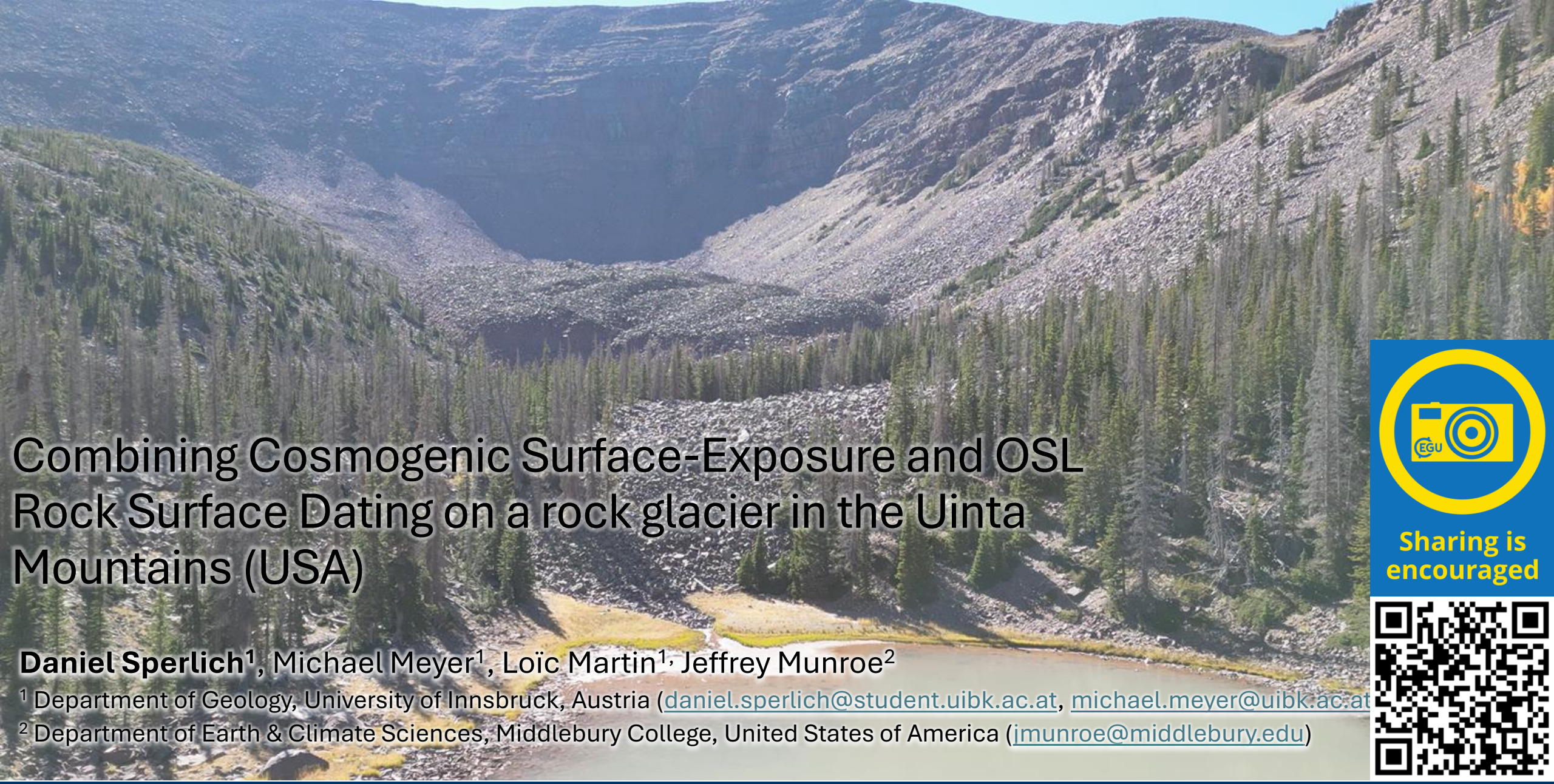

Combining Cosmogenic Surface-Exposure and OSL Rock Surface Dating on a rock glacier in the Uinta Mountains (USA)

