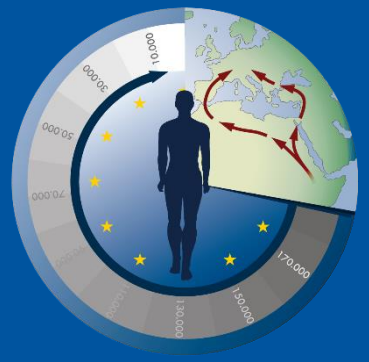



# Chances and challenges in dating tephra marker horizons by luminescence dating techniques

Bösken, J., Klasen, N., Obreht, I., Hambach, U., Veres, D., Zeeden, C., Marković, S.B., Burow, C., Brill, D., Pötter, S., Lehmkuhl, F.

DFG Deutsche Forschungsgemeinschaft

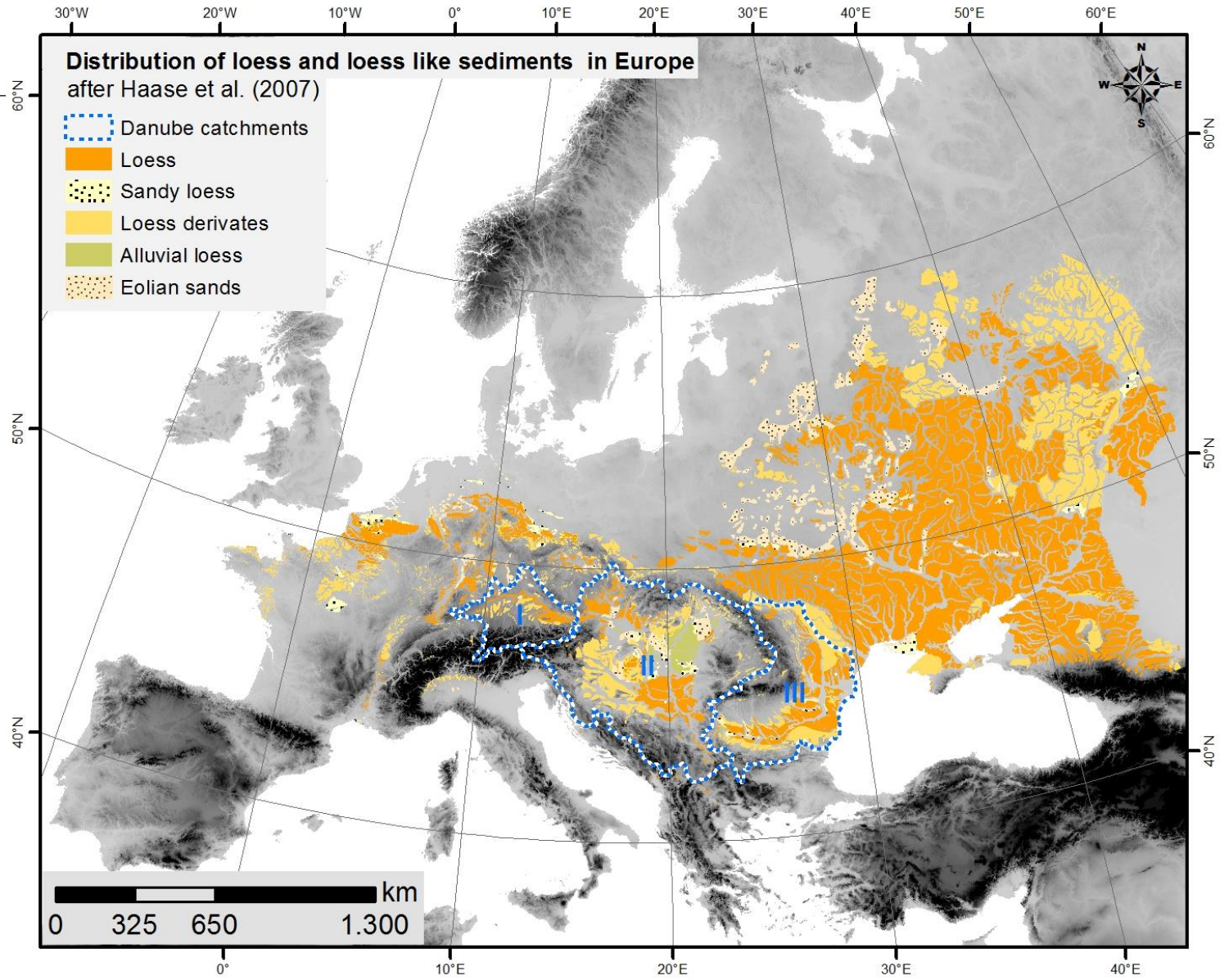
UoC Cologne Luminescence Laboratory

Physical Geography and Geoecology

RWTH AACHEN UNIVERSITY

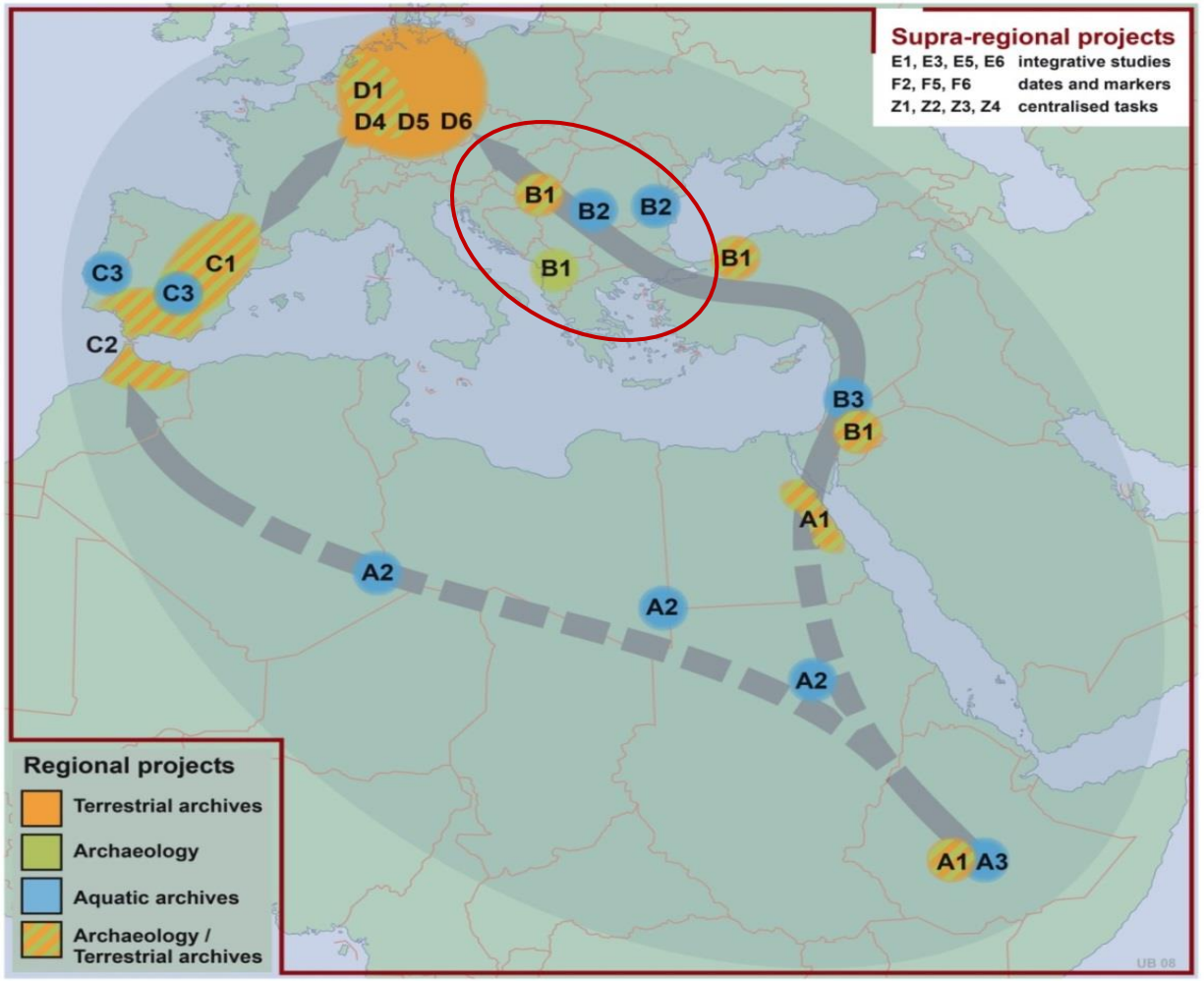
# Loess distribution in Europe

- Loess as wide-spread Quaternary paleoclimatic archive
- widely distributed in the research area

