, Tracey Mark and Kerry Keir for administrative support; and to Brian Tripney for support for the meeting web site.



School of
Geographical &
Earth Sciences



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Foreword

It is a great pleasure to welcome the 2015 UK luminescence meeting to SUERC and Glasgow this July. A few delegates will recall the first meeting in this series, held in Oxford in 1978. Martin Aitken pointed out in the foreword¹ to the proceedings that the optimal situation for a TL laboratory was to interleave applied work and research, which can still be said to be true today despite the many advances in luminescence and electron spin resonance over recent decades. Subsequent triennial international conferences, and the annual UK and regional meetings which punctuate them, have maintained the “multilayered sandwich” of methodological contributions and applied research which Martin found to be so “nourishing and appetizing” in 1978. Another feature has been to ensure that there are other appetising and nourishing offerings alongside the meeting, and plenty of time to enjoy them in the margins of the academic programme. It is hoped that the Glasgow meeting this year will continue these traditions, and will provide a forum where new research and applied work can be discussed in a congenial setting.

UK meetings have been held since the 1980's with venues rotating between the British Museum Research Laboratory, Oxford, Durham, Sussex, Paisley, Edinburgh, Royal Holloway, Aberystwyth, Sheffield, Liverpool and St. Andrews. Their size and international scale continues to grow, to the extent that they can scarcely be described as national meetings today. But the meeting continues to provide an informal forum for discussion of luminescence and ESR research, with an emphasis on recent development, ongoing work and student contributions. In 2001 delegates from four continents, and an age span of six decades, came to Glasgow and SUERC for the first time in this meeting series. It is particularly nice to welcome back researchers, some of whom gave their first international presentations to that meeting. We have an equally wide international attendance this year, and a very full oral and poster program covering a wide range of new and exciting work. Alongside this is a social programme, starting with the hospitality lunch provided by students of South Lanarkshire College to those attending the pre-meeting workshop at SUERC on the 7th July, and including receptions in the University on the 8th, a lunchtime early music recital on the 9th, a Civic reception courtesy of the Lord Provost's office in Glasgow City Chambers, and conference dinner and Ceilidh in the National Piping Centre, also on the 9th. For those with energy to spare after the end of the meeting on the 10th a Hill walk and distillery tour has been arranged at Dumgoyne and Glengoyne near Glasgow.

We hope that you will enjoy the meeting, and are delighted to welcome you to Glasgow for the 2015 UK Luminescence and Electron Spin resonance dating meeting.

David Sanderson, Lorna Carmichael, Alan Cresswell, Tim Kinnaird, Simon Murphy.

1. PACT 2, 1978, ISBN 2-8017-0226-2, xi

Outline timetable

Gamma Dosimetry Workshop SUERC, East Kilbride

Tuesday 7th July 1000-1700 Pre-meeting workshop on Gamma Dosimetry and Monte Carlo Simulation. at SUERC, East Kilbride

UKLUM2015 Meeting

Wednesday 8th July 0800-1800 Registration, academic sessions, first poster session

1800-1930 Drinks reception courtesy of the School of Geographical and Earth Sciences, University of Glasgow and SUERC

Thursday 9th July 0830-1800 Academic sessions and second poster session

1900-2000 Civic Reception Courtesy of the Lord Provost of Glasgow and Glasgow City Council. City Chambers, George Square, Glasgow

2015 for 2030 Conference dinner and Ceilidh at the National Piping Centre, McPhater Street, Cowcaddens, Glasgow

Friday 10th July 0830-1230 Academic sessions, report on gamma ray workshop and close of meeting

Post conference event

Friday 10th July 1330- 1900 Hillwalk at Dumgoyne, followed by Distillery tour

Meeting Venue : East Quad, Gilbert Scott Building, University of Glasgow

Registration, lunch, coffee, poster sessions, reception Room 412

Lectures : East Quad Lecture Theatre

Maps of meeting and reception locations at back of book.

Campus interactive map :<http://www.gla.ac.uk/about/maps/>

Gamma Dosimetry workshop

7th July SUERC, East Kilbride

A pre-meeting workshop at SUERC (in East Kilbride) on calibrating and simulating gamma dose rate measurements is being held on 7th July. The aim of the workshop is to offer opportunities for cross comparison of dose rate instruments on the SUERC calibration pads, and to explore Monte Carlo simulation approaches to gamma spectrometry and dosimetry.

The outcomes will be reported to the UKLUM2015 meeting, and will include consideration of future needs and opportunities for training, validation of simulation methods, and further interlaboratory comparisons of dose rate measurements.

UKLUM15 Meeting Programme

Wednesday 8th July

0800-0900	Registration	Room 412
0900-0920	Welcome addresses	East Quad Lecture Theatre
0920-1020	Session 1 Opening session	Chair Dr. Simon Armitage
0920-0940	Stone, Abi , Bateman, M.D., Thomas, D.S.G.	Rapid preliminary age assessment in the Namib Sand Sea
0940-1000	Sahar al Khasawneh , Andrew Murray, Reza Sohbaty, Kristina Thomsen, Dominik Bonatz	Dating a Near Eastern desert hunting trap (kite) using rock surface dating
1000-1020	Sumiko Tsukamoto , Taro Takeuchi, Atsushi Tani	Can we date gut strings using ESR?
1020-1050	Coffee	Room 412
1050-1230	Session 2 Sedimentary applications	Dr. Julie Durcan
1050-1110	Daniela Constantin , Alida Timar-Gabor, Qingzhen Hao	Fine and coarse quartz OSL dating: Chinese loess vs SE European loess
1110-1130	Piotr Moska , G. Adamiec, Z. Jary and A. Bluszcz	OSL chronostratigraphy of loess-palaeosol sequences in Poland using different dating methods
1130-1150	Nathalie Diaz , Georgina E. King, Pierre G. Valla, Fabienne Dietrich, David Sebag, Frédéric Herman, Eric P. Verrecchia	Luminescence and radiocarbon dating of pedogenic carbonate nodules: palaeoclimatic implications for the Chad basin
1150-1210	Chongyi E , Reza Sohbaty, Andrew Murray, Jan-Pieter Buylaert	Luminescence dating of the Hebei Loess section on the North Eastern Tibetan Plateau using OSL IRSL and post-IR signals
1210-1230	Jinfeng Liu , Reza Sohbaty, Andrew S. Murray, Benny Guralnik, Mayank Jain, Jie Chen, Ming Luo	Optically stimulated luminescence surface dating of glacial and landslide boulders from the Pamir Plateau
1230-1400	Lunch	Room 412
1400-1520	Session 3 Dosimetry and dosimetry materials	Chair Dr. Lorna Carmichael
1400-1420	Makaiko Chithambo	Temperature-dependence of time

1420-1440	Loïc Martin , Sébastien Incerti, Norbert Mercier	resolved luminescence from alpha-Al ₂ O ₃ :C Testing the DosiVox software for basic dosimetric cases. Comparison with tabulated data
1440-1500	Franz Hartung , Nicole Klasen, Jürgen Henniger, Alfred Dewald, Helmut Brückner	Gamma-dose rate determination using in-situ BeO dosimeters
1500-1520	Guillaume Guérin , Jain, M, Mihailescu, L.C.	Luminescence (OSL, Post-IR-IRSL) efficiency dependence on x-ray energy : measurements and implications for dating
1520-1600	Tea	
1600-1800	Poster session 1	Room 412
1800-1930	Drinks reception	Room 412

Thursday 9th July

0830-1010	Session 4 Statistical aspects	Chair Dr. Dimitri Vanderberghe
0830-0850	David Strebler , Dominik Brill, Christoph Burow, Helmut Brückner	Using R for TL dating
0850-0910	Grzegorz Adamiec , Andrzej Bluszcz, Aleksandra J. Heer	Estimation of De error when statistics of count numbers deviate from Poisson distribution
0910-0930	Aleksandra Heer , Grzegorz Adamiec, Andrzej Bluszcz	Improved age estimation in NW alpine forelands by applying new research on statistics of count numbers registered by PM tube
0930-0950	Debra Colarossi , G.A.T. Duller, H.M. Roberts	Single grain equivalent dose measurements of feldspars from incompletely bleached sediments
0950-1010	Nathan Jankowski , Ian Bailiff, Lisa Snape-Kennedy	Application of time and spatially resolved laser scanning for characterisation of coarse grained sediment samples
1010-1030	Coffee	Room 412
1030-1210	Session 5 Landscape dynamics	Chair Dr. Tim Kinnaird
1030-1050	Grzegorz Poręba , P. Moska, P. Mroczek, J. Rodzik	Holocene soil erosion based on luminescence measurement and soil properties
1050-1110	Miguel Castillo , Esperanza Muñoz-	Using OSL for interpreting sediment transport processes: From mountain

	Salinas , David Sanderson, Tim Kinnaird, Luca Ferrari, José Luis Arce, Epifanio Cruz- Zaragoza	rivers of the Jalisco Block to alluvial deposits at the Usumacinta-Grijalva River Basin (Mexico)
1110-1130	Eric Portenga	Valley bottom preservation and disturbance in the southeastern Tablelands of post-European Australia
1130-1150	Iben Hougaard , Simone Pedersen, Andrew Murray, Lars Clemensen	Evolution of the Skagens Odde spit based on OSL dating using quartz and feldspar
1150-1210	Georgina King , Frederic Herman, Pierre G Valla, Benny Guralnik	Quaternary Exhumation of Namche Barwa constrained using Low temperature OSL thermochronology
1210-1400	Lunch	Room 412
1400-1530	Session 6 Luminescence processes	Chair Professor Makaiko Chithambo
1400-1420	Amit Kumar Prasad , Mayank Jain, Torben Lapp, Myung Ho Kook, Nigel R. J. Poolton	A comparative study on XEOL, RL, TL, PL, and OSL emission spectra of Na and K rich feldspars
1420-1440	Renske Lambert , G.E. King, F. Herman, P.G. Valla	Investigating kinetic processes of K feldspar for the application of luminescence thermochronology on the Mont Blanc Massif
1440-1500	Edward Rhodes	Single Grain pIR-IRSL dating of K feldspar from high energy deposits
1500-1520	Adrian Finch	Thermoluminescence of sodalite - an analogue for feldspar and quartz?
1520-1540	Mayank Jain , Amit Kumar Prasad, Nigel R.J. Poolton, Torben Lapp, Myung Ho Kook	Cool quartz and feldspars - what can we learn?
1540-1600	Tea	Room 412
1600-1800	Poster Session 2	Room 412
1900-2000	Civic reception in City Chambers George Square	Courtesy of the Lord Provost of Glasgow and Glasgow City Council
2015- for 2030	Conference Dinner and Ceilidh in National Piping Centre	

Friday 10th July

0830-1000	Session 7 Glacial systems	Chair Dr. Georgina King
0830-0850	Eike Rades , Christopher Lüthgens, Markus Fiebig	Exploring the possibilities of quartz and feldspar luminescence dating for glaciofluvial sediments from the northern alpine foreland
0850-0910	Anders Kristensen , Jan-Pieter Buylaert, Andrew Murray and Nikolaj Krog-Larsen	OSL dating of glaciofluvial and marine deposits on Djursland, a key site for late Pleistocene deposits in Denmark
0910-0930	Alicia Medialdea and Mark D. Bateman.	How do initial assumptions affect minimum age approaches?
0930-0950	Rachel Smedley and Geoff A.T. Duller	Quantifying the causes of scatter in single-grain equivalent dose distributions for quartz
0950-1020	Coffee	Room 412
1020-1130	Session 8 System developments	Chair Dr. Clemens Woda
1030-1050	Kay Dornich , Daniel Richter, Andreas Richter	Recent developments from Freiberg Instruments
1050-1110	Daniel Richter , Dirk Mittelstraß, Sebastian Kreutzer, Markus Fuchs, Kay Dornich	An x-ray irradiator for dosimetric application
1110-1130	Torben Lapp , Myung Ho Kook, Amit Kumar Prasad, Mayank Jain	Single photon EMCCD based spectrograph system for time resolved measurements on the Riso TL-OSL reader
1130-1215	Report and discussion of gamma workshop	
1215-1230	Close of meeting	
1230-1330	Lunch	Room 412
1330-1900	Hill walk and distillery tour	Coach departs Main Gate at 1330

Poster Session 1, Wednesday 8th July

Posters on display from the morning on 8th July until lunchtime on 9th July.

Presenting authors may introduce their poster with one powerpoint slide at the start of the poster session at 1600 on 8th July in room 412.

- 1 **Sumia Abdualhadi**, Barbara Mauz, Paul Nolan Quantifying the Uranium Series Disequilibrium using gamma spectrometry
- 2 **V. Anechitei-Deacu**, A. Timar-Gabor, L. del Valle, J.J. Fornós, R. Begy, C. Cosma ,L. Gómez-Pujol, A.G. Wintle Assessing the maximum limit of SAR-OSL dating using quartz of different grain sizes extracted from aeolianites
- 3 K. Beerten, **Dimitri Vandenberghe**, K. Deforce Optical dating of palaeochannel deposits in the Kleine Nete valley, NE Belgium: first results
- 4 **Clive Brigden**, Neil Hyatt, Edward J. Rhodes Luminescence behaviour of doped borosilicate glass: preliminary findings
- 5 **Jan-Pieter Buylaert**, Christine Thiel, Thomas Stevens, Shuangwen Yi, Andrew Murray, Manfred Frechen, Huayu Lu Gaps in the loess record at Jingbian (northern China) identified using luminescence
- 6 **Louise Dodds**, Lorna Carmichael, David C.W. Sanderson, Tim C. Kinnaird, Katie Hamilton Investigating thermoluminescence and photostimulated luminescence as tools in food authentication
- 7 **Geoff Duller** Ten things you never knew that Analyst could do
- 8 **Kari Eskola**, Markku Oinonen Dating coarse-grained ceramics by optically stimulated luminescence (OSL)
- 9 **Mary Evans**, Sandra Mhlongo, Zubair Jinnah Palaeo-environmental reconstruction of the Diepdrift colluvial deposit, Limpopo Province, South Africa
- 10 **Marine Frouin**, Sébastien Huot, Sebastian Kreuzer, Christelle Lahaye, Michel Lamothe, Norbert Mercier Towards an optimised IR-RF dating protocol for K-feldspars
- 11 **Verónica Guilarte**, Davinia Moreno, Mathieu Duval Evaluating the potential of an He cryogenic system for ESR dating of quartz grains
- 12 **Katie Hamilton**, Lorna Carmichael, David C.W. Sanderson, Emma Meehan, Sean Paling, Alan Cresswell, Tim C. Kinnaird, Louise Dodds Investigating the use of low level gamma spectrometry in studies of food authenticity
- 13 **Vicki Hansen**, Andrew Murray, Jan-Pieter Buylaert, Kristina Thomsen, Mayank Jain, Reza Sohbaty Precision and accuracy in beta source calibration
- 14 **S.G. Kang**, H.M. Roberts, G.A.T. Duller, X.L. Wang, P. Cheng, X.Z. Li Medieval Climate Anomaly and Bond 2 recorded in a late Holocene Chinese loess profile, based on closely-spaced

quartz OSL dating

- 15 **Natalia Kijek**, A. Chruścińska
Basic research on the OSL process in the aspect of natural and laboratory OSL growth curve for young samples
- 16 **Romesh Palamakumbura**, Alastair Robertson, Tim Kinnaird, David Sanderson
Post-IR IRSL dating of carbonate aeolianite deposits to constrain tectonic and sea-level controls on terrace formation processes in northern Cyprus.
- 17 **Eun-Young Yeo**, Andrew Murray, Jan-Pieter Buylaert, Kristina Thomsen & Vicki Hansen
Residual quartz and feldspar OSL signals in recently deposited sediments

Poster Session 2 Thursday 9th July

Posters on display from lunchtime on 9th July until close of meeting on 10th July.

Presenting authors may introduce their poster with one powerpoint slide at the start of the poster session at 1600 on 9th July in room 412.

- | | | |
|----|--|--|
| 18 | Geraint Jenkins , G.A.T. Duller, H.M. Roberts, R.C. Chiverrell | Investigating the potential for luminescence dating of pebbles and cobbles in ice marginal sediments, Isle of Man, UK |
| 19 | Michael Kenzler , S. Tsukamoto, M. Frechen, H. Hueneke, H. Rother | Luminescence dating of an Saalian to Weichselian sequence from the northern German Baltic Sea coast |
| 20 | Reza Sohbaty , Andrew Murray, Josh Borella, Mark Quigley | OSL dating of prehistoric rockfalls Christchurch New Zealand |
| 21 | Nicole Klasen , Janna Just, Finn Viehberg, Bernd Wagner, Asfawossen Asrat, Frank Schäbitz | Luminescence dating of sediment core samples from Chew Bahir (Southern Ethiopia) |
| 22 | Sebastian Kreutzer , Marine Frouin, Christelle Lahaye, Michel Lamothe, Norbert Mercier | Thoughts on data processing and error estimation using the RF ₇₀ protocol |
| 23 | Brice Lebrun , Norbert Mercier, Chantal Tribolo, Guillaume Guérin, Yannick Lefrais | Investigation toward equivalent dose over-dispersion using high resolution autoradiography image processing of resin-consolidated sediments |
| 24 | Benjamin Lehmann , Pierre G. Valla, Georgina King, Frederic Herman | Constraining post-LGM glacier fluctuations using OSL-surface exposure dating in the Western Alps |
| 25 | Sally Lowick | A test-set of Swiss samples for assessing the reliability of both quartz and feldspar ages up to ~ 110 ka |
| 26 | Andrew Mooney , Emma Marshall, David C.W. Sanderson, Tim C. Kinnaird | Re-appraising the heat flow of Scottish granites using TL onset temperature methods |
| 27 | Davinia Moreno , Christophe Falguères, Pierre Voinchet, Jean-Jacques Bahain | Assessing the applicability of ESR dating of quartz grains from karstic infilling sediments |
| 28 | Esperanza Muñoz-Salinas, Miguel Castillo , David Sanderson, Tim Kinnaird, Paul Bishop | Interpreting luminescence signals to assess grain resetting and sediment transport from a PPSL unit in Jalisco Block (Mexico) and other fluvial settings |
| 29 | Lisa Snape-Kennedy , Ian K. Bailiff, Nathan R. Jankowski | The Upper Caucasus: Prospects for dating archaeological contexts |
| 30 | Mareike Trauerstein , Sally E. Lowick, Heinz Veit | Challenges in using dim quartz from glacial and periglacial environments for luminescence dating |
| 31 | Joséphine Tuquoi , Guérin Guillaume | Red TL from heated flints: towards a SAR sequence using various signals (TL, ITL) |
| 32 | Dimitri Vandenberghe , J. | Interpreting the Brabant Member |

- Vandenbergh, K. Beerten, J. De Grave
- 33 **David Sanderson**, Simon Murphy, Tim Kinnaird, Andrew Tait
- 34 **David Sanderson**, Tim Kinnaird, Franck Leandri, Céline Leandri, Michèle Casanova
- 35 **Clemens Woda**, Céline Bassinet, Sara Della Monaca, E. Bortolin, P. Fattibene, F. Trompier, Jon Eakins, Chris Burbidge, Ulrike Kulka
- 36 **Jamie Wood**, P.S. Toms, M.C. Grenfell, F.M. Chambers
- Developments and applications of the SUERC portable OSL reader
- OSL dating of megalithic monuments at Capu di Lugu, Belvédère-Campomoro, SW Corsica
- Luminescence dosimetry using personal items as a viable tool for emergency dosimetry – activities within the European networks RENEB and EURADOS
- Optical dating of blocked-valley lake deposits from eastern South Africa

Abstracts

Rapid preliminary age assessment in the Namib Sand Sea using a portable luminescence reader

Stone, A. E. C.^{1,2}, Bateman, M. D.,³ & Thomas, D. S. G.²

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A rapid assessment of burial age for sedimentary materials using a portable luminescence reader is extremely useful for: (i) aiding the in-situ interpretation of sites and sequences, and (ii) guiding targeted field sampling strategies for full OSL dating. However, the challenge is translating portable luminescence reader signal intensities from samples into an estimate of burial age. We report the results of a simple linear regression between the portable luminescence reader signals and full SAR-protocol OSL burial ages for sediments from the Namib Sand Sea. This acts as a first-order calibration of portable luminescence reader signals into rapid preliminary burial ages for use on new samples at undated sites out in the field.