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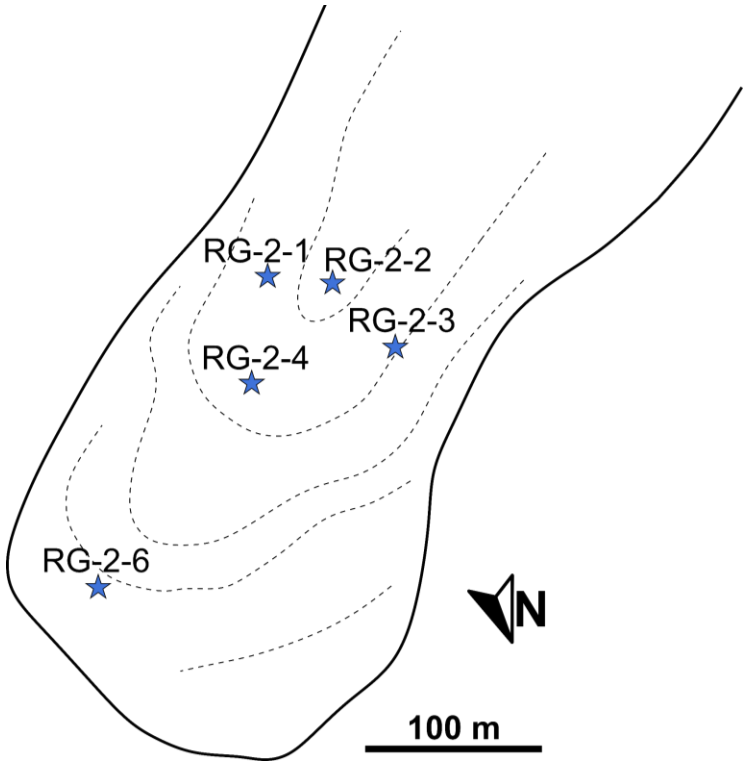
Introduction

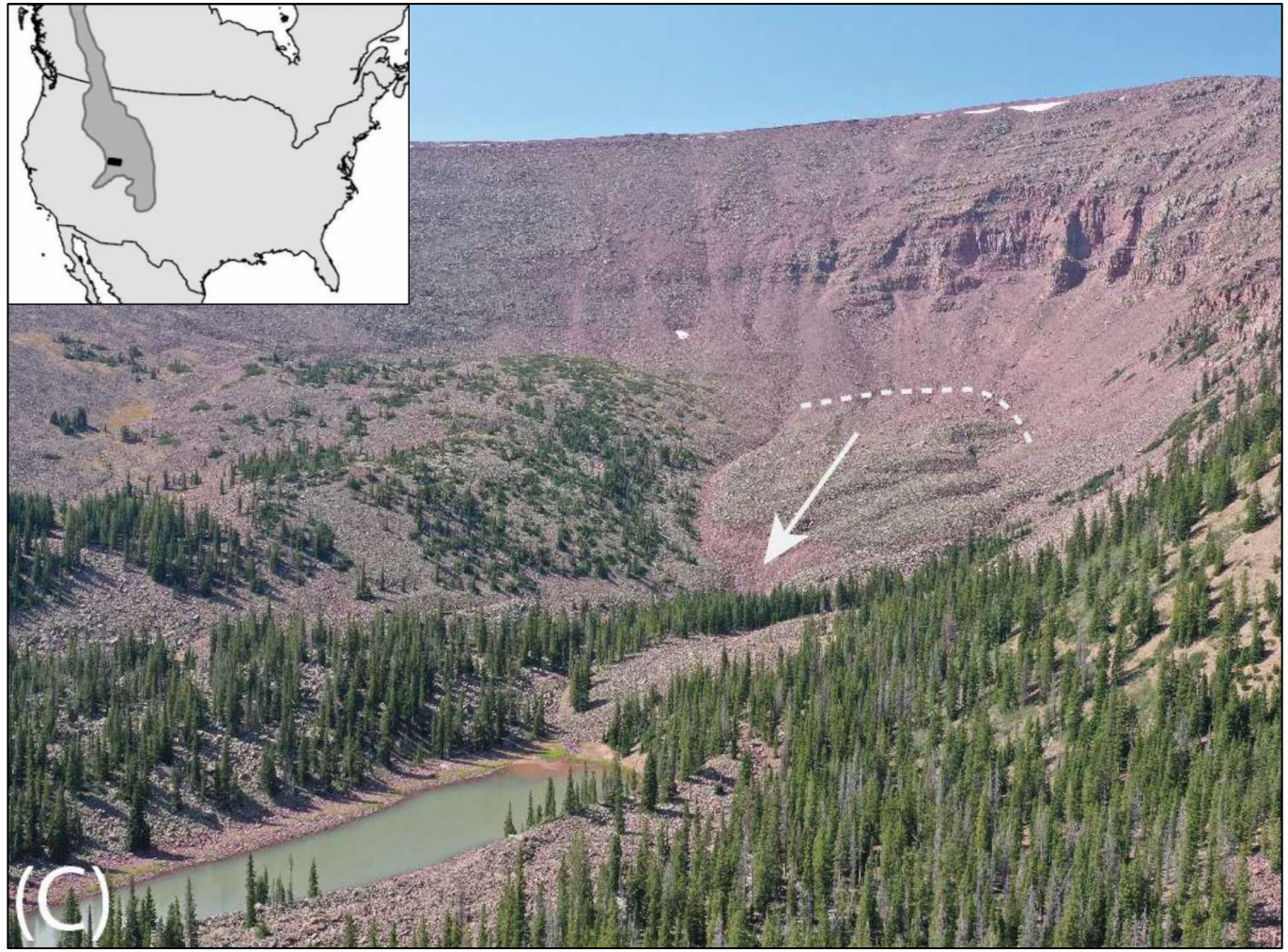
- Rock glaciers are common permafrost features
  - posing a geo hazardous risk
  - storing large amounts of water
  - long term dynamics and response to climate variability poorly understood
- **R**ock **S**urface **e**xposure **D**ating:
  - Established method: Cosmogenic Radionuclide Dating (CRN, e.g. ^{10}Be)
  - Novel method: Luminescence RSeD