We present the calibration published by Stone et al. (2015) and subsequent additional samples that support this calibration. Results show that portable luminescence reader signals differ by over two orders of magnitude between late Holocene and last interglacial age samples and show that useful relative-age information is possible using bulk material in the field.

[1] Stone, A. E. C., Bateman, M. D., Thomas, D. S. G. (2015) Rapid age assessment in the Namib Sand Sea using a portable luminescence reader. *Quaternary Geochronology* doi:10.1016/j.quageo.2015.02.002

Dating a Near Eastern desert hunting trap (kite) using rock surface dating

Sahar al Khasawneh^{1, 2, 3, *}, Andrew Murray¹, Reza Sohbati³, Kristina Thomsen³, Dominik Bonatz²

In this study we date directly, for the first time, an example of a desert kite structure in the southeast of Jordan using luminescence signals from buried rock surfaces. These kites consists of two long low stone- walls lead outward in a funnel-like shape, often with some sort of stone enclosure where the walls meet; they are presumed to be animal traps used by hunters. Little known about the age of these kites because of an absence of attributable artefacts, and the lack of organic matter suitable for carbon dating.

The luminescence samples were taken from recently excavated kite in Jibal al-Ghadiwiyat in the east of al-Jafr (south-east Jordan). One rock sample was excavated from a pit in the kite enclosure; the sample was part of a long upright slab that forms part of the wall of the pit (Figure 1). Sediment samples from the infill of the pit were also collected for single grain measurements. The quartz from both the sandstone construction materials and the infill sediments (accumulated since site abandonment) are very suitable for luminescence measurements (high sensitivity, fast-component dominated).

The luminescence depth profile through the rock slab are shown in Figure 2. The profile shows the history of sequence of burial and daylight exposure for the two surfaces (the inward and outward of the standing slab) Figure 2. Preliminary results from the fitting model of Sohbati et al. (2011) and Freiesleben et al. (2015) gives a construction age of ~6.3 ka from the exposed and ~6.5 ka from buried (during use), indicating that the kite was not in use for a prolonged period.



Figure 1: pit dug in the kite structure shows the standing slab sampled for rock surface dating and the sediment fill sampled for single grain measurements.

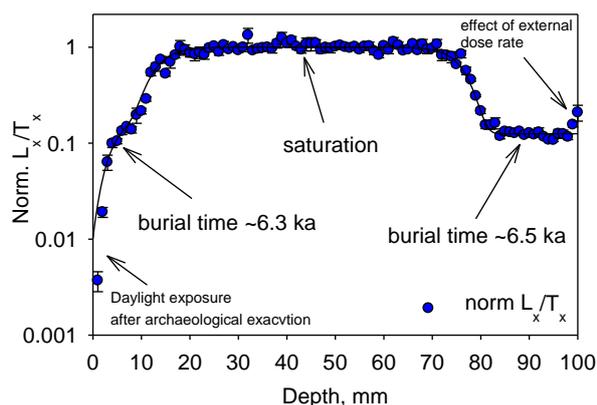


Figure 2: measured luminescence depth profile. Depth= 0 represent the inward-facing side of the rock (the side exposed during use of the kite), depth= 100 represent the outward-facing surface, buried during construction. The solid line is the best fit of the model to the data. Note the log. vertical scale.

Can we date gut strings using ESR?

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Electron spin resonance (ESR) detects not only unpaired electrons at radiation induced defects, but also those at organic radicals and transition metals in organic matters. The intensity of these signals changes with time, mainly by thermal activation processes. The possibility of dating organic substances using organic radicals and Fe³⁺ signals in organic matters has been suggested using, for example, crimps, leathers, and papers [1-3]. In this study we test the potential to date gut strings from early guitars and harp-lutes by ESR. We used eight strings ranging from about 200 years old to the present day; five of them were obtained from instruments made in the 19th century.

The ESR signals at $g = 2$ and $g = 6$ of the low and high spin states of Fe³⁺, respectively, and of an organic radical at $g = 2.005$ were observed from the gut strings. The intensities were compared with either, the known ages of the strings, or the estimated ages of the instruments after normalising by the weight. Both $g = 6$ and the organic radical signals showed a positive correlation with the expected age, but the data are scattered. The $g = 2$ signal on the other hand has a strong correlation with the age, giving a great potential for dating. The mechanism of the signal increase is not fully understood, but it might be caused by the oxidation or denaturation of proteins containing Fe (e.g. haemoglobin) by aging.

European early plucked instruments have recently enjoyed a great revival, however, a few aspects remain unknown (for example: the gauge of gut strings). Old strings are found occasionally on antique instruments and in their cases, but we need a method to test their originality. Our results suggest that ESR of gut strings could give valuable information, not only for performers and scholars but also for the wider musicological field.

[1] Ikeya, M., Miki, T. (1980) *Naturwissenschaften* 67, 191.

[2] Ikeya, M., Miki, T. (1985) *Naturwissenschaften* 72, 32.

[3] Ikeya, M., Miki, T. (1986) *J. Archaeol. Chem.* 4, 1.

Fine and coarse quartz OSL dating: Chinese loess vs. SE European loess

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We report on quartz SAR-OSL investigations on 8 samples collected from a new exposure of Xifeng loess in Central Loess Plateau (China) that covers the last glacial-interglacial cycle. The aim of the study was to compare the luminescence properties of fine (4-11 μm) and coarse (63-90 μm) quartz extracts for testing whether the non-concordant OSL chronologies previously reported on these grain sizes of quartz from Romanian and Serbian loess represent a widespread feature.

Standard luminescence investigations confirm the suitability of the application of the SAR-OSL protocol previously applied for dating Romanian and Serbian loess (preheat at 220 °C for 10 s, cutheat at 180 °C and elevated temperature OSL). The quartz OSL signal under continuous-wave optically stimulation regime proved to be fast decaying and thermally stable. The SAR protocol accurately recovered given doses of up to 500 Gy for both grain sizes. However, after irradiating the fine grains with a dose of ~8000 Gy on top of the natural dose the measured OSL signal was interpolated below the saturation limit.

Similar to quartz from Romanian and Serbian loess, the dose response curves are best fitted with a sum of two exponential functions. Pulsed OSL experiments confirmed that this behaviour is inherent to quartz and not caused by the contamination with another mineral. As in the case of Romanian loess, the fine quartz OSL dose response curves have higher saturation characteristics (D_0 of ~130 Gy, ~1500 Gy) than the coarse grained quartz (D_0 of ~40 Gy, ~300 Gy), even though for doses up to ~100 Gy the dose response curves of the two grain sizes overlap. These values are strikingly similar to our previous reported values on quartz extracted from European loess. As in the case of Romanian quartz, for low equivalent doses (<100 Gy) the ages (up to 26 ka) are in very good agreement while for equivalent doses higher than ~150 Gy the equivalent doses obtained on coarse grains are higher than the equivalent doses obtained on fine grains and consequently the ages diverge (up to 30%), the discrepancy increasing with depth. We note that both in the case of European as well as Chinese loess quartz OSL ages obtained on fine and coarse quartz are in agreement only for equivalent doses in the region where the dose response curves of the two grain sizes overlap.

OSL chronostratigraphy of a loess-palaeosol sequences in Poland using different dating methods.

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Loess formations in Poland display a close relationship with cooling and warming periods of the Northern Hemisphere during the Pleistocene. Loess sequences sensitively record regional palaeoclimatic and palaeoecological changes. In general, loess is typical for cold and dry, periglacial climate and environment. The intercalated palaeosols are indicators of warmer and more humid climate representing interstadials or interglacials. The silty and sandy aeolian material originates mainly from weathered rock surfaces affected by frost shattering or from glaciofluvial/fluvial deposits of river flood plains. In Poland, loess and loess-like formations occur in the southern part of the country, mostly in the south polish uplands, i.e. in the Lublin, Sandomierz, and Cracow Uplands. In addition, such deposits are found in the forelands and foothills of the Carpathians and Sudetes. At present, luminescence dating provides the greatest number of chronostratigraphic data concerning loess deposits. According to our project we report luminescence ages of loess from the last glacial cycle in SE Poland (up to about 100 ka), obtained in the Gliwice Luminescence Laboratory. Four different loess profiles from different regions in SE Poland were chosen for this investigation. For each profile (Biały Kościół, Złota, Tyszowce, Strzyżów) about 20 samples for luminescence dating and six for radiocarbon dating were collected. Two different fractions were investigated, the polymineral fine grains fraction (4-11 μ m) and medium quartz grains (45-63 μ m). For the fine fraction equivalent doses were determined using post-IR IRSL₂₉₀ and for medium quartz SAR OSL was used. Obtained OSL chronostratigraphy for the last 40k years was also confirmed by radiocarbon dating. Ages obtained for different fractions differ, especially for the oldest part of the loess profiles medium sized quartz yields younger ages than polimineral fine grains and what would be expected from the geological point of view. In addition for all loess profiles samples were collected in a vertical section at close intervals of ca. 5 cm and documented in respect of their sedimentology, palaeopedology and stratigraphy. In addition to high resolution OSL dating, grain-size distribution, carbonate and organic carbon contents, geochemical composition and magnetic susceptibility were determined.

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Luminescence and radiocarbon dating of pedogenic carbonate nodules: palaeo-climatic implications for the Lake Chad Basin

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Pedogenic carbonate occurrence in silicate geological settings may act as a sink in the continental carbon budget. Here we investigate the timing and mechanisms of pedogenic carbonate nodule formation associated with clay-rich soils in granitic watersheds of the Chad Basin (Northern Cameroon). In the present-day, the clay-rich soils are observed as variously developed mima-like mounds and buried structures. Carbonate nodules occur at various depths but are mainly accumulated at the surface. The nodules' precipitation may be linked to palaeo-pedogenesis inherited from the African Humid Period (c. 14.8 - 5.5 ka BP). Moreover, the parent material of the clay-rich soils seems not to be related to the local granitic bedrock, which raises the questions of its origin and age. K-feldspars (K-F) trapped in the nodules are derived from the clay-rich soil and can be used to date this sediment deposit. Nodule sizes vary and average diameters range from 2 to 6 cm. As they were exposed to sunlight during sampling, we contrasted luminescence signals obtained from external and internal nodule parts to confirm that internal signals were light-safe. Our results using the post IR-IRSL225 protocol on small aliquots (SA) and single grains (SG) showed that K-F grains from the internal part are not heterogeneously bleached, with SG overdispersion values of ~30%. Electron microprobe single grain K-content measurements were homogeneous ($12.67 \pm 0.37\%$, $n=131$); indicating that variations in fading rates, rather than dosimetry, may explain the overdispersion values. As the nodule interiors are light-safe, we analysed ten nodule cores from different depths, extracting the 90-180 μm size fraction and using the IR-IRSL225 protocol on SA.

A further challenge in this depositional setting is a changing dose rate due to U-series disequilibrium induced by carbonate precipitation. As nodule precipitation is temporally constrained by independent radiocarbon dating (5-7 ka cal BP), K-F luminescence ages were determined in three different ways: (i) assuming secular equilibrium, (ii) estimating the effect of U-series disequilibrium, and (iii) using the isochron method developed by Li et al. (2008). The latter method uses the contrast between internal dose rates and D_e values for grains of different sizes (40-90, 90-125, 125-180 and 180-212 μm , in our case), to determine an age unaffected by dose rate disequilibrium. Five nodules were investigated. Poor luminescence properties meant that it was not possible to generate isochron ages for two nodules. Comparing the ages calculated with these different methods shows that (i) results are within uncertainties for all methods for two of the nodules, but (ii) inferred ages obtained with the isochron method are ~20 ka older for the remaining nodule, sample X0. Furthermore as the nodule ages are known from ^{14}C dating, this isochron age cannot be reconciled with the measured external dose rate from the soil, and may be indicative of partial bleaching prior to deposition. Moreover, differences in the thermoluminescence curves measured during preheating, suggests that the provenance of some grains varies, which may explain the differential bleaching of some grains.

Precisely dating of this clay-rich material deposit will give important constraint on its origin, and enable integration of their dynamics within the Chad Basin during the late-Pleistocene.

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Luminescence dating of the Hebei loess section on the Northeastern Tibetan Plateau using OSL, IRSL and post-IR IRSL signals

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The extensive aeolian deposits of the Tibetan Plateau are important environmental archives, as they retain information about the past interplay between Asian monsoon and Westerlies and the link between dust accumulation and Quaternary glaciations. In northeast Tibet, mantles of sandy loess form a distinct belt which covers an elevation range between 3500 to 4500 m on the east-facing slopes of the A'nyêmaqên Mountains. However, there is little chronological information available for the loess deposits in this region. Here we provide a numerical chronology for late Pleistocene dust deposition in the region using luminescence dating. Twenty-nine samples were collected from a 8-meter thick homogeneous (without any visible intercalated paleosols) loess section at Hebei. The luminescence characteristics of sand-sized (63-90 μm) quartz and K-feldspar fractions were investigated. The dependence of the quartz OSL D_e and dose recovery ratio on preheat temperature was investigated for three samples (top, middle and bottom of the section). Our results indicate that a SAR protocol with preheat and cut-heat temperatures of 200°C (10 s) and 160°C, respectively, is suitable for these samples. The D_e and dose recovery ratio of the post-IR IRSL signals is independent of preheat over a wide temperature interval (180°C to 280°C, stimulation temperature 30°C below the preheat temperature). In contrast, the fading rates decrease from ~0.8%/decade to ~0.2 %/decade over this temperature range, suggesting that the laboratory fading rates are not affecting the D_e preheat plateau. The preliminary results point to late Pleistocene to Holocene dust deposition in this region.

Optically stimulated luminescence surface dating of glacial and landslide boulders from the Pamir Plateau, China

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Optically stimulated luminescence (OSL) is increasingly applied to the dating of rock surfaces. As part of testing the reliability and applicability of this new technique, we sampled a series of glacial and landslide boulders from the Pamir Plateau, China; these had been previously dated using ¹⁰Be cosmogenic nuclide (CN) dating. The boulder samples are from three different sites in the research area, with a wide CN age range of ~8 to 70 ka.

Measurement of the IR₅₀ signals as a function of depth into the surface exposed at the time of sampling of all the boulders in this study clearly shows that there is no detectable signal to a depth of at least 10 mm, suggesting that the IR₅₀ signal has been fully reset to this depth. However, samples with different CN exposure ages appear to have luminescence signals reset to similar depths, suggesting that rock-surface erosion rate might have significant effect on the luminescence depth profile. A new model including the rock erosion rate and internal dose rate from the rock was developed to account for this observation. Our measurements also confirm earlier suggestions that a rock surface retains a record of its daylight exposure and burial history. An investigation into the IR₅₀ depth profiles from the buried side of the boulders indicates that the buried side of only one boulder (13XJ64-1 from Kuergun) out of six was apparently well-bleached before burial. This observation casts doubt on the reliability of the CN age for this boulder; for the IR₅₀ signal to be reset, the boulder must have been at the surface and thus acquired a CN signal (inheritance) prior to final emplacement. Nevertheless, using OSL, we can confidently determine the burial age of the bottom surface of this boulder.

Temperature-dependence of time-resolved luminescence from $\alpha\text{-Al}_2\text{O}_3\text{:C}$

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The influence of measurement temperature on lifetimes and time-resolved luminescence intensity has been investigated. The measurements were augmented by results on spectral emission of luminescence from $\alpha\text{-Al}_2\text{O}_3\text{:C}$. The lifetimes were evaluated from time-resolved luminescence spectra. Spectral measurements were carried out using thermally stimulated and X-ray excited optical luminescence. The most prominent emission bands in $\alpha\text{-Al}_2\text{O}_3\text{:C}$ as studied appear at 380 and 420 nm and are associated with oxygen vacancies in $\alpha\text{-Al}_2\text{O}_3\text{:C}$. All emission bands are independent of temperature below $\sim 100^\circ\text{C}$ or so whereas thereafter the dominant emissions are subject to thermal quenching in the same temperature range. Complementary measurements based on, for example, phototransfer suggest that changes in lifetimes might also be related to slight shifts in corresponding emission bands. The luminescence intensity goes through a peak with stimulation temperature. The initial increase is ascribed to combined effects of optical stimulation and thermal assistance to various degrees on the electron traps. The subsequent decrease is described as the effect of thermal quenching. The latter changes are reversible with measurement temperature.

Testing the DosiVox software for basic dosimetric cases, comparison with tabulated data.

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The recently released DosiVox software (Martin *et al.*, in press) allows simulating dose rates for trapped charge dating in various situations, and to take in account the heterogeneity of samples and surrounding sediments. We present the results of several tests in order to investigate the accuracy of DosiVox in standard cases, and comparing with calculations and simulations from Aitken (1985), Guérin *et al.* (2012) and Martin *et al.* (2014). Alpha, beta and gamma dose rate are considered in modelings at various scales depending on the particle ranges. A first approach of dose rate variations when deviating from standard cases is proposed.

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γ -Dose Rate Determination Using In Situ BeO Dosimeters

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The determination of the environmental dose rate \dot{D} is an essential part of several dating techniques. In luminescence dating for example this is revealed by the age equation $t = D_e / \dot{D}$, where the age t is calculated by the quotient of the equivalent dose D_e and the environmental dose rate \dot{D} [1].

One opportunity to determine \dot{D} is the approach of in situ dosimetry. The most important benefit of this approach is to perform measurements in the original occurring radiation field. Thus the effect of uninfluenced environmental conditions, like heterogeneous sediments, the cosmic radiation and a varying water content can be recorded directly.

A device that enables to determine the part of the dose rate \dot{D}^{CY} , that is caused by cosmic and γ -radiation, and that applies in situ measurements is the BeOmax dosimetry system [2]. Originally developed for the purpose of personal dosimetry, the BeOmax dosimetry system is also useable for further scientific applications. The system consists of small OSL dosimeters with beryllium oxide (BeO) as luminophore and of special designed reader and bleaching units, which makes it easy to handle. It is calibrated to dose in air.

This study is one of the first to test and show the properties of the BeOmax dosimetry system in terms of luminescence dating. The dose rates \dot{D}_{is}^{CY} of the in situ measurements at different sites and setups were compared to the dose rates \dot{D}_{sp}^{CY} that were ascertained in laboratory γ -spectrometric measurements. The in situ measurements resulted in sufficient sensitivity to reveal heterogeneities of dose rate influencing parameters. However, the comparison to corresponding γ -spectrometric measurements pointed out, that the absolute values of the in situ measurements are not yet usable for dating. The comparison also showed $\dot{D}_{is}^{CY} > \dot{D}_{sp}^{CY}$ at one of the sites and $\dot{D}_{is}^{CY} < \dot{D}_{sp}^{CY}$ at a different site. Whether or not this behaviour can be explained by a possible correlation between the spectrometric determined element concentrations and \dot{D}_{is}^{CY} , has to be confirmed. For that purpose the radiation transport simulating code GEANT4 will be used [3].

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Luminescence (OSL, post-IR IRSL) efficiency dependence on x-ray energy: measurements and implications for dating.

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In luminescence dating, it is assumed that different radiations (except the heavy charged particles) are equivalent in terms of luminescence output, *i.e.* the luminescence resulting from a 1 Gy irradiation is independent of the source of radiation. In particular, in coarse grain dating, the trapping responses to beta particles, gamma rays and secondary electrons in nature are assumed to be equivalent to each other and to that of the laboratory calibration source. Only in the case of fine-grain dating the effect of alpha track saturations is considered additionally in the dose rate calculation.

It has been shown earlier that low energy x-rays are less efficient in producing OSL compared to beta particles, because of their higher ionisation density [1]. Here, we investigate the dependence of luminescence production per unit dose delivered by photons as a function of their energy. Irradiations of both quartz and feldspar samples in controlled conditions allowed us to give low (< 10 Gy) known doses to a number of samples whose OSL (in the case of quartz samples) and post-IR IRSL signals (in the case of K-feldspar extracts) were measured to determine an equivalent dose per unit delivered dose. We show a strong systematic variation in OSL and post-IR IRSL efficiency as a function of photon energy (a factor of up to ~20 over the investigated energy range, from 8 to 662 keV). The lower energy photons lead generally to lower luminescence efficiency – although the trend is not monotonic for feldspar post-IR IRSL. We conclude that the trapping efficiencies for different photons resulting from the decay of natural radioactive elements in sediments are not likely to be equivalent, questioning one of the fundamental assumptions in luminescence dating. This observation could have important consequences for age calculation and in particular lead to effective dose rate calculations in a similar way as for alpha dose rates. The experimental results, their interpretations and consequences will be presented and discussed.

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Parallel ^{60}Co calibration transfer using quartz OSL and verification of absorbed dose evaluation using a SAR protocol, for a selection of different $^{90}\text{Sr}/^{90}\text{Y}$ irradiators, samples, grain-sizes, supports, and signal integrals

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Parallel multiple aliquot calibration transfer is combined with evaluation of standardized single aliquot regenerative OSL dose response characteristics to produce a robust and efficient transfer protocol for mineral samples used in dating and retrospective dosimetry. This is implemented from an IST-LPSR ^{60}Co primary air kerma in air standard, to a matrix of quartz-based sample types (activated, heated, bleached) plus polymineral in different Risø and Daybreak $^{90}\text{Sr}/^{90}\text{Y}$ irradiators, on different support types (aluminium 0.5 mm; stainless steel 0.25 and 0.5 mm), of different grain sizes (90/100-160 μm ; 160-250 μm), for different signal integrals (Ch11-30, 391-490; Ch11-13, 14-15). Differences between grainsize and support ranged up to 25% but were specific to the irradiator-support-grainsize permutation, e.g. for the oldest Risø irradiator, source-sample distance and backscatter compensate for the smaller grainsize, but this is not the case in more recent models or for larger grains, while in the Daybreak this is not compensated so differences depend simply on material. Calibration transfer results are compared with retrospective absorbed dose evaluation using SAR-OSL. Measured/given beta exposures were close to unity for activated and heated material, which exhibited predose sensitization, and vice versa for optically bleached samples. Each value was best reproduced for gamma irradiation when using the respective multiple aliquot calibration coefficient. Parallel multiple aliquot calibration transfer using OSL integrated over the majority of signal decay was found to offer better accuracy and precision than retrospective single aliquot measurements, and was robust for polyminerals as well as quartz.

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Using R for TL dating

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R is a programming language and environment for statistical computing and graphics. It provides a wide variety of statistical and graphical techniques and is highly extensible [1]. Since 2012, a package specifically designed for luminescence dating is available [2]. However, it mainly includes functions for the analysis of OSL data.

Unlike OSL data, where the luminescence signal and background information are extracted from the same decay curve, for the analysis of TL data, different records have to be combined. Hence, data pretreatment is needed. Also, while OSL dating nearly exclusively uses the SAR protocol, in TL dating, the MAAD protocol is still applied as a standard. We therefore developed a series of **R** functions designed for the analysis of TL data.

The pretreatment of the TL data can be separated into three steps: First, separation of the TL curves used for the D_e estimation and the TL curves from preheat. Second, subtraction of the background signal from the luminescence signal. Third, alignment of the TL peaks. Peak scattering can be linked to different origins. If it is random, it is probably not linked to second-order kinetics and peak alignment will improve the D_e estimation.

For the D_e estimation, two functions using the SAR and MAAD protocol were developed. Both include plateau tests for each TL curve. The SAR function provides a D_e for each disc and functions from the **R** package ‘Luminescence’ are used to estimate a final D_e from the dose distribution. The MAAD function includes sublinearity correction and directly provides a final D_e estimate. In both cases, a series of parameters can be modified to improve the D_e assessment: (i) the integration temperature interval; (ii) the dose interval used; and (iii) the growth curve model. Rejection criteria are also included to identify problematic discs. Finally, the *growth curve approach* is combined with a *dose plateau approach*, which allows to improve the selection of the temperature interval.

One of the main problems encountered was tracking the uncertainties. Rather than estimating the uncertainties *a posteriori*, we generate an estimation of the error for each data point before any pretreatment. By considering random errors, it becomes possible to update this estimation each time the data are modified.

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Estimation of D_e error when statistics of count numbers deviates from Poisson distribution

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As shown in [1] for most systems the count numbers recorded by a photomultiplier tube (PMT) do not follow a Poisson distribution and display a larger variance than would be expected. In addition, the variance excess varies from one measurement system to another. In [2] we have shown that a distribution of count numbers is most appropriately described by a negative binomial distribution with different parameters for the dark counts and photon induced counts. In the current work we discuss how to use this information for calculating D_e errors and what are the implications for the analysis of results of D_e determinations.

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Improved age estimation in NW alpine forelands by applying new research on statistics of count numbers registered by PM tube

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In order to estimate the deposition time span of sediments surrounding two postglacial lakes in the NW alpine foreland D_e s were determined from coarse grains of quartz measured either in a multi-grained aliquot or a single grain procedure using the SAR protocol [1]. Analysis of the single grains response to stimulation from the readers' diodes revealed that the quartz used for the D_e determination contained grains of widely varying sensitivity with a clear predominance of dim grains [2]. As shown in [3] and [4] the statistics of counts recorded using a photomultiplier tube (PMT) depends on the characteristics of the particular counting device and on the sensitivity of the measured quartz. It means that when internal scatter of a particular PMT is low and the measured quartz is bright, count numbers follow the Poisson distribution. On the other hand, if insensitive quartz is measured on a counting device exhibiting high internal scatter, the resulting count numbers distribution is far better described by negative binomial distributions, distinct for the background and for the photoninduced counts. Not taking into account this interdependence leads to underestimation of the D_e standard errors, especially when the dim quartz significantly influences the measurements as in the case of the data from the alpine NW foreland. For the time being, in order to remedy this problem we propose a simple formula derived from dose recovery test performed with a quartz concentrate and on a reader both set to be used in combination for the age determination:

$$k_0 = 1 + \left(\sqrt{1 + \left(\frac{OD_{drt}}{RSD_{drt}} \right)^2} - 1 \right),$$
 where OD_{drt} is the overdispersion in CAM and RSD_{drt} the relative

standard deviation, both calculated for the dose recovery test. The factor k_0 is then used to multiply the standard errors (SE) of D_e s calculated in first step in analysis software for an age determination sequence of D_e measurements. The so extended range of the SE of D_e s may prevent appearance of results suggesting e.g. age mixing or young minimum ages in the final age modelling. Examples from the NW alpine foreland will be discussed.

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Single grain equivalent dose measurements of feldspars from incompletely bleached sediments

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Lyons (2012) described a sequence of Quaternary fluvial sediments in South Africa for which he obtained ages in stratigraphic order for 10 samples, ranging from 200 years to in excess of 100 ka, using the optically stimulated luminescence (OSL) signal from quartz. The high overdispersion in equivalent dose (D_e) values calculated for the youngest samples clearly demonstrated that these sediments were incompletely bleached at deposition. Colarossi et al. (in press) determined ages for the same samples using the post-infrared infrared stimulated luminescence (post-IR IRSL) signal from K-rich feldspar separates. The feldspar post-IR IRSL D_e values are consistently larger than those expected based on the quartz ages, and the D_e distributions from the feldspars display consistently lower overdispersion than the quartz D_e values. The difference in bleaching characteristics of the two signals may explain the larger post-IR IRSL D_e values, but the lower overdispersion cannot be explained in this way. Measurements for both minerals were made on small aliquots, with between 20 and 30 grains on each aliquot, and greater averaging in the feldspar aliquots may explain the difference in overdispersion values.

In this study single grain measurements of the post-IR IRSL signal from feldspars were made to remove the impact of averaging, and the D_e values compared to the small aliquot post-IR IRSL₂₂₅ and the quartz OSL distributions. The post-IR IRSL₂₂₅ D_e value obtained from single grains for the youngest sample is much closer to the expected value than that calculated using small aliquots by Colarossi et al (in press). Additionally, the ages based on D_e values determined from single grains of feldspar show closer agreement with the quartz OSL ages than the small aliquot feldspar ages. Thus, due to a relatively large proportion of feldspar grains which give light and the resultant averaging of the luminescence signal, single grain K-rich feldspar measurements appear more reliable than small aliquots for dating environments characterised by poorly bleached sediments.

Colarossi et al. (in press) Comparison of paired quartz OSL and feldspar post-IR IRSL dose distributions in poorly bleached fluvial sediments from South Africa. *Quaternary Geochronology*, doi:10.1016/j.quageo.2015.02.015

Lyons (2012) Chronology and controls of Late Quaternary sedimentation, pedogenesis and erosion across interior South Africa. Unpublished PhD thesis, Aberystwyth University.

The application of time- and spatially-resolved laser scanning for characterisation of coarse-grain sediment samples

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The radiation sensitivity of sediment grains used in optically stimulated luminescence (OSL) dating is known for being highly variable. This variability is dependent upon the geological setting, sediment history and also grain mineralogy, typically quartz and feldspar. It is not only frustrating, but also monetarily and time expensive, when collected samples simply do not have favourable luminescence properties to allow for accurate OSL age estimation. A means of routinely determining the distribution of luminescence sensitivities and mineralogies within aliquots of sample is required to target those samples most favourable to the OSL method and also customise the overall dating approach to the site. In this paper, we outline the initial development of an approach to assess the potential of samples for single grain measurements with minimal preparation using a laser-scanning system [1] with capability to perform both spatially- and time-resolved measurements. With one pass of the system, a mapping of bright grains in each aliquot (standard disc size) is obtained and providing information on their respective mineralogies. This surveying approach is being employed with samples collected for dating purposes associated with ancient irrigation systems that were 1) sieved but untreated and 2) treated with acids to isolate specific mineral fractions.

[1] Bailiff and Mikhailik, (2003). *Radiation Measurements*. 37: 151-159

Holocene soil erosion based on luminescence measurement and soil properties (case study: Kolonia Celejów, E Poland)

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Loess areas are the one of the most susceptible to mechanical denudation associated with water erosion. This is natural process but was intensified by the agricultural practices. In south Poland, anthropogenic deforestation of some slopes, and consequently intensive water soil erosion, start with the beginning of the Neolithic about 5 ka ago. However, in many places these processes began much later. This process was intensified many times during the Neolith, bronze age, iron age, medieval age or later. As a result of soil erosion, at the foot of the slopes and bottoms dry loess valleys have been accumulated reaching up to several meters thick Holocene sediments of various ages. This work presents the results of Optically Stimulated Luminescence (OSL) dating of Holocene slope sediments from Kolonia Celejów (Nałęczów Plateau, Eastern Poland). The subject of studies is a loess-soil sequence in a huge gully system on western part of loess plateau. The selected sediment profile was modified by pedogenic processes, postpedogenic redeposition and secondary accumulation as the colluvial layers. In this study simultaneously with luminescence measurement were done detailed pedagogical and micromorphology studies. Those additional analysis allow to recognize the lithological or pedogeneic features in the examined profiles and thus improve the interpretation the luminescence dating results. The top of the sediment were measured also by gamma spectrometry to assess the ¹³⁷Cs isotope which is a marker of modern sediment (no older than 60 years). The studied sediment profile from Kolonia Celejów contains a thick layer of Holocene slope sediments and below is a loess under pedogenic processes. The obtained results have shown that Holocene colluvial sediments containing grains of quartz can be approximately dated using OSL. Obtained results are important for the study of Holocene soil erosion and accumulation of colluvial sediment in Central Europe. The work is the result of the research project No. DEC-2011/03/D/ST10/05788 funded by the National Science Center.

Using OSL for interpreting sediment transport processes: From mountain rivers of the Jalisco Block to alluvial deposits at the Usumacinta-Grijalva River Basin (Mexico)

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The OSL has been proved to be a powerful tool for dating and obtaining information about the processes involved in sediment transport at different types of fluvial settings. In this oral paper we present the main results of two researches carried out at different sedimentary fluvial environments. The OSL is used in both studies to evaluate the grade of resetting of the mineral grains transported by rivers. In our two study areas we observe that the mineral grains are poorly reset, in these cases the inherited signals are useful to elucidate the mechanisms that drive the erosion of the landscape.

The first case of study corresponds to the Jalisco Block, which is a tectonically active landscape located in the west of Mexico. There, rivers flowing to the Pacific coast deliver large amounts of sediment from the highlands to the floodplains. We observed that in the most tectonically active areas of the Jalisco Block the sediment mobilized in the channels have higher values of luminescence compared to areas with mild tectonic activity.

Our second case of study is located along the floodplain of the Usumacinta and Grijalva River Basin, which is composed by alluvial deposits resulting from the denudation of mild tectonically active mountain ranges. In this case the sequences of recent flood deposits, evaluated by means of vertical sediment profiles, provided information about the source of the sediment. Our results also suggest that the erosion and sediment accumulation in the landscape is likely to be controlled by the activity of cyclones, which trigger hyper-concentrated flows, that leave horizons with poorly rested sediments along the floodplain.

Valley bottom preservation and disturbance in the southeastern Tablelands of post-European Australia

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Hillslope and gully erosion following the conversion of forested landscapes to open agricultural fields and grazing pastures leads to the occurrence of aggradational sedimentary deposits in valley bottoms around the world, collectively known as post-settlement alluvium (PSA). Research over the last few decades has focused on understanding the processes leading to gully incision, which typically precedes PSA deposition, and the timing of erosion. As a result, we know relatively very little about the geomorphological processes acting on valley bottom landscapes and environments during PSA deposition.

PSA deposition in the southeastern Australian Tablelands occurred shortly after European arrival in the early AD 1800s, a result of gully incision in headwater catchments during periods of high rainfall. Pre-disturbance valley bottoms were occupied by swampy meadow (SM) wetlands, most of which are now buried under mantles of PSA. In uneroded SM landscapes, bulk optically stimulated luminescence (OSL) measured on poly-mineral, poly-grain size sediment samples produce no luminescence at the valley bottom surface and systematically increase with depth. This down-profile bulk sediment OSL trend in SM sediment is characteristic of uneroded SM landscapes throughout the Tablelands and will likely be altered if disturbed during PSA deposition; the bulk sediment OSL profile in SM sediments will be preserved if PSA deposition only buries SM environments with no disturbance.

We identified sixteen SM-PSA stratigraphies exposed along stream gullies eroded into valley bottoms after PSA deposition and measured the bulk sediment OSL across the SM-PSA sedimentary transition to assess the degree of valley bottom disturbance during PSA deposition. Our findings show that SM environments in six of the sixteen catchments are remarkably well preserved under deposits of PSA. SM environments in seven of the catchments indicate a small degree of valley bottom disturbance during PSA deposition. The final three catchments have chaotic bulk sediment OSL depth trends, and disturbance histories in these catchments are not easily interpreted. Our work therefore exemplifies how bulk sediment OSL measurements can be used to identify the degree of landscape preservation or disturbance in valley bottoms affected by PSA deposition.

Evolution of the Skagens Odde spit based on OSL dating using quartz and feldspar

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The Skagens Odde spit system is located in the northernmost part of Jutland and is one of the largest spit systems in Europe. The system has prograded towards the northeast as a result of sediment accumulation driven by transport by a northeastwards longshore current. The spit system developed during the Holocene, especially after the culmination of the Early Atlantic transgression (≈ 7200 years ago). Because of isostatic rebound after the LGM, the southern part of the spit is now raised about 14 m above sea level; towards the north it gradually falls to the modern backshore beach plain level at 1.5m. The location thus provides a unique opportunity for studying spit evolution and relative palaeo-sea-level change. Earlier studies used OSL- and ^{14}C -dating to document the spit growth. The younger northern part of the spit shows smoothly decreasing ages with distance, as expected, whereas unpublished data from the older southern part show scattered ages with distance, without a clear pattern. Our new study uses OSL measurements from quartz and feldspar from the southern part of the spit to confirm the existing data. A new model-description is then developed for this part of the spit, to explain the different sedimentary and uplift processes that began to build the spit, before changing to those current today.