- This Talk: Highlighting several sources for errors in preliminary data

Study Site + CRN-Ages

Sample	^{10}Be age (a)	^{10}Be 2σ uncertainty (a)
RG-2-1	6780	310
RG-2-2	3650	190
RG-2-3	8130	360
RG-2-4	6050	290
RG-2-6	10000	480



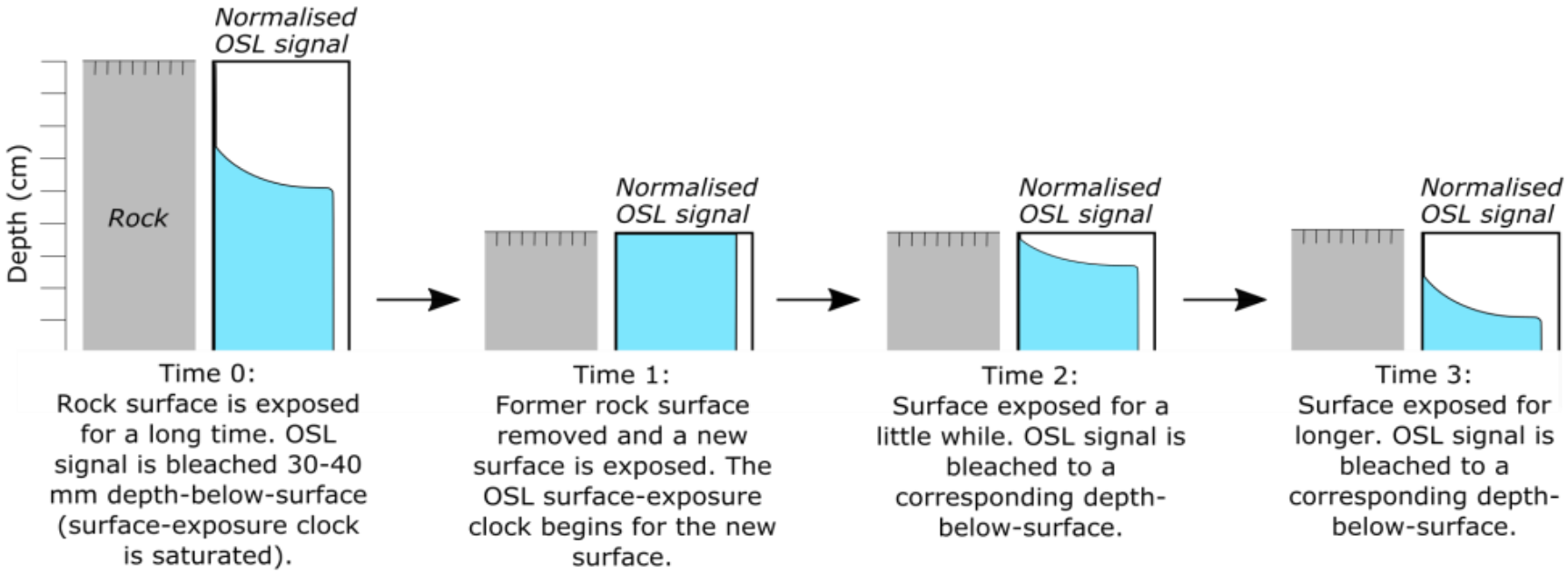


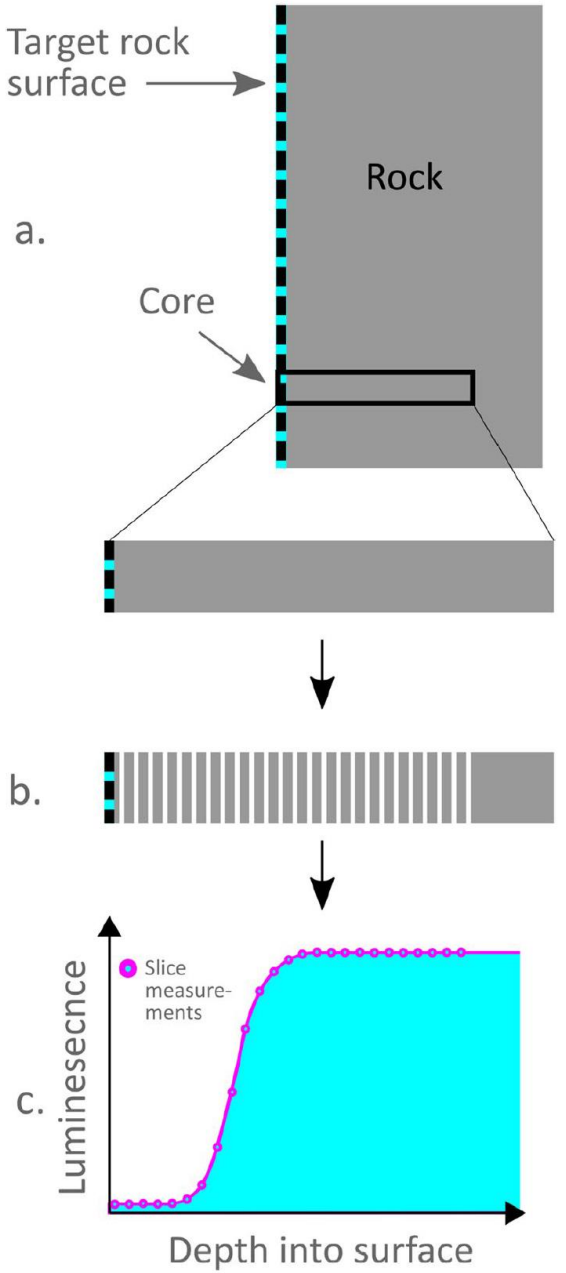
Edited after Munroe et al. 2024

OSL RSeD Method

- Bleaching with Depth Model (Sohbati et al. 2011, Sohbati et al. 2012)