Late-Quaternary exhumation of Namche Barwa constrained using Low-temperature OSL-thermochronology

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Extensive geomorphic evidence shows that glaciations throughout the Quaternary period have influenced the erosion histories of mountainous regions. However, it is challenging to quantify these changes in exhumation because established thermochronology methods are unable to reliably resolve changes within the past 1 Ma. Optically stimulated luminescence (OSL)-thermochronology has lower closure temperature (30-70 °C) than other thermochronometric systems, and offers the potential for constraining near-surface changes in exhumation rates over Quaternary timescales.

The Namche Barwa massif (eastern Himalayan syntaxis) has experienced extremely rapid exhumation throughout the late-Cenozoic to Quaternary period (e.g. Seward and Burg, 2008). This setting is therefore challenging for the application of traditional low-temperature thermochronometers, but provides a useful test-site for the application of OSL-thermochronology in resolving late-stage cooling histories. Ten bedrock samples were prepared, five of which were within the rapidly exhuming zone. Na- and K-feldspar rich fractions were extracted and a MET protocol was used which comprises IRSL measurements at 50, 100, 150 and 225 °C to record multiple signals for each individual sample. The different MET signals have different thermal stabilities (thus different closure temperatures), and therefore provide better constraint on cooling rates.

Results show that samples within the rapidly exhuming zone exhibit thermal signatures, whereas samples beyond this zone have experienced cooling rates too low for resolution using OSL-thermochronology. Incorporating sample specific laboratory-constrained kinetic parameters into a charge-trapping model, results in predicted cooling rates comparable with independent cooling rate controls. These results demonstrate that OSL-thermochronology has the potential to constrain Quaternary cooling histories in rapidly-exhuming settings.

A comparative study on XEOL, RL, TL, PL and OSL emission spectra of Na and K rich feldspars

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Recently Jain et. al. [1] have shown that the IRSL emission in UV, blue, yellow and far-red bands share the same electron trap and broadly follow the same recombination kinetics, however, the exact mechanism of charge transport and luminescence emission at each site is still poorly understood. We use different excitation methods and lifetime measurements to further understand these recombination mechanisms. The photoluminescence (PL) directly probes the energy states of luminescence centres, whereas radioluminescence (RL), x-ray excited optical luminescence (XEOL), thermoluminescence (TL) and optically stimulated luminescence (OSL) contain additional information on charge transport and electron-hole recombination. A combination of XEOL, RL, TL, PL and OSL spectra can thus provide valuable information.

We report on oligoclase and sanidine mineral specimens. The RL, TL and OSL spectra has been measured with a high sensitive spectrograph attached to Risø TL/OSL DA 20 reader [2]. The PL, XEOL and OSL spectra are measured in a Horiba spectro-fluorometer, where we have made an in-house attachments with a 40 kV x-ray tube, laser stimulation port, PMT detection module, and a closed-loop He cryostat [3]. The results and their implications will be presented and discussed.

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[2] Lapp, T., Kook, M., Prasad, A. K., Jain, M. (2015) A single photon EMCCD based time resolved spectrograph system optimised for the Risø TL/OSL Reader. UK Luminescence and ESR Meeting 2015.

[3] Jain, M., Prasad, A. K., Poolton, N. R. J., Lapp, T., Kook, M. (2015) Cool quartz and feldspars – what can we learn ? UK Luminescence and ESR Meeting 2015

Investigating kinetic processes of K-feldspar for the application of luminescence thermochronometry on the Mont Blanc massif

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Luminescence dating has been proposed as a low-temperature thermochronometer, which has the potential to quantify the recent exhumation history of mountain ranges [1]. During rock exhumation, the balance between continuous electron trapping (from in situ radioactive decay) and detrapping (from exposure to heat) within minerals changes as thermally stimulated detrapping is increasingly reduced during cooling along a geothermal gradient. Using the luminescence signal from these minerals, particularly quartz and feldspar, the thermal history of rocks can be constrained and exhumation rates can be derived. It is therefore essential to understand the kinetic processes which govern electron trapping and detrapping. Here we investigate two recently proposed models for feldspar, namely a general order kinetics [2] and band-tail states model [3], and assess their applicability for luminescence thermochronometry, in particular the extent to which the laboratory kinetics can be extrapolated over geological timescales.

The setting of this study is the actively eroding Mont Blanc massif in the European Alps. Samples from the Mont Blanc tunnel were obtained at ambient temperatures ranging from 16 to 32 °C. Furthermore, recent studies indicate that the Mont Blanc massif experienced rapid exhumation during the last 2 million years (up to ~2 km/Myr) [4]. Therefore, it is anticipated that these samples will exhibit a luminescence thermochronometric signal.

The IR₅₀ and post-IR IRSL₂₂₅ signals of K-feldspar extracts were measured and sample parameters (i.e., trapped charge concentration (n/N), characteristic dose (D_0), g -value, and environmental dose rate (\dot{D})) constrained. After accounting for fading, the majority of the samples show a thermal signature. Isothermal decay experiments were used to constrain the thermal kinetic parameters of the two models, and interestingly, experiments in which we use a range of regenerative doses reveal first order kinetics. This result implies that the general order kinetics model might not be applicable for thermochronometric studies. In contrast, the band-tail states model may be more appropriate.

Ultimately, we intend to use the IR₅₀ and post-IR IRSL₂₂₅ signals of K-feldspar to infer a Quaternary cooling rate for the Mont Blanc massif. Moreover, the signal accumulation may give insight into local thermal field evolution, influenced by hydrothermal flow since the LGM.

[1] Herman, F., Rhodes, E.J., Braun, J., Heiniger, L. (2010). *Earth and Planetary Science Letters* 297, 183-189.

[2] Guralnik, B., et al. (2015). *Radiation Measurements*, in press.

[3] Li, B. and Li, S.-H. (2013). *Journal of Luminescence* 136, 5-10.

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Single grain pIR-IRSL dating of K-feldspar from high energy deposits

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Recent success dating fluvial sediments using a K-feldspar single grain pIR-IRSL protocol with the second IRSL measurement at 225°C was reported at the 2014 Montreal LED meeting, and in Rhodes (2015). In almost all samples, some grains display higher equivalent dose values, presumed to result from incomplete zeroing. A number of samples from very high energy deposits, rapidly laid down after large scale landsliding, and from very poorly sorted alluvial and colluvial sediments in mountain settings, show more severe incomplete zeroing, yet provide age estimates that are apparently consistent with each other and independent chronological control.

These contexts provide a great opportunity to assess the limits of this dating approach, in terms of prior bleaching histories for individual grains. Other locations remain undated, as preliminary results provided no consistent patterns, and research continues to find an improved way to tackle these. I will discuss the approaches taken, recent minor developments, and potential of this technique to provide ages where dating using quartz OSL is often not possible owing to low sensitivity.

Rhodes, E.J. 2015 Dating sediments using potassium feldspar single-grain IRSL: initial methodological considerations. *Quaternary International* 362, 14-22 <http://dx.doi.org/10.1016/j.quaint.2014.12.012>

Thermoluminescence of Sodalite – an Analogue for Feldspar and Quartz?

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Sodalite is a feldspathoid mineral, comprising a three-dimensional framework of Al and Si tetrahedra surrounding a cage in which tetrahedral Na_4Cl groups are found. Chemical substitutions on the framework and in the contents of the cage mean that there are several sodalite group minerals, showing a wide range of colour and luminescence properties. Many have bright UV-C photoluminescence in hand specimen and some are tenebrescent (=photochromic, i.e. change colour on exposure to UV). Luminescence in sodalite group minerals is derived from many centres including activations by Mn^{2+} , S_2^- in the cages, and Fe^{3+} substituted within the aluminosilicate framework. A whole range of point defects from F centres and non-bonding paramagnetic oxygen defects are implicated in luminescence in the UV and blue. Self-trapped excitons are believed to be the cause of UV-A luminescence.

The present study has measured the spectroscopic thermoluminescence in sodalite group minerals between 20 and 673 K on the RLTLCL system at St Andrews. There are several TL peaks in this temperature range. Many TL peaks (e.g. 110 and 185 K) occur at the same temperature in all sodalite group minerals, irrespective of the emission profile, consistent with a model whereby the trap is physically a defect within the framework that all sodalites share. Each sodalite has a different emission spectrum and often the TL is expressed in whichever emission profile is characteristic of that variant. However, sometimes TL is expressed only in one part of the spectrum; e.g. TL peaks at 70 and 100 K in pink sodalite are only observed at 710 nm, even though such an emission is absent when the sample is excited directly. I interpret this to indicate that the trap and recombination centre (here Fe^{3+} on the framework) are linked in energy (and space?) and we infer the trap in this case to be an F centre or paramagnetic oxygen defect coupled to Fe^{3+} . A similar feature in Be-sodalite (tugtupite) is observed at different temperatures (140 and 220 K), hinting at clustering (or at least teleconnections) between framework Fe^{3+} traps (presumably point defects) and framework Be^{2+} .

The significance of this study may lie in the analogies to be drawn for other framework silicates such as feldspar and quartz. Sodalite has high symmetry (usually cubic), is rarely twinned and many types of defect implicated in feldspar and quartz at trace levels are stable in sodalite at high concentrations. The present study provides some tantalising insights into the physical nature of traps – the holy grail of many dosimetry studies. It provides firm evidence for coupling (certainly in energy but presumably also in space) between traps and recombination centres, the precursor for tunnelling, and therefore that defect ordering is critical to understanding luminescence behaviour. We may infer that these features contribute to the more complex behaviour of sodalite's cousins.

Cool quartz and feldspars – what can we learn?

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Luminescence emissions are generally enhanced and better resolved at low temperatures, providing a clearer view of the processes involved. Furthermore, processes like excited-state tunnelling, mid-range hopping, mapping of the dosimetric traps and band tail (low energy) states can only be observed/accomplished at the cryogenic temperatures. We have recently extended a Horiba spectrofluorometer facility (excitation and emission spectrometers) with cryogenic cooling and additional stimulation and detection modules for continuous-wave and time-resolved measurements. A 40 kV x-ray tube has been incorporated as an in-situ ionising source. The sample can be held isothermally between 7.5 and 293 K and can be ramped up at a desired rate. This system allows measurements of low temperature photoluminescence, time-resolved luminescence, radio-luminescence and thermoluminescence, and the possibilities of dual probe such as x-ray/laser and Xe/laser for unravelling charge trapping, transport and competing recombination pathways. We will present an overview of the possibilities for low temperature science and some new measurements with quartz and feldspars.

Exploring the possibilities of quartz and feldspar luminescence dating for glaciofluvial sediments from the Northern Alpine Foreland

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The concept of four Quaternary glacial advances to the Northern Alpine Foreland (NAF) has already been developed at the beginning of the 20th century by Penck and Brückner (1901/1909). The different glaciation are assigned to specific stratigraphic units, which can be connected over the complete NAF area. Mostly the chronology for the stratigraphic units is based on morphostratigraphical findings and correlation with the Marine Isotope Stages (MIS). This study is part of a project funded by the Austrian Science Fund (FWF) and it expands the previous work already completed within the project for the eastern NAF to the mid to western part of the NAF, focusing on deposits and glaciofluvial terraces usually assigned to MIS 6. The sediments were deposited when large piedmont glaciers reached far into the Alpine foreland. We sampled five gravel pits exposing glaciofluvial sediments located near to the former glacial margin. Numerical dating of the respective sediments in that area has only been conducted to a limited extent. Previous studies report several methodological issues that limited the outcome with respect to the geochronological and chronostratigraphical implications.

Due to the proximity of the sampling sites to the glacial outlet the possibilities of incomplete resetting of the luminescence signal need to be evaluated. Therefore, we explored the resetting properties of feldspar signals using the post infrared infrared (pIRIR) protocol with varying elevated temperatures (150 °C, 225 °C, 290 °C) and tested the possibilities of the standard IRSL protocol. Furthermore, we measured the quartz OSL signal, which is known to bleach faster than the feldspar signal. Prior studies indicated a high medium component contribution to the quartz signal, which could lead to age underestimation. In addition, quartz from the research area was in general reported to yield very dim signals. However, first tests on small aliquots of quartz conducted in this study revealed the occurrence of fast component dominated quartz signals. Therefore, extensive test were conducted on the signal properties of the Quartz fraction.

Compared to the results from the Eastern NAF, first findings for samples from the mid to Western NAF reveal significant differences in luminescence signal characteristics for both quartz and feldspar signals. Apart from the chronostratigraphic aims of the project, we plan to investigate possible reasons for these differences with relation to depositional, as well as the lithology of the of the catchment areas and the mineralogy of the bulk glaciofluvial material.

OSL dating of glaciofluvial and marine deposits on Djursland, a key site for Late Pleistocene deposits in Denmark

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The aim of this study is to produce a numerical chronology for glacial deposits in Djursland (eastern Jutland, Denmark) - a key site for studying glacial and interglacial sediments. Many coastal sections and gravel pits have impressive successions with multiple tills interlayered with glaciofluvial or marine sediments, providing excellent opportunities for unravelling the glacial history of the area. The current paradigm is that the glacial deposits primarily belong to the last three Weichselian ice advances: the Kattegat advance c. 29-27 ka, the mid Danish advance 23-20 ka and the Young Baltic advance c. 19-18 ka (Pedersen & Petersen, 1997; Houmark-Nielsen 2010). These correlations are primarily based on sedimentological analysis of the tills, including till fabric, grain size analysis and petrographic analysis; there are very few absolute age constraints. However, the new observation of marine Eemian sediments in one of key section (Mols Hoved) has questioned the interpretation that most of the sediments on Djursland belong to the Weichselian glaciation. Coarse-grained (180-250 μm) quartz and K-feldspar were extracted using standard sample preparation techniques. SAR OSL and SAR pIRIR50,290 protocols were used to determine the quartz and feldspar doses. The quartz luminescence characteristics are found to be suitable (fast component, good recycling and dose recovery) but only 12 out of 26 samples have De values ≤ 150 Gy; several samples have natural OSL signals close to or in saturation on the dose response curve illustrating the need for another dosimeter. Because of the potential for incomplete bleaching of glaciofluvial deposits we compare the IR50, pIRIR290 and quartz OSL results to identify those younger samples that have quartz signals that are probably well-bleached at deposition (Murray et al., 2012). Our preliminary results indicate that the quartz OSL signal of many of the young samples was indeed sufficiently bleached at deposition and that at least some of the sediments sections in Djursland are older than previously thought.

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How do initial assumptions affect minimum age approaches?

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Use of minimum age models to determine burial dose is a widely applied method in luminescence dating. Incomplete bleaching commonly can occur in certain sedimentary environments, e.g. Glacial. This partial bleaching leads to scattered dose distributions from which it is hard to discern the true burial dose. The most common approach is to select a proportion of the lowest measured D_e values presuming these are best bleached using for example the Minimum Age Model (MAM) or Internal-External consistency criteria (IEU). Both these models, need starting parameters based on the over-dispersion of a well bleached distribution (σ_b for MAM, a and b given by the over-dispersion as a function of the measured dose: $OD = a \times D_e + b$, for IEU). Assumptions made relating to these starting parameters define the results obtained. It is therefore of key importance to understand the sensitivity of these models, MAM and IEU, to these starting criteria. In this work, these have been studied for a series of glacial sediments. Accuracy on the age estimation of these samples is critical as those will be the foundation to establish the deglaciation patterns of the last ice sheet within the BRITICE-CHRONO project. The effect on the estimated true burial dose has been studied for starting over-dispersion ranging between 5 and 50%. Results show that some samples are insensitive to variation in the starting values used whilst others have a threshold below which the models are highly sensitive.

Quantifying the causes of scatter in single-grain D_e distributions for quartz

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BRITICE-CHRONO is a large consortium project that will provide an extensive geochronological dataset constraining the retreat of the last British-Irish ice sheet. This study focuses on a sequence of glaciofluvial samples from BRITICE-CHRONO that were collected along the line of ice retreat of the Irish Sea Ice Stream. The bedrock geology along this transect is highly variable and so the samples are likely to have been sourced from different bedrock types. Therefore, the samples are expected to have variable dose rates, but there is also the potential for the samples to have different luminescence characteristics.

When determining ages for partially-bleached sediments using the Minimum Age Model (MAM) or Internal External Uncertainty (IEU) model it is important to define the amount of scatter in a D_e distribution that would be expected for a sample that was well bleached upon deposition. Scatter in D_e values from single grains of quartz may arise not only from partial bleaching but also from the instrument reproducibility, variability in luminescence characteristics and microdosimetry. The instrument reproducibility can be constrained, but understanding the relative magnitude of the additional contributions is important in the selection and application of the statistical models used to calculate ages. In this study, dose-recovery experiments have been performed on the glaciofluvial samples from along the Irish Sea Ice Stream to quantify the influence of the luminescence characteristics on the D_e distributions. The results suggest that the luminescence characteristics of the quartz grains can be highly variable between samples and so the relative influence on the value of σ_b for the MAM should be adjusted accordingly. The homogeneity of the dose-rate to individual grains within a sample has also been investigated to assess the significance of microdosimetry on the D_e distributions and whether there is any difference between samples.

Recent developments from Freiberg Instruments

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The **lexsyg**research [1] has been recently joined by the **lexsyg**smart, a low cost luminescence reader, which provides the basic functionalities of heating, stimulation, irradiation and detection (including a filter changer) for luminescence dating of 40 aliquots.

Several new features were developed for the **lexsyg** luminescence reader family, notably new stimulation sources, mostly based on LED technology. The narrow bandwidth luminescence stimulation is now extended to include UV and other wavelengths. Besides facilities for μ s pulsed stimulation, time resolved luminescence measurements are now possible with laser rise times below 10 ns, transient detection down to 2,5 ns and time point accuracy < 50 ps. The stability of the heating element has been further improved and is now capable of heating to 710°C with heating rates up to 40 K s⁻¹. Single grain analysis of spatially resolved luminescence measurements with an attached EMCCD camera is achieved via an interface with a revised AgesGalore software package, allowing the semi-automated analysis of hundreds of grains (or regions of interest – ROI) within user specified rejection criteria.

All **lexsyg** luminescence readers are controlled by the LexStudio 2 software, which allows the use of the full potential of each individual system, while providing a maximum of safety for the equipment and minimizes user error. Measurement parameters can be almost freely defined and allocated to individual aliquots, including a new feature of semi-automated programming of standard SAR sequences (SARPI). Basic analysis functions are available in the software LexEva, which also provides the interface to the 'R luminescence package' [2] for extended analysis of luminescence measurements.

The line of dosimetric equipment is completed by a new benchtop ESR spectrometer, which allows low temperature measurements. The spectrometer can be optionally equipped with auto-samplers for powder, solid and liquid samples, as well as with a goniometer. Samples can be bleached and an irradiation facility is provided with an attached x-ray source, which also fits to the **lexsyg** luminescence readers.

[1] Richter, D., Richter A., Dornich K., 2013. **lexsyg** - a new system for luminescence research. *Geochronometria* 40, 220-228.

[2] Kreutzer, S., Schmidt C., Fuchs M., Dietze M., Fischer M., Fuchs M., 2012. Introducing an R package for luminescence dating analysis. *Ancient TL* 30, 1-8.

An X-ray irradiator for dosimetric application

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As an alternative to the commonly employed β -sources, an X-ray irradiator was developed for lexsyg research and lexsyg smart luminescence readers. Radiation exposure from X-ray tubes is zero when switched off, they do not have to be especially disposed after their life-time and are therefore favorable from the point of personal and environmental radiation safety. The main advantage in practice compared to, e.g. $^{90}\text{Y}/^{90}\text{Sr}$ - β -sources, is the adjustable X-ray energy flux and photon energy spectrum by selectable X-ray tube current and voltage, respectively, in addition to manually changeable beam hardening filters. This enables a dose-rate range of several orders of magnitude, allowing significant irradiation time reduction in high dose applications like sediment dating, while still being able to deliver small doses as well, e.g. for short exposure dosimetric applications.

The fully housed X-ray irradiator is based on a Varian VF-50 tube with tungsten target, monitored by a silicon photodiode. The tube can be operated between 15 kV and 50 kV tube voltage and 0.1 mA to 1.0 mA cathode current. Measurements with an ionization chamber revealed excellent constancy of the dose-rate and reproducibility with deviations of < 1% and < 2%, respectively.

A simple model was devised to determine the approximate energy spectrum at sample position for the specific setup and verified with an X-ray spectrometer. The modelled filter (aluminum) thicknesses with respect to X-ray energy spectra and sample thickness were found in accordance with published values.

Internal consistency was checked with dose recovery tests (DRT) of quartz coarse grain samples, which provide results within a few percent of unity, comparable to β -DRTs. This shows the general applicability of the SAR protocol for X-ray irradiation as well as suitability of the quartz samples employed. For external verification the X-ray tube was calibrated with γ -irradiated quartz for several tube high-voltage and current settings. Beta-doses from zeroed other quartz samples were recovered with X-ray irradiation within a few percent of unity, as well as the natural dose of a quartz sample. Different current settings for the same voltage provided the according proportional dose-rates, indicating the absence of dose-rate effects, which was further verified by OSL measurements of $\text{Al}_2\text{O}_3:\text{C}$.

The suitability of the X-ray irradiator for quartz and $\text{Al}_2\text{O}_3:\text{C}$ dosimetry is shown and it thus appears to be suitable for other materials as well. The X-ray generator is also available for a radiofluorescence setup, as well as an attachment for MagnetTech ESR spectrometers.

A single photon EMCCD based spectrograph system for time-resolved measurements on the Risø TL/OSL Reader

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The emission spectra of TL and OSL/IRSL signals has been studied by several authors (see e.g. Baril et al.[1], Bøtter-Jensen et al. [2], Rieser et al. [3]). The main challenge in these investigations has been to obtain high enough sensitivity to study natural samples. Recently Lomax et al. [4] has applied a spectrograph with a cooled CCD camera to obtain the high sensitivity necessary for general use in luminescence studies. In this study we will present our design of a high sensitivity spectrometer acquisition system that can be attached to a Risø TL/OSL Reader and allow routine time-resolved acquisition of TL and OSL emission spectra of natural samples. The design criteria and considerations will be presented and discussed. The spectrograph and optical interface has been chosen and designed for maximum optical throughput, and a cooled EMCCD camera has been chosen for highest possible signal to noise ratio at the detection stage. A comparison between cooled CCD and EMCCD will be shown. Examples of the use of this system with natural samples will be given.

[1] Baril, M. R., Huntley, D. J. (2003a) Infrared stimulated luminescence and phosphorescence spectra of irradiated feldspars. *Journal of Physics: Condensed Matter*, 15(46), 8029–8048.

[2] Bøtter-Jensen, L., Duller, G. A. T. and Poolton, N. R. J. (1994) Excitation and emission spectrometry of stimulated luminescence from quartz and feldspars. *Radiat. Meas.* 23, 613-616.

[3] Rieser, U., Krbetschek, M. R. and Stolz, W. (1994) CCD-camera based high sensitivity TL/OSL-spectrometer. *Radiat. Meas.* 23, 523-528.

[4] Johanna Lomax, Dirk Mittelstraß, Sebastian Kreuzer, Markus Fuchs (2015) 2005OSL, TL and IRSL emission spectra of sedimentary quartz and feldspar samples. *Rad. Meas.* doi:10.1016/j.radmeas.2015.02.018

Poster session 1

Quantifying the Uranium Series Disequilibrium using gamma spectrometry

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Many of the naturally occurring radioactive elements are members of radioactive decay chains. These chains originate from parent nuclides with very long half-lives and end with a stable nuclide of lead.

In any natural material containing uranium which was not disrupted for tens of millions years, a state of secular equilibrium will occur between parent nuclide and its daughter products. However, when sedimentary deposits are formed, many geological processes can occur which may cause isotopic fractionation of the elements resulting in a state of disequilibrium between the parent nuclide and its daughters in the chain.

This research is intended to quantify secular disequilibrium in the uranium chain by an accurate determination of the activity of different isotopes in the decay chain in some samples derived from different environments using low-level high-resolution gamma spectrometry. For this purpose a Broad Energy Ge [BEGe] detector has been used to detect gamma radiation from nuclides in the decay chains. This detector was chosen as it covers a wide energy range of 3 keV to 3 MeV with a good resolution and high efficiency.

As some of the gamma rays are low in energy an important aspect of the presentation will be the accurate determination of the detector efficiency as a function of gamma –ray energy and an investigation of the effects of self-absorption of the gamma rays in the samples used. Labsocs software was used to compute the detector efficiency taking into account all the physical parameters including the geometry of the detector and the samples.

Because ^{238}U emits a weak gamma-ray line (0.064% yield) at 49.55 keV which cannot be detected using gamma spectrometry technique, the activity of ^{238}U was estimated from gamma rays of its immediate daughter ^{234}Th (63 keV and 92 keV). However, the peak of 92 keV is interfaced with other K-X and gamma-photopeaks from members from the three natural decay series, including 93.3 keV $\text{XK}\alpha 1$ thorium line. For this reason a gf3 fitting technique was used to resolve this problem and isolate the peak area for this line. The activities of ^{226}Ra in all measured sediments exceed those of its parent ^{238}U by up to 212%, and lesser levels of disequilibrium exist between ^{226}Ra and those later in the decay chain. To conclude, the precise measurements of disequilibrium in the uranium decay series is performed by an accurate determination of its radionuclides activities.

Assessing the maximum limit of SAR-OSL dating using quartz of different grain sizes extracted from aeolianites

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Single-aliquot regenerative-dose optically stimulated luminescence (SAR-OSL) dating studies of Romanian loess using fine (4-11 μm) and coarse (63-90 μm) quartz have previously resulted in a series of controversial issues hitherto largely unexplained. We extend here the investigations on fine (4-11 μm) and different coarse (63-90, 90-125, 125-180, 180-250 and 63/90-250 μm) quartz grains, in this case using quartz extracted from carbonate-rich aeolianites from two sites on the Balearic island of Eivissa. The results indicate that the different pattern of growth of the fine and coarse grains is not limited to loess, being characteristic of quartz from aeolianites as well. As for Romanian loess, the dose response curves for all grain sizes were best fitted using the sum of two saturating exponential functions. For the aeolianites, the coarse quartz grains start showing saturation at doses of about 500 Gy, whereas the OSL signal obtained for the fine fraction shows continuing growth for doses up to 2000 Gy. Examining the fitting parameters of these dose response curves, we provide evidence that the saturation characteristics (D₀ values) are not meaningful unless high enough doses are given for the OSL to reach saturation. Moreover, we suggest that no limit for dating can be assessed in terms of D₀ values of either of the two saturating exponential functions. For the fine fraction, the mismatch between the SAR dose response curve and the dose response curve obtained when doses are added to the natural suggests that equivalent doses larger than 300 Gy would not result in reliable ages, limiting the OSL dating of these samples to maximum 400 ka. For doses up to 200 Gy, the dose response curves of fine and coarse grains can be superimposed. This finding, alongside the agreement between the ages obtained up to 170 ka increases confidence in the accuracy of the ages obtained for equivalent doses up to 200 Gy. Pulse annealing experiments show that the OSL signals for both grain sizes from the samples from Eivissa are stable for at least 1 million years.

Optical dating of palaeochannel deposits in the Kleine Nete valley, NE Belgium: first results

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The Late Quaternary geomorphology, stratigraphy and age of the fluvial deposits in the Kleine Nete valley are poorly documented, and entirely based on palaeobotanical analyses of peaty material in the 1970's. The aim of this study is to test the performance of the OSL technique for dating palaeochannel deposits and the concomitant fluvial development of the river valley, which would help understanding the palaeohydrological evolution of this particular catchment.

During road construction works, a cross-section through the Kleine Nete alluvium could be observed, directly (tens of meters) south of the present river course and underneath an abandoned channel that is traceable on historical maps and still visible in the landscape today. The river's alluvium is very thin – the sediment thickness usually does not exceed 2-3 m – while the composition is monotonous, either sand or peat with at a thin loamy layer at the top. Different fluvial facies, including horizontally laminated (sample OSL-1) and cross-bedded sands (OSL-2), channel-fill sands (OSL-3), in-situ (?) peat layers, reworked peat mixed with sand (OSL-4), and loamy alluvium were encountered and sampled for grain-size analysis, palynological analysis and quartz-based SAR-OSL dating.

The D_e distributions in small (2 mm diameter) aliquots of samples OSL-1 and -3 are asymmetric, with relative standard deviations (RSD) of ~84 % and ~106 %; they are interpreted as reflecting incomplete resetting. For samples OSL-2 and -4, the distributions are much tighter (RSD's in the range of ~26-30%) and comparable to those that have previously been reported for undisturbed completely-reset windblown sediments.

Using simplified age models, the optical dates for the three lowermost samples are consistent with palynological results. Surprisingly, the optical age of well-bleached sample OSL-4, 11 ± 1 ka, is not in agreement with the palynological age of ~8.5 ka, which is the earliest age for the massive appearance of *Alnus* pollen in the region. Several explanations for the observed discrepancy are given, including the possibility that 2 mm-sized aliquots are too large to capture the smallest doses that would most likely reflect the true burial age.

Luminescence behaviour of doped borosilicate glass: preliminary findings

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In order to understand the chemical behaviour of impurities within glass as a function of changing environmental conditions including high doses, raised temperatures and long burial durations, several borosilicate glass samples doped with aluminium, cerium, iron or lanthanum were created. An initial survey of TL, OSL and IRSL signals observed in these displayed differences between samples, and with respect to the undoped borosilicate glass. Differences observed include variable TL peak structures and temperatures, and differences in IRSL and OSL sensitivity and growth. A pronounced “ultrafast” OSL signal component, significantly reduced by heating to 180°C, appears to be present in all samples, though at different sensitivities. Pulsed OSL measurements of the Al-doped glass show some interesting behaviour, with the initial rapidly decaying signal characterised by slow build-up and decay ($\tau \sim 30 \mu\text{s}$) within each pulse (“quartz-like”), while a much more slowly decaying component displays more “feldspar-like” rapid transitions ($\tau \sim 5\text{-}10 \mu\text{s}$). An initial assessment of preliminary TL, IRSL and OSL observations will be presented, and the potential of these measurements to provide useful constraints for the understanding of chemical changes within the glass, and the physical and chemical basis of the contributing traps and luminescence centres discussed.

Gaps in the loess record at Jingbian (northern China) identified using luminescence

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As part of a larger project investigating the pattern of dust deposition across the Chinese Loess Plateau we have sampled five loess sections at the northern edge of the loess plateau at Jingbian. Medium to fine sand (63-180 μm) was successfully extracted from all samples. Feldspar post-IR IRSL signals stimulated at 290°C (pIRIR₂₉₀) were used to date the section. Comparison with quartz OSL confirms that it is possible to almost completely reset the pIRIR₂₉₀ signal by exposure to daylight ($D_e < 10$ Gy). First IR stimulation plateau measurements suggest that there is no clear dependence of D_e on first IR stimulation temperature between 50 and 260°C for samples <500 Gy whereas for older samples first IR stimulations above 170°C are required. For samples <50 ka there is good agreement between quartz and feldspar ages (allowing for ~6 Gy offset in feldspar) confirming the reliability of the feldspar ages. In one section the entire MIS3-4 stages (~55 ka) are missing but MIS5 is continuous. In two other sections most or all of MIS6-7 (between 50 and 80 ka) is missing in a section going back to at least 300 ka. It is clear that at this desert-margin site an absolute chronology is essential if loess units are to be correctly identified and used in palaeoclimate reconstruction.

Investigating thermoluminescence and photostimulated luminescence as tools in food authentication

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Luminescence has been used extensively since its discovery in the late 17th century for a wide variety of different identification techniques ranging from mineral dating methods, to irradiated food detection and antique authentication. As food authenticity has become an increasing issue this investigation was designed in order to explore the use of thermoluminescence (TL) and photostimulated luminescence (PSL) as a method of food authentication by identifying provenance information. Shellfish products, in particular razor clams, were examined as this product is exported globally and is of high value to the Scottish food industry. A preliminary study was carried out on an archive of more than 16000 TL data files, which included both natural and 1kGy irradiated data sets. The study showed significant promise in the global location discrimination of shrimp and prawn samples. This then lead to the experimental study of razor clams, sourced from 3 locations across Scotland, using both TL and PSL techniques. Variation was demonstrated on this local scale using first peak half maximum analysis of TL data and it was also shown that sufficient minerals could be extracted from the razor clams in order to measure PSL in the blue optical (470nm) and infrared (880nm) stimulation wavelength ranges. In particular it was shown in this study that samples sourced from the Outer Hebrides varied more significantly than those sourced from Orkney and East Lothian. Finally it was concluded from this analysis that luminescence does in fact show significant location discrimination potential and with further development could potentially be used in food authentication.

Ten things you never knew that Analyst could do

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The software package Analyst was developed to facilitate the processing and analysis of luminescence data. The primary function has been to derive equivalent dose (D_e) estimates based upon a variety of protocols (both multiple aliquot and single aliquot), but a range of other types of analysis are also possible.

The most recent version of Analyst (v4.31) has been available since May 2015 and offers a number of additional analytical capabilities, along with a manual and online help system. This poster illustrates some of the types of analysis that are possible in this new software release.

Dating Coarse Grained Ceramics by Optically Stimulated Luminescence (OSL)

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We have made OSL-dating [1] from pieces of ceramics containing coarser grained quartz. The size of the pieces were about 3-4 cm in diameter and 1 cm thick. They were from broken vessels from different sites in Finland, Estonia and Lithuania. The coarser grained quartz is from sand or crushed stone material that has been added to clay as temper material to prevent the ceramics from cracking during the drying and firing stages of the manufacture.

The separated quartz from these kind of samples giving very strong luminescence signal and OSL results gives very accurate value for total dose absorbed to samples after the latest time they were heated. Depending on the purpose of the vessels this can be when they were manufactured or last time used in food preparation.

Although the absorbed total dose can be measured very accurate within about 5% error limits, the main problem in age determination lays in dose rate estimations. We are in ongoing process to find suitable pieces of ceramics containing char that can be used in radiocarbon dating and compare the results in results obtained by using OSL-dating. By this comparison we can find how well dose rate estimations based on beta- and gamma-measurements can be used in estimating the actual dose rate affected to ceramics during their history.

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Palaeo-environmental Reconstruction of the Diepdrift Colluvial Deposit, Limpopo Province, South Africa

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A colluvial deposit formed on the Diepdrift farm situated about 5 km north of Bela Bela in Limpopo Province, South Africa. The site is located in the Bushveld Complex, surrounded by the granites of the Rooiberg Suite. The deposit is deeply incised, and is the only locally-situated, gullied deposit of its size, in the Bela Bela area. The source of the deposit is the two large, granite domes flanking it to the east and the west. These domes form radial drainage patterns, and water flows off the slopes and converges in the Diepdrift deposit, forming a river that meanders through the gullies. The river flows southwards and collects in a dam in the adjacent farm. The gullied deposit consists of poorly-sorted, angular to sub-angular, coarse-grained, immature sediments, interlayered with palaeosols. The gullies vary in depth between 1 to 6 m, and in some places, the gullies have eroded to bedrock level.

The aim of this research project is to reconstruct the palaeo-environmental history of the Diepdrift colluvial deposit, and to explain the causes and evolution of the gullies at this site. Central to this reconstruction is the timing of the depositional sequences through optically stimulated luminescence (OSL) dating. These high resolution luminescence ages will allow for the correlation of the stratigraphy to recognised climatic events that were recorded in the Quaternary.

Results indicate that the luminescence age for the youngest horizon is $2\,290 \pm 30$ years BP and the oldest stratigraphic unit is $37\,260 \pm 625$ years BP. The ages are not always consistent with stratigraphy, indicating post-depositional mixing and poor bleaching of the sediment grains. These ages suggest that the timing of deposition pre-dates agriculture in this area, and the gullying cannot be a result of this form of land-use. Also, the shift from colluvial horizons to palaeosols indicates a climate control over the deposit, and that colluviation tended to occur during arid climatic conditions, while pedogenesis tended to occur during wetter, more stable conditions.

Towards an optimised IR-RF dating protocol for K-feldspars

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For luminescence dating applications, K-feldspar provides an alternative when quartz is not available or found to be in dose saturation. Anomalous fading, its most relevant drawback, is still the object of intensive methodological investigations. Amongst others, the infrared radiofluorescence (IR-RF) signal of K-feldspars shows the promise of a fading-free signal [1]. However, the general suitability and reliability of this method are still in doubt. In previous studies we proposed a set of optimal bleaching parameters to totally reset the IR-RF signal [2] and we underlined the importance of controlled temperature conditions during irradiation [3]. The proposed settings showed a better reproducibility between measurements and seem to prevent electron trapping in thermally unstable traps.

Here, we propose a new SAR IR-RF protocol (RF₇₀), which takes advantage of the previously proposed settings. Our contribution shows the general suitability of the RF₇₀ signal for luminescence dating applications with K-feldspar samples. This study presents RF₇₀ dating results from nine samples of different origin and of known age using a *lexsyg research* luminescence reader. Additionally, the **R** package 'Luminescence' has been enhanced with an analysis routine developed for a SAR IR-RF analysis [4].

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[3] Huot, S., Frouin, M., Lamothe, M. (accepted) Evidence of shallow TL peaks contributions in infrared radiofluorescence, *Radiation Measurements*

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Evaluating the potential of an He cryogenic system for ESR dating of quartz grains

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Electron Spin Resonance (ESR) dating of quartz is based on the detection of various radiation-induced paramagnetic centers associated with defects present in the crystalline structure of quartz [1,2]. Among them, Aluminium $[\text{AlO}_4]^\ominus$ and Titanium centers $[\text{TiO}_4/\text{M}^\oplus]^\ominus$ ($\text{M}^\oplus = \text{Li}^\oplus, \text{H}^\oplus$ or Na^\oplus) have become so far the most widely used. However, unlike other materials like fossil tooth enamel, ESR signals of both the Al and Ti centers are not visible at room temperature and measurements should be performed at very low temperature instead.