$$L = L_0 e^{-\overline{\sigma\varphi_0} t e^{-\mu x}}$$

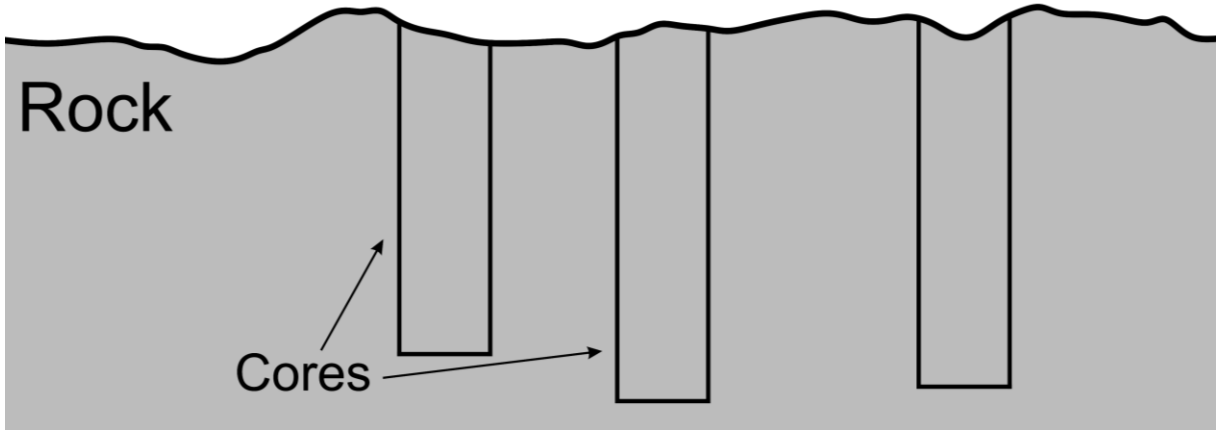


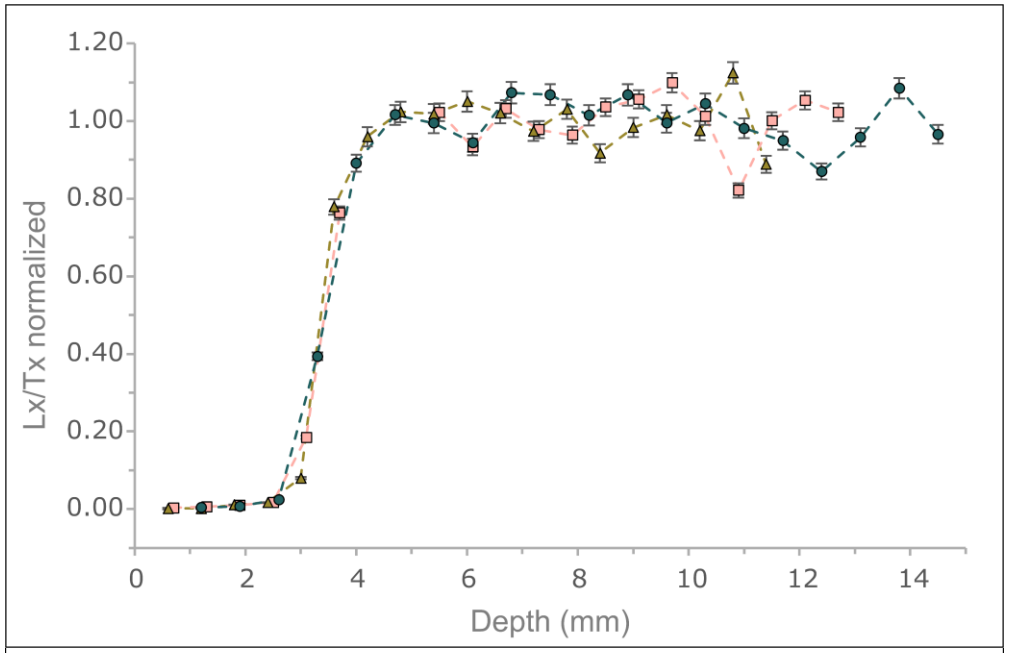


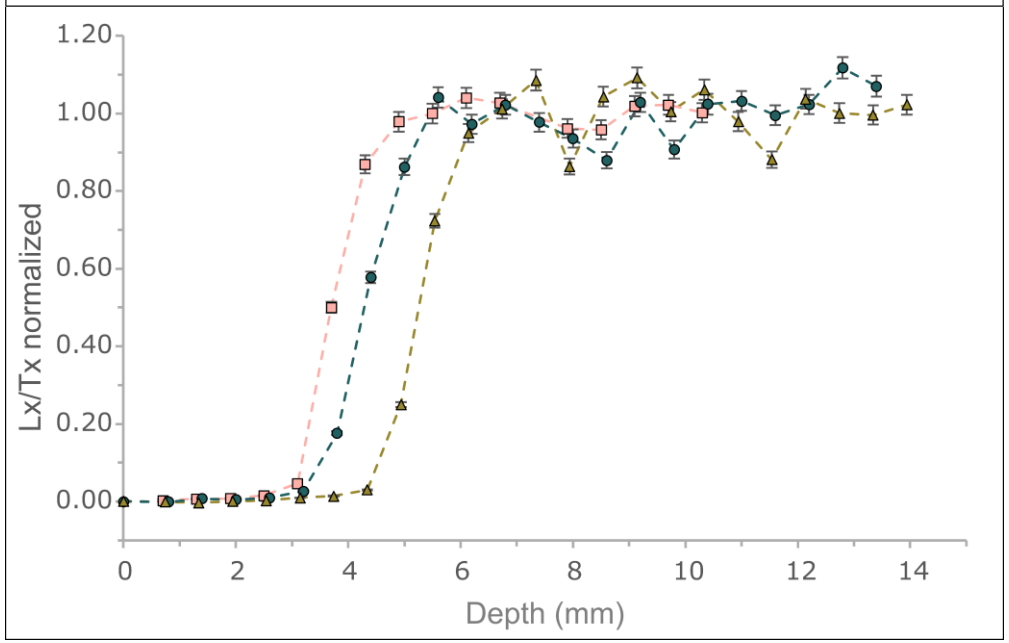
Gliganic et al. 2024

Results – Bleaching Profiles

- High scatter in x-axis due to surface roughness
- Depth resolution: ≥ 0.6 mm
  - x=0 and error hard to constrain
- Several cores per sample necessary
- Data of several cores can be merged for higher resolution



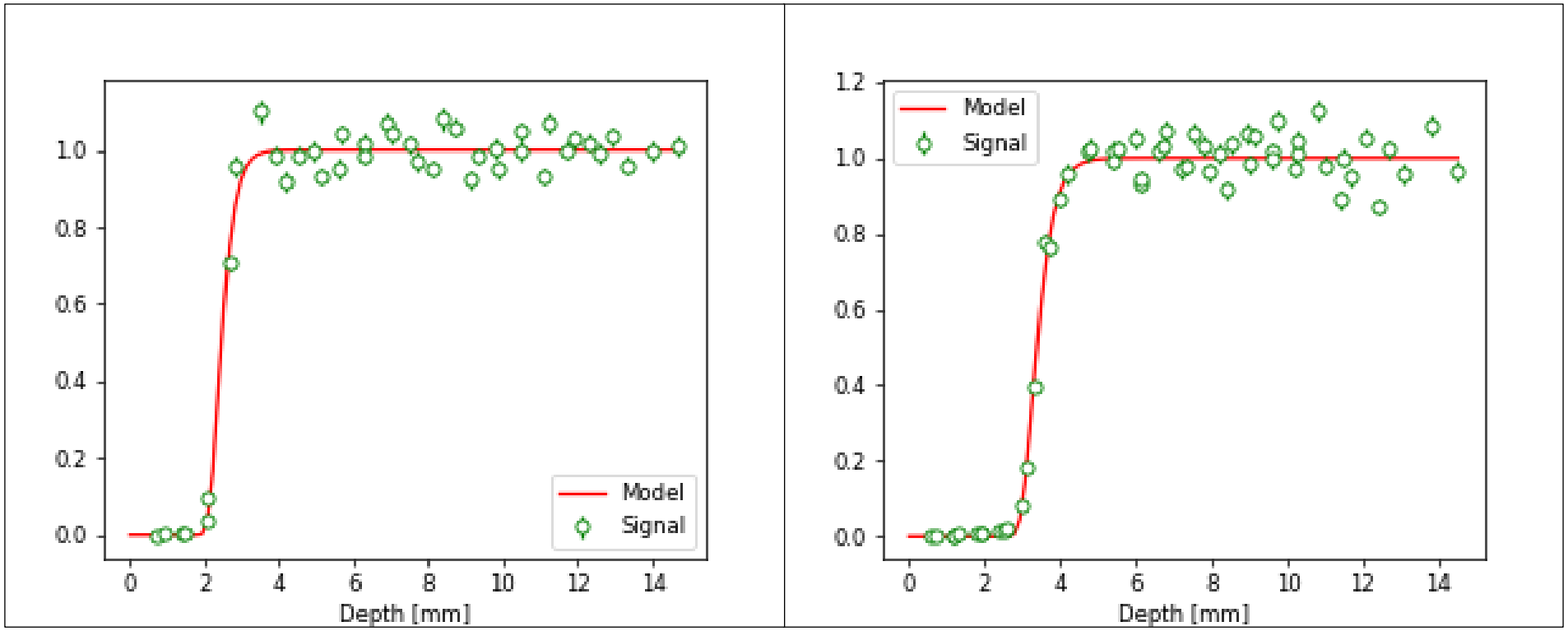




Results - Fitting

- Fitting to model with Python time machine software (Lehmann et al. 2018, Meyer et al. 2023)
- $L = L_0 e^{-\overline{\sigma\varphi_0} t e^{-\mu x}}$