A previous study of our group showed the strong influence of temperature on the ESR signal of the Al center: basically, the signal resolution and intensity are significantly increasing when the temperature decreases [3]. In geochronology, ESR measurements of quartz are usually carried out using liquid nitrogen systems, i.e. at temperatures between 77 and ~ 115 K, and measurements < 77 K have almost never been really carried out.

With the recent acquisition of an Elexsys E500 ESR spectrometer coupled with a 4112 HV Bruker Helium system, we got the opportunity to evaluate whether measurements close to He temperature may actually provide a significant improvement in ESR dating of quartz grains. To do so, we studied the behavior of Al and Ti centers in terms of sensibility and resolution of the signal at temperatures between 10 to 150 K and quantified the influence of temperature on the ESR signal of both centers. In particular, the impact on the ESR signal Ti-center will be specifically studied, since its great potential in ESR dating (i.e. fast bleaching kinetics and no residual ESR intensity, contrary to the Al center) is usually mainly limited by the difficulty to achieve reliable and reproducible measurements given the low signal-to-noise ratio usually encountered in quartz samples.

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Investigating the Use of Low Level Gamma Spectrometry in Studies of Food Authenticity

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Gamma spectrometry is a well-established and frequently used technique in the identification and quantification of radionuclides, mainly in the areas of nuclear physics, geochemical investigations and astrophysics. The area of food authentication has become more prominent with consumers becoming increasingly aware and taking an interest in where their food originates. This investigation focuses on transferring low level gamma spectrometry into the area of food provenance and authentication, by looking at spectra produced from lamb samples of known origin. Analysis was carried out using a shielded 50% relative efficiency GMX detector in the Scottish Universities Environmental Research Centre on 16 samples of lamb meat to determine whether there were measurable quantities of radionuclides present, and if so whether the activity concentrations were specific to geographical location. Of these samples 14 were from known locations across Scotland and one each from New Zealand and Chile. Gamma rays from the natural series of uranium and thorium along with potassium and anthropogenic radionuclides were studied. From the radionuclides Potassium 40 & Caesium 137, could be detected reasonably well. These radionuclides were shown to have some potential in giving indications of geographical information. However the radionuclides, from the both the thorium & uranium decay chains, were harder to measure as the activity concentrations in the samples were at or beneath detection limit for the surface detector. To improve detection conditions comparative measurements were made with a LoAx Germanium detector operated in the Boulby Underground Laboratory. Detection limits at Boulby of approximately 250 mBq kg⁻¹ were obtained in this work, which compare favourably with the surface measurements at SUERC with detection limits of 450 mBq kg⁻¹. In both cases the results show that radiocaesium activity concentrations in lamb meat have promising regional variations within Scotland, relating to rainfall and past fallout deposition histories, and that the two imported samples can be distinguished from the locally produced lamb. Potassium 40 is readily detected but conveys information about lean mass content of meat rather than provenance. Further work is needed to improve measurements conditions to establish whether natural series activity may add useful provenance information.

Precision and accuracy in beta source calibration

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Recently we showed that the reproducibility over >12 years of the calibration of our most well-known beta source was not as good as would be expected from the reproducibility within a given set of measurements. This led us to conclude that, using any single batch of calibration quartz, the apparent beta source dose rate might vary by more than 10% from one calibration to the next. Others have also expressed concern over apparent systematic differences between batches of calibration quartz. As a result of these real difficulties, we have begun a systematic investigation into the precision and accuracy of our beta source calibration methods, and their variability with time. Here we report some preliminary results of these investigations. The dose recovery ratios of 8 different batches of quartz (manufactured between 2003 and 2015) are first considered. These are all shown to be satisfactory, giving us confidence that any systematic differences do not arise from poor luminescence characteristics. We then investigate whether there are any systematic effects arising from the use of 8 different sources of quartz. The origins of the over-dispersion in the calibrations resulting from a single batch of quartz are also considered.

Medieval Climate Anomaly and Bond 2 recorded in a late Holocene Chinese loess profile, based on closely-spaced quartz OSL dating

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Millennial time scale climate changes during the last glacial have been recorded in Chinese loess. In this study, a 200-cm late Holocene loess profile at Weinan, on the southern margin of the Chinese Loess Plateau (CLP), was studied to see whether similarly rapid events are visible in the Holocene loess record. Samples collected at 20-cm intervals were dated with the Single-Aliquot Regenerative-Dose (SAR) Optically Stimulated Luminescence (OSL) protocol applied to fine-grained (4-11 μm) quartz. The characteristics of the quartz luminescence signals indicate that the SAR protocol is appropriate. The 10 quartz OSL ages obtained are stratigraphically in-order, and increase from 0.21 ± 0.01 ka to 3.48 ± 0.22 ka through the section, with no reversals. A calibrated Accelerator Mass Spectrometer (AMS) ^{14}C age of 0.79 ± 0.02 ka on charcoal at 72 cm depth is consistent with the quartz OSL chronology. The chronology reveals that the rate of dust accumulation has continuously increased since the late Holocene. Magnetic susceptibility and mean grain size data (at 2-cm intervals) show a general cool/dry trend since 3.5 ka, a relatively warm/humid period of ~ 1.0 - 0.7 ka (corresponding with the Medieval Climate Anomaly, MCA) and a relatively cool/dry period of ~ 2.9 - 2.5 ka (corresponding with Bond 2). The long-term pattern of climate change since the late Holocene, the MCA, and the Bond 2 event recorded at Weinan could be correlated with records of the East Asian summer monsoon (EASM), and also with reconstructed temperature records from Central-East China and the Northern Hemisphere. The long-term recession of the EASM since the late Holocene could be attributed to decreasing Northern Hemisphere summer insolation. The relatively warm/humid MCA and the relatively cool/dry Bond 2 are probably caused both by changes in the North Atlantic climate and variations in solar activity.

Basic research on the OSL process in the aspect of natural and laboratory OSL growth curve for young samples

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The equality between the growth curve of OSL generated by the natural radiation (natural growth curve) and the OSL growth curve reconstructed in laboratory conditions (laboratory growth curve) is the basic assumption of luminescence dating of Quaternary samples. Both growth curves, however, arise by sample irradiation with extremely different dose rates and recently some doubts emerge concerning the proper reconstruction of the natural growth curve in laboratory [1, 2]. When the assumption of the equivalence of the growth curves is not valid, it is impossible to determine the age. Establishing the sources of the discrepancy between both growth curves by means of the fundamental investigations of the OSL process is the elementary condition in order to find the possibility for introducing appropriate corrections into dating protocol. Such corrections should allow for determining the age in problematic cases, or for the elimination of the sample which do not give a chance to obtain reliable dating outcomes from measurements.

It is impossible to determine experimentally the natural growth curve, due to the very low natural dose rate and, in consequence, long times of the sample irradiation. The sole possibility to investigate the natural growth curve is computer modeling of the OSL process that involves numerical solution of differential equations which present the kinetic model of OSL.

The computer simulations, carried out here in Matlab, took into account all the processes occurring in the sample during its deposition time in environment, e.g. the process of filling electron traps in the natural conditions or OSL signal zeroing, as well as those which occur in a laboratory during dating procedure, e.g. registration of the natural OSL or sample irradiation. Both growth curves, natural and laboratory, were reconstructed and compared for a model including one shallow electron trap (which disrupts the OSL process), two deeper electron traps (active in OSL process), one disconnected deep trap (it does not take part in TL and OSL process) and one luminescence center. In order to focus on the young samples the simulations were carried out for the short times of natural irradiation. Low occupation of traps brings usually complications in the stimulated luminescence response to dose what can be observed as nonlinearities of the growth curves. Wide range of centre parameters (e.g. the concentrations or re-trapping coefficient of traps) was used for searching the main source of the difference between the natural and laboratory growth curve.

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Post-IR IRSL dating of carbonate aeolianite deposits to constrain tectonic and sea-level controls on terrace formation processes in northern Cyprus during the Late Pleistocene

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The Kyrenia Range, northern Cyprus is an east-west trending mountain range, which formed due to major tectonic uplift during the Middle to Late Pleistocene. Luminescence dating is used to unravel the tectonic and sea-level processes affecting the mountain range during the Late Pleistocene. The tectonic uplift resulted in a series of stepped terraces on the flanks of the mountain range. This study focuses on the youngest of all the Pleistocene terraces, locally known as the Koupia terrace. The Koupia terrace comprises patchy deposits of lithified carbonate aeolianite along the northern coast of Cyprus.

Initial field profiling was carried out on the Koupia terrace deposits (Palamakumbura *et al.*, 2015) to assess their luminescence characteristics and aid with sedimentary interpretations. Laboratory profiling was undertaken on two sedimentary sections to accurately constrain how the luminescence characteristics vary within each section to improve the accuracy of dating. Dating samples were taken from the base of the terrace deposits with lowest scatter of stored doses and sensitivities. Dose rates were calculated from eight samples collected from around the two dating samples. A combination of field gamma spectrometry, high-resolution gamma spectrometry (HRGS) and thick source beta counting (TSBC) were used to calculate dose rates. Wet gamma dose rates of 0.4 to 0.7 mGya⁻¹ were deduced in the laboratory, which is comparable to field measurements of 0.4 to 0.5 mGya⁻¹ (Palamakumbura *et al.*, 2015). OSL dating was initially attempted on quartz however, the quartz proved to have low intensities, low sensitivity and a lack of thermal stability of the fast component. Therefore, the quartz system was not used for dating; focus was therefore shifted on to the feldspar system for dating.

IRSL and post-IR IRSL analysis was carried out on 16 aliquots of K feldspar per sample using single aliquot regenerative (SAR) protocols. The stored dose estimates from IRSL and post-IR IRSL produced a large scatter of values, which is attributed to the sedimentary history of the deposit, which resulted in mixed age grains. Fading tests were carried out over 10⁶ seconds, giving ratios of 0.93 ± 0.06 and 1.08 ± 0.08, for IRSL and post-IR IRSL, respectively. Finally, ages were calculated with standard microdosimetric models providing two ages of 76.1 ± 3.5 ka and 58.7 ± 2.6 ka.

The final ages show that the carbonate aeolianite deposits of the Koupia terrace formed during the most recent glacial stage during a global sea-level minimum. These deposits are interpreted as representing arid climatic conditions during a glacial stage in northern Cyprus, with ongoing tectonic uplift during the Late Pleistocene.

Residual quartz and feldspar OSL signals in recently deposited sediments

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The degree of bleaching of quartz is increasingly being addressed by comparing the apparent quartz ages with that derived from feldspar IR and post IRIR signals. Based on laboratory measurements of bleaching rates under a simulated sunlight spectrum, it is expected that the differential bleaching rates of these signals implies that if the feldspar signals give ages that are comparable to those from quartz, the quartz is very likely to be well-bleached. The implication of this assumption is that in very young or modern samples, quartz will always be better bleached than feldspar, and that in the best bleaching environments, even the feldspar residual doses will be small or negligible. Here we investigate these hypotheses by first summarising measurements of differential bleaching undertaken in our laboratory, and comparing the spectrum of our solar simulator with typical natural spectra. We then report on the residual feldspar and quartz doses recorded by >20 modern/very young sediments from various deposition environments, and discuss the implications for using feldspar doses as an indicator of the completeness of bleaching in quartz.

Poster session 2

Investigating the potential for luminescence dating of pebbles and cobbles in ice marginal sediments, Isle of Man, UK

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Establishing the time of deposition of glaciofluvial sequences is vital when attempting to constrain the dynamics of ice streams and ice sheets. One example of such work is the BRITICE-CHRONO project, which studies the decay of the last British-Irish ice sheet. The use of optically stimulated luminescence (OSL) for dating sand-sized grains from glaciofluvial sediments has been shown to be feasible (e.g. Thomas et al., 2006) but faces considerable challenges, primarily due to the limited opportunities for bleaching of the OSL signal during transportation and deposition of the sediment at some sites (Duller 2006). An alternative to analysis of sand-sized grains is measurement of pebbles and cobbles; these may provide an insight into exposure and burial histories (Freiesleben et al., in press). However, the feasibility of using pebbles and cobbles within glaciofluvial sediments for dating depends upon the probability of finding clasts that have been exposed to daylight before and during deposition. This study assesses the proportion of clast surfaces that were exposed to sufficient light at deposition to permit dating. Clasts have been collected from a series of ice-marginal sandur exposed at Orrisdale on the Isle of Man, UK (Thomas et al., 1985). To maximise the probability of finding clasts where bleaching of mineral grains occurred, a lithofacies approach was used to identify sediment deposited during waning flow and in shallow, slow-flowing water columns. From each clast 9 mm diameter cores were extracted. These were then sliced and used for infrared stimulated luminescence measurements using protocols similar to those described by Freiesleben et al. (in press). The distribution of apparent dose in the clasts is presented.

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Luminescence dating of an Saalian to Weichselian sequence from the northern German Baltic Sea coast

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At the northern German Baltic Sea coast the cliff of Klein Klütz Höved exhibits a glacio-tectonically dislocated sequence of glacial and interglacial sediments. Based on pollen analyses, and a few thermoluminescence (TL) and optically stimulated luminescence (OSL) ages from the early 1990 the sediment succession indicate a deposition time during the Late Saalian (MIS 6), Eemian (MIS 5) and Weichselian (MIS4-2) [1].

The main objective of our investigation is to improve the age database across the whole profile. Furthermore we want to discuss and evaluate the possibility of an Early or Middle Weichselian ice advance of the Scandinavian Ice Sheet into the study area. Hence nine samples for luminescence dating were taken from Klein Klütz Höved. We present the first results of coarse grained (150-100 µm) quartz OSL dating using a SAR protocol. Additionally we conducted a post-IR infrared stimulated luminescence (pIRIR) dating using feldspar, for samples with an assumed Saalian or Early Weichselian age. The new results enable us to correlate the Klein Klütz Höved outcrop with sites in Denmark and northern Germany.

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OSL dating of prehistoric rockfalls, Christchurch, New Zealand

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Blind faults are notoriously difficult to characterize as they are not accompanied by any expression at the surface. As a result, any geological feature associated with such faults that enables characterization of their behaviour is of great value to any seismic hazard analysis. Co-seismic rockfalls during the 2011 Christchurch earthquakes caused five fatalities and significant damage to infrastructure. The occurrence of these earthquakes on previously unidentified blind faults and the abundance of paleo-rockfall boulders point to the potential role of these faults in past rockfall activity in the region. In an attempt to establish the timing and frequency of similar earthquakes in the past, we constrain the emplacement time of prehistoric rockfall(s) using luminescence dating. Thirteen samples were collected from (i) loess and loess colluvium deposits underlying the paleo-rockfall boulders and (ii) reworked loess colluvium accumulated behind the boulders after their deposition on the hillslope. The ages are determined using optically stimulated luminescence (OSL) from quartz and infrared stimulated luminescence at 50°C (IR₅₀) and post-IR elevated temperature at 225°C (pIRIR₂₂₅) from K-rich feldspar. All signals pass the routine tests associated with the performance of single-aliquot regenerative (SAR) protocol. The average IR₅₀ and pIRIR₂₂₅ residual doses in laboratory-bleached samples are 1.09±0.08 and 3.1±0.3 Gy (n=39). The average fading rate of 1.44±0.11 %/dec. (n=39) for the pIRIR₂₂₅ signal is markedly lower than the corresponding value of 3.97±0.11 %/dec. (n=39) for the IR₅₀ signal, indicating that any age correction for the pIRIR₂₂₅ signal should be much smaller than that for the IR₅₀ signal. Preliminary results show that the corrected pIRIR₂₂₅ ages are generally in agreement with the quartz ages, while the corrected IR₅₀ ages underestimate quartz ages. OSL ages constrain the timing of paleorockfalls to between ~2 ka and ~12 ka, consistent with ³He cosmogenic nuclide exposure ages from the surface of the fallen boulders.

Luminescence dating of sediment core samples from Chew Bahir (Southern Ethiopia)

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The Chew Bahir lake basin is located in the southern part of the Main Ethiopian Rift at about 500 m a. s. l. in the source area of the emergence of anatomically modern humans. The basin is part of limnogeological investigations of the Collaborative Research Centre 806 - "Our way to Europe" and the Hominin Sites and Paleolakes Drilling project (ICDP-HSPDP), in order to understand climatic and environmental influences on the evolution of hominines in eastern Africa during the last 4 million years.

This study presents luminescence dating results of six samples of a sediment core of 42.3 m that was drilled in March 2014 from the center of the lake basin. We applied post infrared infrared stimulated luminescence (pIRIR290) [1] to polymineral fine grain and coarse grain potassium feldspar samples. Prior-IR stimulation temperature tests [2] were carried out to check the suitability of the pIRIR290 protocol. The equivalent dose was independent from the prior-IR stimulation temperature for most samples, except for two samples, for which an increase of the equivalent dose was observed for prior-IR stimulation temperatures above 140 °C. Residual doses were below 5 Gy after 24 h of exposure in a solar simulator and laboratory doses were recovered within 10 % of unity.

Additionally, we applied blue stimulation to one fine grain and one coarse grain quartz sample. A preheat plateau was observed for the fine grain quartz sample only. The natural signal of the coarse grain quartz sample showed a strong contribution of the medium and the slow components. Preliminary pIRIR290 age estimates of between 70 - 115 ka were compared to a palaeomagnetic record for independent stratigraphic control.

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Thoughts on data processing and error estimation using the RF₇₀ protocol

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Despite considerable technical advances in commercially available luminescence dating equipment serious challenges arise when the measured data need to be processed in a flexible and efficient way. The **R**-package 'Luminescence' [1] provides one solution for this challenge by taking advantage of a powerful statistical programming environment: **R**.

To analyse infrared radiofluorescence (IR-RF, throughout RF) measurements on K-enriched feldspars and to test the applicability of the RF₇₀ protocol [2], we enhanced an existing software routine (`analyse_IRSAR.RF()`) that is already part of the **R**-package 'Luminescence'. This allows us to process the RF₇₀ measurement data including D_e and D_e -error calculation in an efficient and transparent way.

Our contribution focuses on the details of this routine and its implementation in **R** and the package 'Luminescence'. Generally, for the D_e estimation we followed the approach implemented in the software *RLanalyse* [3], here enhanced using rejection criteria and error estimation. Applying the developed routine allows to directly analyse obtained RF₇₀ measurement data without using other software. The chosen rejection criteria and the implemented error estimation are presented and discussed using simulated data and real examples.