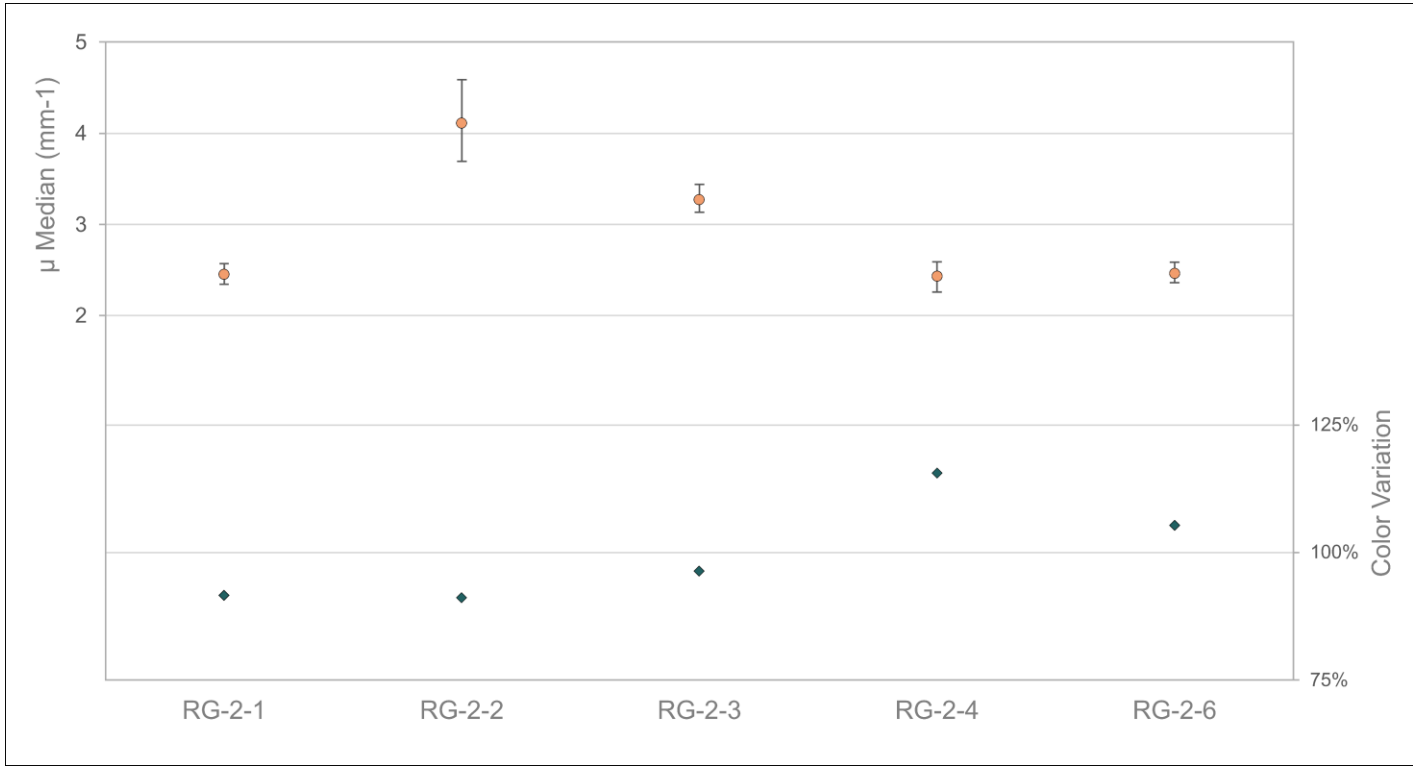
L	[1]	Luminescence remaining at depth x
L_0	[1]	Maximum luminescence signal
σ	[cm^2]	Photoionisation cross section
ϕ_0	[$cm^{-2}\ a^{-1}$]	Photon flux at rock surface
$\sigma\phi_0$	[a^{-1}]	Effective luminescence signal decay rate
t	[a]	Exposure time
μ	[mm^{-1}]	Light attenuation coefficient
x	[mm]	Depth



Results - Fitting

- Poor data density on slope: inaccurate estimation of $\sigma\phi_0$ and μ
- Variation of μ due to variation in rock color can be outruled