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Investigating kinetic processes of K-feldspar for the application of luminescence thermochronometry on the Mont Blanc massif

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Luminescence dating has been proposed as a low-temperature thermochronometer, which has the potential to quantify the recent exhumation history of mountain ranges [1]. During rock exhumation, the balance between continuous electron trapping (from in situ radioactive decay) and detrapping (from exposure to heat) within minerals changes as thermally stimulated detrapping is increasingly reduced during cooling along a geothermal gradient. Using the luminescence signal from these minerals, particularly quartz and feldspar, the thermal history of rocks can be constrained and exhumation rates can be derived. It is therefore essential to understand the kinetic processes which govern electron trapping and detrapping. Here we investigate two recently proposed models for feldspar, namely a general order kinetics [2] and band-tail states model [3], and assess their applicability for luminescence thermochronometry, in particular the extent to which the laboratory kinetics can be extrapolated over geological timescales.

The setting of this study is the actively eroding Mont Blanc massif in the European Alps. Samples from the Mont Blanc tunnel were obtained at ambient temperatures ranging from 16 to 32 °C. Furthermore, recent studies indicate that the Mont Blanc massif experienced rapid exhumation during the last 2 million years (up to ~2 km/Myr) [4]. Therefore, it is anticipated that these samples will exhibit a luminescence thermochronometric signal.

The IR₅₀ and post-IR IRSL₂₂₅ signals of K-feldspar extracts were measured and sample parameters (i.e., trapped charge concentration (n/N), characteristic dose (D_0), g -value, and environmental dose rate (\dot{D})) constrained. After accounting for fading, the majority of the samples show a thermal signature. Isothermal decay experiments were used to constrain the thermal kinetic parameters of the two models, and interestingly, experiments in which we use a range of regenerative doses reveal first order kinetics. This result implies that the general order kinetics model might not be applicable for thermochronometric studies. In contrast, the band-tail states model may be more appropriate.

Ultimately, we intend to use the IR₅₀ and post-IR IRSL₂₂₅ signals of K-feldspar to infer a Quaternary cooling rate for the Mont Blanc massif. Moreover, the signal accumulation may give insight into local thermal field evolution, influenced by hydrothermal flow since the LGM.

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Investigation toward equivalent dose over-dispersion using high resolution autoradiography image processing of resin-consolidated sediments

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The over-dispersion parameter is now widely used for characterizing equivalent dose (D_e) distributions, and it is well known that a part of its value is induced by spatial heterogeneities of the beta emitters in the sediments [2]. Estimating this contribution and beyond, having a knowledge of the distribution of the beta dose rate (D_r), is a key point for interpreting the D_e distribution and calculating an accurate age. Until now, only a few studies have attempted estimating the D_r distributions, most of the time through modeling and numerical simulations [3]. Meanwhile the relevance and accuracy of these approaches is strongly dependent on the data input.

One possibility for getting information on the distribution of the beta emitters is to take advantage of a beta autoradiographic system including a Dürr-Medical high resolution image plate scanner and imaging plates [4]: such system was used for getting images of resin-consolidated sediments. Digital image processing was then achieved using the ImageJ open-source software [1]. Spatially discrete high radiation emitters called hot-spots were thus identified and statistical information were obtained thereon. The present poster will focus on such image processing techniques and their relevance to the study of over-dispersion values of D_e distributions.

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Constraining post-LGM glacier fluctuations using OSL-surface exposure dating in the Western Alps

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Providing tight spatial/temporal constraints on glacier fluctuations over the late-Pleistocene remains an important challenge for understanding glacier response to climate change. In most mountainous settings, paleo-glacier reconstructions are limited because they lack precise temporal constraint, which would enable their use as a paleoclimate proxy. OSL-surface exposure dating was recently proposed [Sohbati et al., 2011]. This new method offers the possibility to improve glacial reconstruction. Because the OSL signal is sensitive to light, OSL-signal bleaching within a rock sample depends on its exposure time, and can therefore be used to date the duration of exposure of glacially-polished bedrock or erratic boulders. However, successful application of this technique requires calibration. Indeed, Sohbati et al. [2011] proposed the following model:

$$\frac{Lx}{Tx}(x, t) = L_0 e^{-\overline{\sigma\phi_0}t} e^{-\mu x}$$

where Lx/Tx is the normalized natural luminescence signal measured at a depth x (mm) after exposure time t (s). L_0 is the normalized natural luminescence signal at depth, $\overline{\sigma\phi_0}$ (s^{-1}) is the effective decay rate of luminescence for a sample directly exposed to daylight, and μ (mm^{-1}) is an attenuation coefficient of light penetrating through the rock. To use this model and to calculate the exposure time, L_0 has to be determined and $\overline{\sigma\phi_0}$, μ must be calibrated.

Here, we focus on the Mer de Glace glacier (Mont Blanc massif, France) where the post-LGM glacier dynamics remains poorly constrained with short glacier re-advances during the mid-Pleistocene and Holocene [LeRoy et al., 2015]. First, we aim calibrate the exposure dating model parameters. We have sampled a vertical transect of polished bedrock surfaces with known exposure ages (from 10 years to 165 years) from the Montanvers train station (1913 m) to the present-day position of the Mer de Glace. Five bedrock samples were drilled into 1-cm diameter cores, which have been cut into 1-mm thick slices, before measuring the natural $IRSL_{50}$ luminescence profile. Three replicates were measured for each sample.

In turn, because we know the exposure time (t) of each bedrock sample, we empirically infer $\overline{\sigma\phi_0}$ and μ . Then, assuming that $\overline{\sigma\phi_0}$ has remained constant through time, we will apply OSL exposure dating on higher-elevation (and older) bedrock surfaces to constrain paleogeographical fluctuations of the Mer de Glace since the Last Glacier Maximum.

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A test-set of Swiss samples for assessing the reliability of both quartz and feldspar ages up to ~ 110 ka

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When applying luminescence dating to sediment samples from within Switzerland, there are a number of factors that may influence the reliability of the ages using both quartz and feldspar. Fine grain quartz ages from Switzerland have been considered reliable up to ~ 180 ka, while other regions report age underestimations as low as 40 ka. The feldspar signal may saturate significantly later than that for quartz, although the conventional infrared stimulated luminescence (IRSL₅₀) signal is normally reported as suffering anomalous fading. Elevated temperature post-IRIR protocols have been shown to isolate a more stable signal that suffers less fading (Buylaert et al., 2009; Thiel et al., 2011), but when applied to waterlain sediments from Switzerland produced significant age overestimations, which could not be simply explained by the large residual doses measured (Lowick et al., 2012). Recently, a more moderate multi-elevated temperature pIRIR protocol has been proposed that avoids the problems of both large residual doses and anomalous fading (Fu and Li, 2013). Fine grain quartz ages of between 30 – 110 ka have been obtained from a set of samples taken from a loess profile in the north of Switzerland and now offer a good opportunity to investigate both the quartz and feldspar signals. For the quartz, the signal shows no evidence for age underestimation at > 100 ka. For the feldspar fraction, these windblown sediments should avoid problems of partial bleaching and make it easier to successfully apply one of the elevated temperature pIRIR protocols to Swiss sediments, and to assess the validity of a fading correction as D_e values fall above the linear part of the dose response curve (Huntley and Lamothe, 2001). Saturation characteristics for all protocols will be compared, and ages, residual doses and g-values will be presented for each of the IRSL protocols.

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Re-appraising the heat flow of Scottish granites using TL onset temperature methods

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In response to increasing demand for low carbon energy there is a global search for viable geothermal resources, resulting in reappraisal of temperature gradients of sub-surface strata. In the UK appraisals of the heat flow from radiothermal granites were conducted in the 1980's in response to the increased oil prices of the 1970s. Recent research has suggested that failure to account fully for Pleistocene cooling may have led to systematic underestimates of the potential resource for deep geological resources in UK locations covered by the British Ice Sheet, when comparing heat flow observed in contemporary thermal gradients, with heat production rates estimated from radionuclide concentrations. Research at SUERC, based on model feldspars and samples from a deep borehole in Finland, confirmed the potential of thermoluminescence (TL) onset temperature methods to estimate thermal gradients with information recovered from signals accumulated over recent Quaternary timescales, as a new tool to re-appraise the heat production-heat flow paradox implied by these earlier geothermal assessments. In this work we have obtained granite samples from three of the original boreholes in the Grampian region in the Scottish Highlands. TL onset temperature methods have been applied to feldspar concentrates extracted from these samples, to look for thermal gradient anomalies, with potential linkage to Pleistocene cooling effects. New estimates of radionuclide contents using high resolution gamma spectrometry for comparison with the scintillation spectrometry based work of the 1980s, and to undertake new estimates of nuclide specific heat production rates from these locations.

Sixteen samples were obtained from the British Geological Survey rock store from retained core material from the Ballater, Cairngorm and Bennachie granites, at depths of approximately 90-100, 150-200 and 280-300 m. Following mineral separation, natural TL was recorded on duplicate aliquots using an SUERC TL reader and first peak half maxima temperatures determined. The data were calibrated using regenerative procedures with reheating in a laboratory furnace for 30 minutes, at temperatures from 50-250 °C, and used to determine apparent temperatures for each sample. Thermal activation energies and frequency factors for the natural and regenerated data sets were determined, and used to estimate the temporal response times for natural systems at the different borehole depths. Gamma spectrometry was conducted using 50 g ground mass samples from the same material, analysed for ^{40}K and U, Th series using a shielded 50% GMX spectrometer, and activity concentrations determined relative to the SUERC internal Shap granite standard. Series specific heat production coefficients were used to determine the heat production for each sample.

The results from Ballater show a similar profile to that obtained from the Outokumpu borehole in Finland and may be consistent with Pleistocene cooling anomalies. For the Bennachie and Cairngorm granites more complex thermal profiles were observed, with a thermal deficit at 150-200m, which appears to correspond with previously unreported U series anomalies in the radioactivity profiles. These results add significant new information to the discussion of the heat flow anomaly of these granites, but also suggest that hydrological processes may need to be considered further alongside Pleistocene cooling to account for the radiometric and luminescence anomalies.

Assessing the applicability of ESR dating of quartz grains from karstic infilling sediments

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Similarly to Optically Stimulated Luminescence (OSL) dating, the ESR signal measured in quartz may be reset by optical bleaching, allowing thus to date the moment when the sediment has been last exposed to sunlight. Actually, there is quite a wide range of ESR dating studies of optically bleached quartz grains from fluvial, eolian and littoral context, but so far the specific application to karstic environment has never been reported.

Taken into account that many prehistoric sites have been discovered in caves, their study provides an important source of evidence about the first human settlement in Europe. In that regard, ESR dating of quartz extracted from cave sediments might provide some useful chronological information, especially in the case of azoic, not volcanic or too old deposits that preclude the use of other numerical methods such as luminescence or Ar/Ar.

The present study reports ESR dating results of quartz grains from the Gran Dolina site in Atapuerca (Spain). The sedimentary infilling of Gran Dolina represents one of the most complete Pleistocene sequences with a thickness of about 18m divided into 11 lithostratigraphic units including several archaeological levels. In particular, the upper part of the sequence (from TD6 to TD10 levels) has been extensively dated in the recent years by means of various techniques such as combined ESR/U-series, luminescence (TL, IRSL, TT-OSL), U-series and magnetostratigraphy. Consequently, the data set available is an excellent independent age control to evaluate the consistency of the ESR age estimates that have been obtained. This comparison will provide a good overview of the real potential of this application in cave environment.

Interpreting luminescence signals to assess grain resetting and sediment transport from a PPSL unit in Jalisco Block (Mexico) and other fluvial settings

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We present the main OSL results of using a Pulsed-Photon Stimulated Luminescence (PPSL) unit, also known as Portable OSL reader, for a case study in Jalisco Block and other fluvial settings. The PPSL used here is developed from the Scottish Universities Environmental Research Centre (SUERC) and it consists of a chamber where one sample at a time is placed in a petri dish. Diodes in this chamber stimulate the sample with photons from arrays of light-emitting diodes in the blue (470 nm) and infrared (880 nm) portions of the electromagnetic spectrum. A single photon counting photomultiplier, filtered to accept luminescence from approximately 300 to 360 nm (using 12 mm Schott UG 11 filters) is used to register luminescence signals during pulsed stimulation. The PPSL unit cannot be used for sediment dating since it lacks a radiation source and a heating system. By contrast to the traditional dating equipment, the PPSL unit allows the treatment of larger samples (i.e. several grams of polymineral and poly-grain size sediment) that do not require any mechanical and chemical treatments such as sieving (for grain size selection) and acid soakings (for mineral separation). The different luminescence intensities obtained from bulk sediments at the case studies presented here, demonstrates that BLSL/IRSL signals from the PPSL unit provides useful information for fluvial studies. Moreover, in some cases, the total photon counts helped us to clarify depositional processes that had not been considered before luminescence analysis.

The Upper Caucasus: Prospects for dating archaeological contexts

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Archaeological fieldwork currently undertaken in the Upper Caucasus has provided the opportunity to test the suitability of sediments for luminescence dating techniques from various archaeological landscape features and occupation horizons, including heated sediments from burning events. In the initial phase of this investigation, the potential of quartz was examined. The quartz derived from deposits in this geologically young mountainous region has dominant slow to medium OSL decay components arising from both volcanic-derived quartz and limited cycles of erosion, deposition and transportation, characteristics that are often problematic due to issues of age underestimation. The sediment samples from landscape contexts contained an abundance of K- and Na- feldspars and, despite thorough etching and heavy liquid separation treatments, the blue-OSL signals from surviving single bright feldspathic grains masked those from quartz in small aliquots. After mineralogical assessment of the separated fractions, three major characteristics were identified: 1) weathered quartz derived from active colluvial contexts are very dim; 2) fresh quartz from riverine fluvial sediments exhibits bright OSL but dominated by slowly decaying components; and 3) weathered quartz derived from surface-runoff and aeolian deposition produced weak OSL from only a few of the grains. Characterisation of these sediments suggests that they originate from a range of sources that produce a mix of quartz grains with weak OSL intensities, have undergone limited recycling and include grains of volcanic origin. In contrast, quartz extracted from the finely stratified burnt occupation produced bright OSL signals with a dominant medium-fast component, and this offers the opportunity to establish a chronological framework for deposits that extend from early to late occupation of the site. Meanwhile characterisation of the feldspathic component is underway to establish the potential for dating the landscape features.

Challenges in using dim quartz from glacial and periglacial environments for luminescence dating

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Using quartz from Swiss glacial and periglacial sediments for luminescence dating can be problematic in respect to partial bleaching and in terms of the quartz signal characteristics. Northern alpine quartz was found to exhibit dim signals^{1,2}, potentially with a prominent medium component present in either the natural or the regenerated dose signals, sometimes in both. A discrepancy between component composition of natural and the regenerated dose signals may indicate the presence of thermally unstable components, which would result in an underestimation of equivalent dose and age. Furthermore, a prominent medium component in the natural dose signal could be the result of incomplete bleaching, leading to an age overestimation. A rapid method to assess the dominance of the fast component in the initial part of a quartz signal is the fast ratio^{3,4}, which compares parts of the signal selected to represent the fast and medium components. In this study we investigate the impact of using the fast ratio as a rejection criterion on small aliquot equivalent dose distributions of samples taken from glacial and periglacial environments in northern Switzerland. We explore the potential of the fast ratio to identify problematic quartz signals with regard to unstable signal components and partial bleaching. For selected samples the fast ratio data is compared with the component contributions calculated from curve deconvolution of the signals. Some quartz single grain data is also included in the study. As the analysis of single grain signal components appears to be more complicated⁵, the data is primarily used to confirm that our small aliquots of the potentially partially bleached sediments adequately reflect a single grain resolution.

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Red TL from heated flints: towards a SAR sequence using various signals (TL, ITL)

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Thermoluminescence from heated flints is usually measured in the UV-blue emission window for dating purposes (Aitken, 1985). However, the stronger emission of burned material in luminescence occurs in the red/orange waveband, and it has been suggested that the red thermoluminescence signal could be less prone to sensitivity changes (Richter & Krbetschek, 2006). As a result, this signal could allow using a SAR protocol, which would reduce the amount of material needed (compared to Multiple Aliquot protocols) and thus increase the number of samples available for dating.

The samples investigated here come from the Roc de Marsal site (Dordogne, France), known for the discovery of a Neanderthal infant skeleton in 1962 (Bordes & Lafille, 1962). The site comprises an important Mousterian sequence (Levallois debitage followed by Quina technology). Different paleodosimetric methods, such as TL and OSL (Guérin *et al.*, 2012), IRSL (Frouin, 2014) and ESR (Skinner, 2011) have placed the occupations of the site between MIS 5 and MIS 3 (Guérin *et al.*, 2012 ; Frouin, 2014) but important (and sometimes systematic) differences occur between the methods, in particular for the higher levels of the stratigraphy (Quina Mousterian).

The aim of this study is to develop a well-suited protocol for red thermoluminescence signals from heated flints, to refine the chronology of the Quina levels and better constrain their potential association with particular climatic events. Measurements were performed on a Lexsyg Research TL/OSL reader with a red enhanced PMT (H7421-40) and a filter combination centered on 565 nm at the IRAMAT-CRPAA (University of Bordeaux-Montaigne). We will present here tests of reliability for a range of protocols (SAR and SARA using various TL and ITL signals measured in different parts of the spectrum) to measure the red thermoluminescence signal on natural and annealed samples collected in 2009 from the Mousterian levels, for which Guérin *et al.* (2012) already measured equivalent doses using a classical multiple aliquot protocol.

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Interpreting the Brabant Member

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In Belgian loess stratigraphy, the Brabant Member comprises a cryoturbated horizon (Nagelbeek Tongued Horizon; NTH) that is covered by a unit of homogeneous silt, which lacks distinct sedimentary structures. We present a compilation of luminescence dates that have been obtained for this member, including new results (using OSL and IRSL signals from fine-sandy quartz and polymineral fine-grained separates, respectively) from sections in Belgium and the Netherlands.

A discrepancy in age between silt and sand-sized grains has previously been observed; this remains to be understood. The entire dataset, however, indicates that the Brabant loess was deposited sometime in between 18 and 25 ka.

The results are related to the OSL-chronostratigraphy for sandy aeolian deposits in Belgium and the Netherlands. The Brabant loess would be the time-equivalent of what is known as “Older Coversand I” (OCI) in the classical stratigraphic subdivision of the Late Weichselian fluvio-aeolian and aeolian sediments in the NW European lowlands. This is in contrast to former interpretations relating the Brabant loess as a lateral equivalent of the ‘Older Coversand II’. Surprisingly, the Brabant loess generally lacks the cryoturbation features that are characteristic for OCI, nor does it archive the Beuningen Gravel Bed, a regional lithostratigraphic marker for permafrost degradation and aeolian deflation associated with the formation of a desert pavement. In addition, it remains a question where the silt (loess) – as an equivalent of the ‘Older Coversand II’ – has been deposited.

Developments and applications of the SUERC portable OSL reader

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Portable OSL readers were first developed at SUERC in 2005 ahead of fieldwork examining tsunami deposits in SE Asia, and have subsequently undergone an evolution and development both in terms of instrumentation and in fields of application. Whereas the initial reader used continuous wave stimulation only, the introduction in the second generation instruments of the pulsed PSL stimulation board originally developed for detection of irradiated foods, opened the way to both CW and pulsed synchronous detection. Sequence software developed in 2009 provided access to pulsed modes as well as to CW, and to versatility in developing complex measurement sequences for multi-wavelength stimulation and bleaching. Meanwhile the hardware evolution has continued, with significant weight reductions within the original two box configuration, and new systems now produced to a one box design which removes signal and cable connection between the detector head and the control unit, and provides for a developmental environment for further enhancements.

Systems have been supplied to a number of user groups working in geoscience and archaeology, who have engaged in a diverse range of application work, the majority of which continues to use CW stimulation. The original recognition that OSL intensities combine age proxy information with co-factors relating to sediment origin, brightness and dose rate holds up. The use of depletion indices as proxies for optical attenuation properties and initial residual conditions is also useful for field interpretation. Stratigraphically significant variations in post-stimulation phosphorescence (PSP) and IRSL/OSL ratios have been observed, and can be potentially useful to field interpretation of data. At SUERC the use of portable OSL profiling has become routine practice in dating applications and sampling in geoscience and archaeology – with more than 30 case studies to date in marine and terrestrial contexts. Discontinuities, erosional contacts, and inversions have been seen and recognized using field profiling, and it has proved helpful in both sample positioning and in interpreting sedimentary sequences.

Where sedimentary systems have been well characterized, which increasingly involves luminescence profiling, it is also possible to use rapid OSL screening measurements to map, classify and interpret sediment stratigraphies. The poster illustrates some recent applications of the systems. They are also useful for teaching, and have potential for dosimetry applications.

OSL dating of megalithic monuments at Capu di Lugu, Belvédère-Campomoro, SW Corsica

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Corsica has rich and diverse archaeological landscapes including the remarkable Statue Menhirs, considered as emblematic adaptations from megalithism in a Mediterranean island setting. Megalithic monuments are numerous on the island, the relationship between the Corsican and other European examples relating to important questions of cultural contact and innovation in prehistory. Chronology is central to research frameworks within which the evolution and dynamics of island culture can be related to the European assemblage. Yet dating is problematic, depending largely on material with indirect associations with the critical stages of construction, modification, and disuse of the monuments and their environments. Further development of methods to date lithic monuments is needed, as is modern work to tie them to the chronologies of associated cultural landscapes and palaeo-environments.

In this paper we present OSL investigations associated with archaeological intervention by the Regional Archaeological Service of Corsica (DRAC) at Capu di Lugu. Excavations were carried out in May 2014 at the Stantare Menhir and Tolla 2, a nearby chambered tomb. Both sites have been affected by past agricultural activities, and face further disruption with the resumption of upland pasturing. DRAC are therefore working closely with the proprietor to document surviving features and develop managed solutions to record and conserve archaeological elements in the landscape. Critical questions for the work reported here, were to assess whether OSL profiling could identify undisturbed sediments with clear associations to constructional features, which could be used for dating.

Real-time profiling was used to map the luminescence chrono-stratigraphy of sediments associated with the principal stones on both sites. Some 92 samples were investigated in the field, from 10 sedimentary sequences. This was followed by laboratory characterisation of 33 selected sediments, and OSL dating of 5 samples. The profiling results can distinguish the natural stratigraphy of the immediate surroundings of the Stantare site from archaeological deposits in the stone socket, and revealed the gradations of luminescence intensity within it. The laboratory profiles however confirmed that the combination of modern root disturbance, and residual signals from degraded clasts in the fill, so far prohibit accurate dating of the Menhir setting. At the Tolla 2 site profiling data successfully identified a set of undisturbed sediments in key association to the principal end slab of the tomb. OSL dates were however obtained from sediments beneath the slab, which fall into the archaeological period. The youngest two imply a constructional date of 2870 \pm 190 BC. We believe that these are the first successful OSL dates for construction of a major Megalithic monument in Corsica. Considering the results obtained on a degraded site such as Capu di Lugu, the method has potential for application elsewhere.

Luminescence dosimetry using personal items as a viable tool for emergency dosimetry – activities within the European networks RENEB and EURADOS

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The increasing risk of a mass casualty scenario following a large scale radiological accident or attack necessitates the development of appropriate dosimetric tools for emergency response. Personal objects have been studied as fortuitous dosimeters, among them, electronic components (resistors, inductors) with an alumina substrate found on the circuit board of mobile phones have proven promising using either Thermoluminescence [1, 2] or optically stimulated luminescence [3, 4]. As in a mass casualty scenario, the demands on capacity for triage are likely to surpass the possibility of any single laboratory, trans-national networking becomes essential.

This issue is currently being addressed in the EU project RENEB (Realizing the European Network of Biosimetry, www.reneb.eu), where several biological and physical dosimetry techniques are being tested with regard to speed of analysis and increase in measurement capacity. The final goal of the project is to establish a sustainable European network in physical and biological dosimetry involving laboratories and organisations from 16 countries, that can become a part of EU radiation emergency management. Currently, five physical dosimetry laboratories are involved but the network will be open for joining of new members.

This presentation will summarize the main OSL/TL properties of alumina substrate from electronic components (zero dose signal, dose response, fading), describe two measurement protocols, optimized for either speed of response or accuracy and show the results of the first two inter-comparisons using mobile phones as emergency dosimeters [5], involving the RENEB laboratories and seven external laboratories of the EURADOS network (www.eurados.org).

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Optical dating of blocked-valley lake deposits from eastern South Africa

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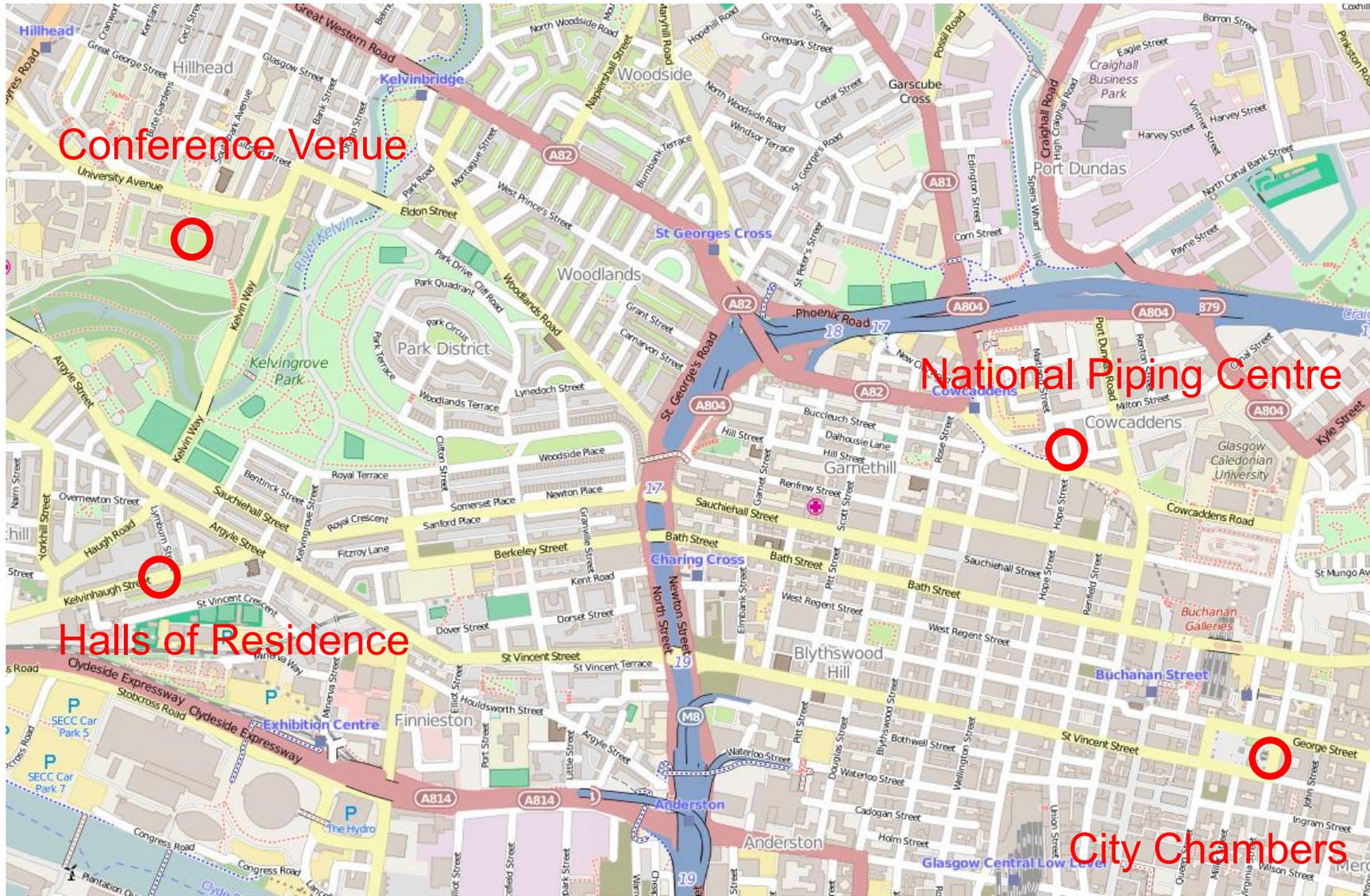
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Blocked-valley lakes form when a main river channel aggrades at a higher rate relative to a tributary, impounding the tributary valley. Once disconnected from the main river channel, blocked-valley lakes can begin to fill with alluvium and on occasion can form biologically diverse swamps. Preservation of stratigraphic layers within these lacustrine archives provides the opportunity to examine potential proxies for environmental change. Existing work in eastern South Africa indicates that blocked-valley lake sedimentology remains heavily influenced by the main river channel following disconnection and that subsurface stratigraphy can record abrupt changes within the environment ^[1,2]. Using high-resolution OSL dating, this study aims to evaluate sedimentation rates and pinpoint abrupt disturbances that have affected blocked-valley lakes on the Mfolozi floodplain, eastern South Africa.

Section and core samples were collected from three sites; Futululu, Domoina Sands and South Lake, situated on the northern, central and southern area of the floodplain respectively. Moisture and organic content were quantified at 1 cm intervals within the core samples, revealing relatively sharp fluctuations that require dose rate modelling and stringent sampling for D_e estimation. Owing to the young age (<4 ka) and waterlain origins of the deposits, inter-grain D_e analysis has been adopted. We present findings from initial inter-grain D_e analysis of section samples and outline a sampling strategy for the high-resolution OSL dating of core lengths.

[1] Grenfell, M.C., Ellery, W., Grenfell, S.E. (2008). *Earth Surface Processes and Landforms* 33, 2029-2044.

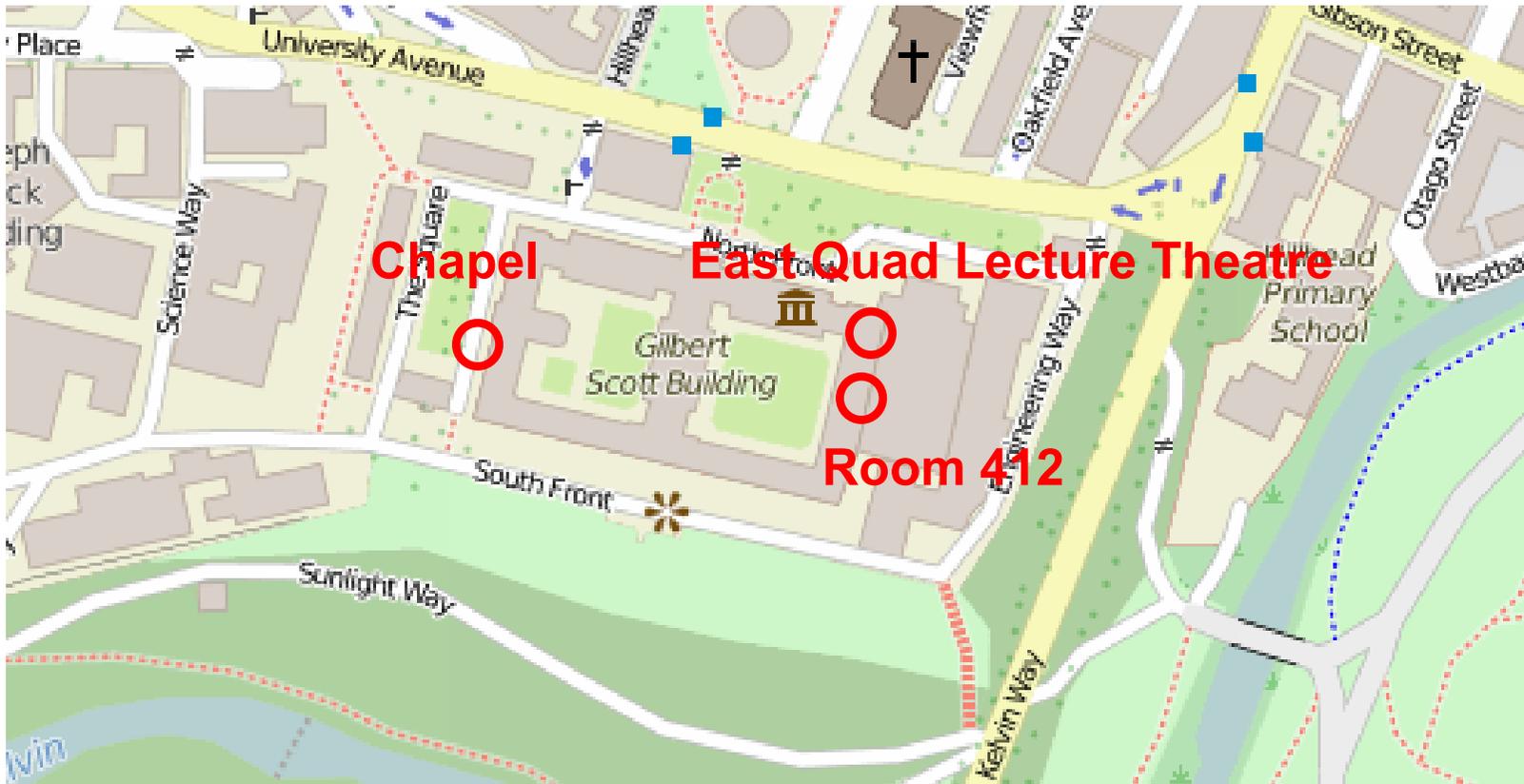
[2] Grenfell, S.E., Ellery, W.N., Grenfell, M.C., Ramsay, L.F., Flugel, T.J. (2010). *Sedimentology* 57, 1159-1174.



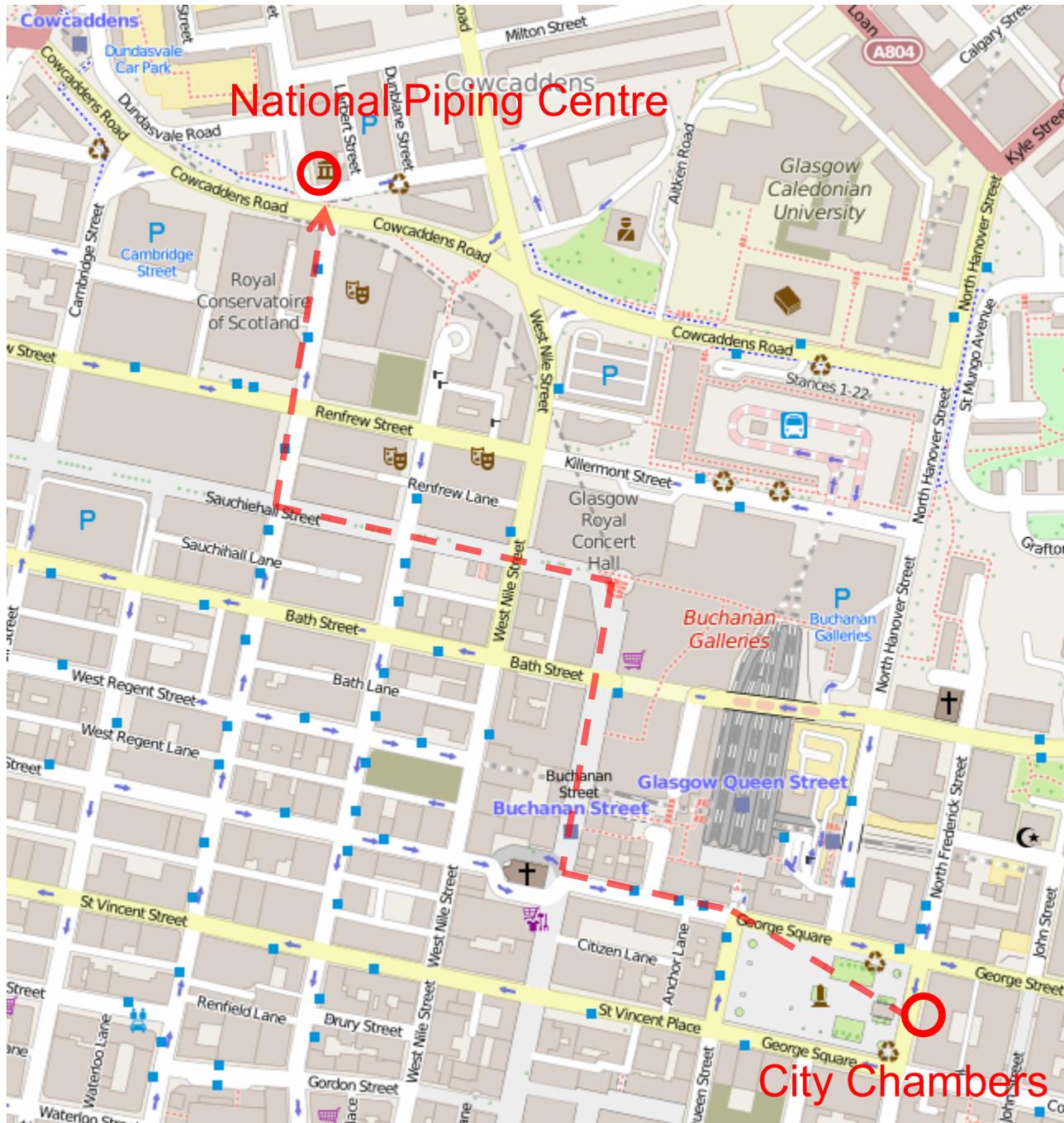
UKLUM15 General Location Map



UKLUM15 Venue and Halls of residence



UKLUM15 Venues



UKLUM15 Civic reception and conference dinner locations