→ Exclusion of 2 samples

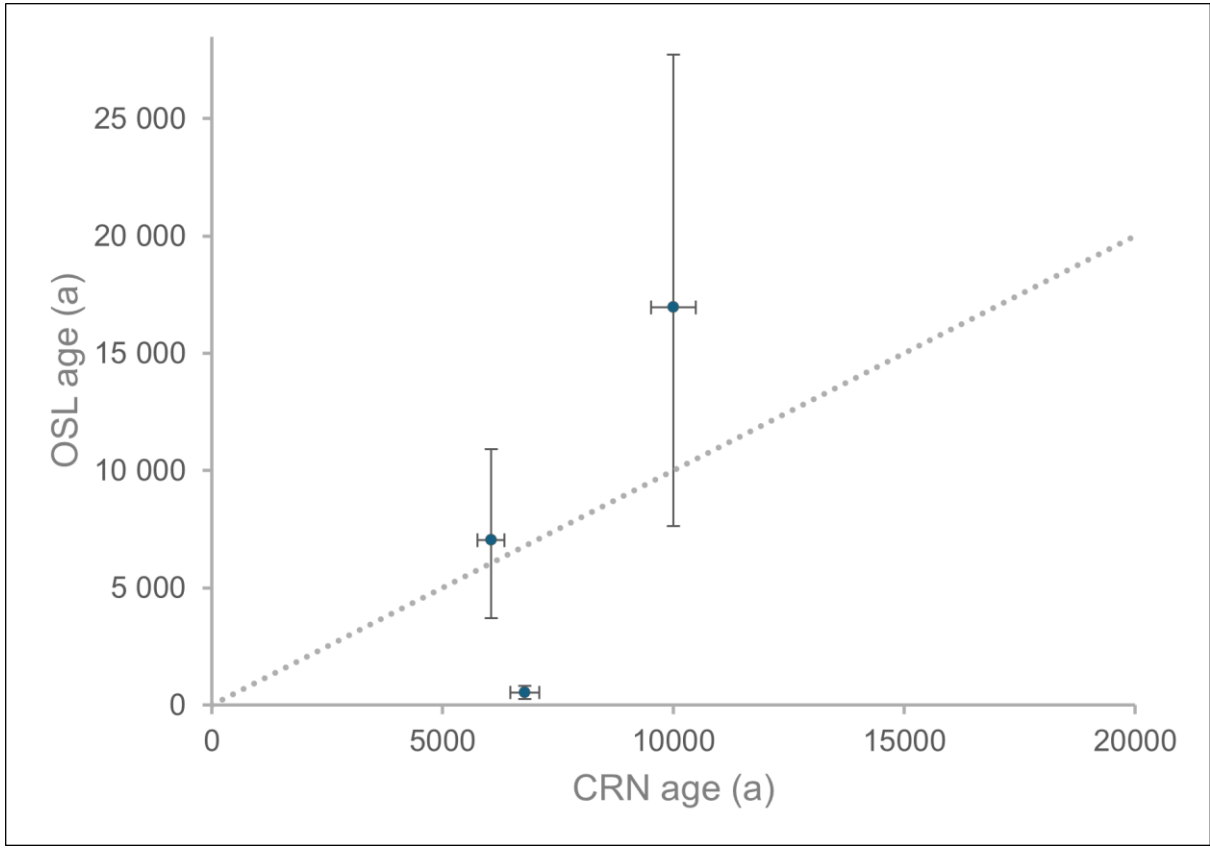


Sample	σϕ -1σ (a-1)	σϕ (a-1)	σϕ +1σ (a-1)	μ -1σ	μ (mm-1)	μ +1σ
RG-2-1	4.0	11.9	7.0	0.10	2.45	0.12
RG-2-2	30.3	48.1	81.8	0.42	4.11	0.48
RG-2-3	20.4	55.2	39.5	0.14	3.27	0.17
RG-2-4	86.6	157.9	178.4	0.17	2.43	0.16
RG-2-6	104.3	258.6	216.6	0.10	2.46	0.12

Results – Age Comparison

- Age comparison of CRN and OSL RSeD
  - Simulated calibration workflow – predictive test
  - Average $\sigma\phi$ and μ
- RG-2-1 and RG-2-6 fit within 1σ

→ Exclusion of RG-2-4



	CRN		OSL RSeD		
Sample	^{10}Be age (a)	2σ uncertainty (a)	-1σ (a)	age (a)	+1σ (a)
RG-2-1	6780	310	280	538	280
RG-2-4	6050	290	3323	7028	3881
RG-2-6	10000	480	9319	16957	10783

Conclusion

- RG-2 is a perfect testing ground for developing Luminescence RSeD
- Ideal sampling procedure
  - OSL RSeD first(micro-erosional features, surface roughness, lichen cover, surface orientation)
  - CRN afterwards
- Ideal RSeD sample preparation (smooth sample surface, multiple cores per sample, highest possible slicing resolution)
  - Resolution must be improved
  - Fitting must be improved

Perspective

- Alternative CRN-dated RG in French Alps (Lehmann et al. 2022) for testing imaging approach using EMCCD camera and IRSL signals (Fsp)

- Investigate how bleaching front develops in samples with high surface roughness using EMCCD camera (Fsp)

Thank you for your attention!

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Aerial Photo of RG-2 by Jeffrey Munroe

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