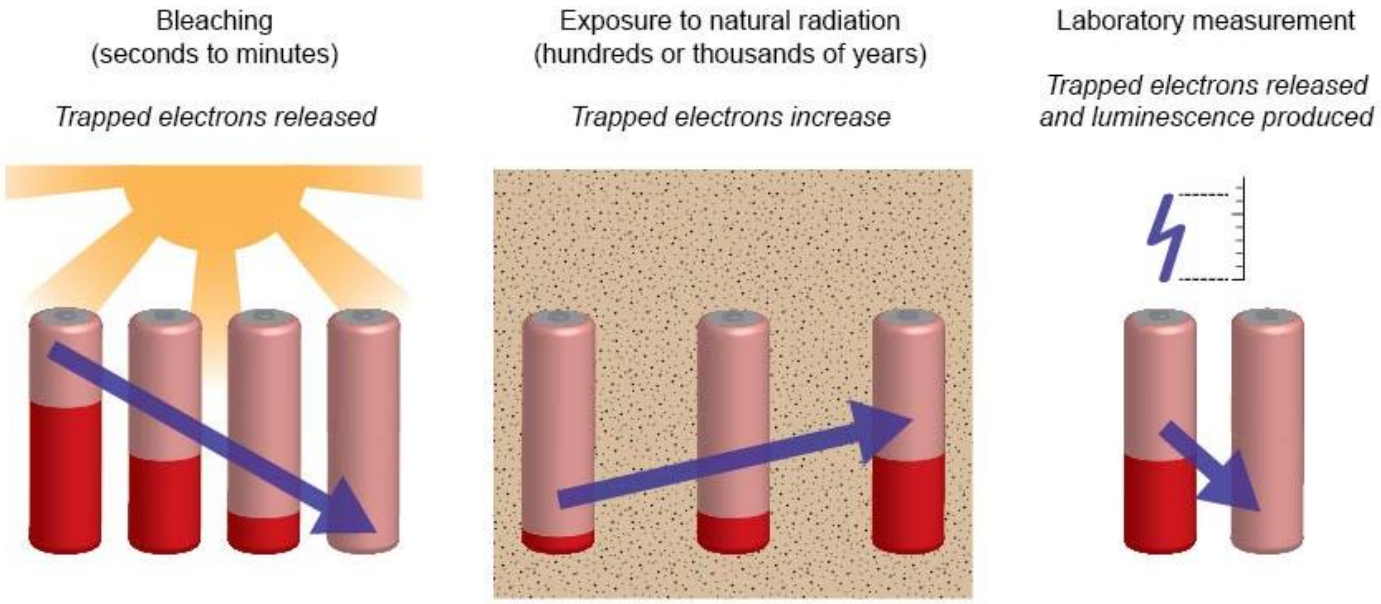


# CRC 806 „Our Way to Europe“

- Climatic conditions & fluctuation → influence on dispersal of Modern Man
- “Eastern trajectory” of modern human migration into Europe



# Optically stimulated luminescenc (OSL) dating




Accumulated signal induced by natural occuring radioactivity

$$\text{Luminescence age (a)} = \frac{\text{equivalent dose (Gy)}}{\text{Dose rate (Gy a}^{-1}\text{)}}$$

1 Gy = 1 J/Kg

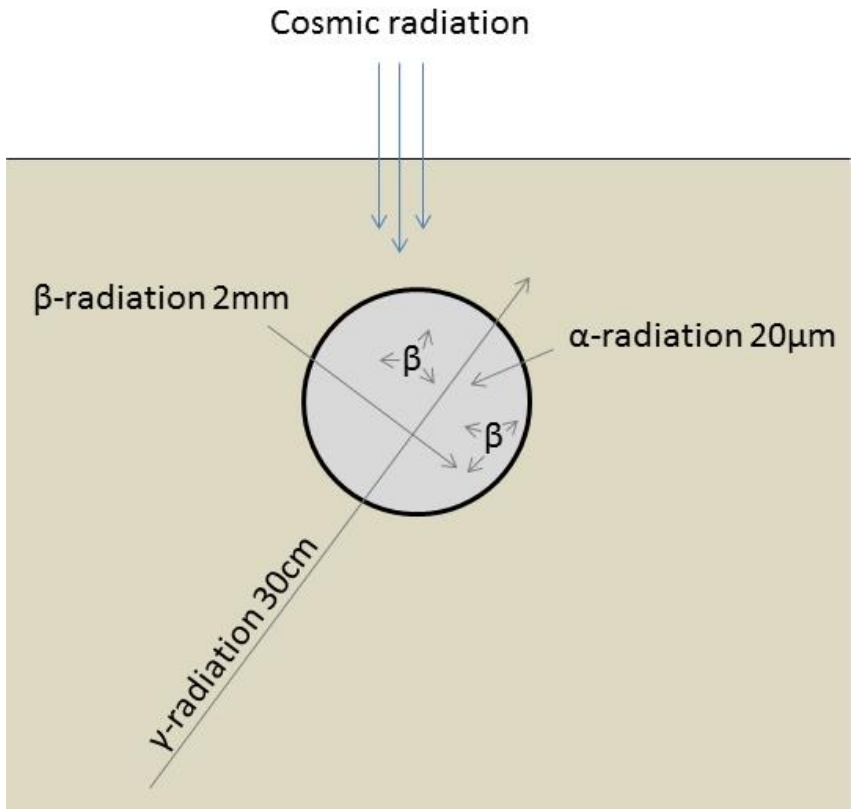
Amount of energy deposited per mass of mineral due to radiation exposure over time

# Dose rate

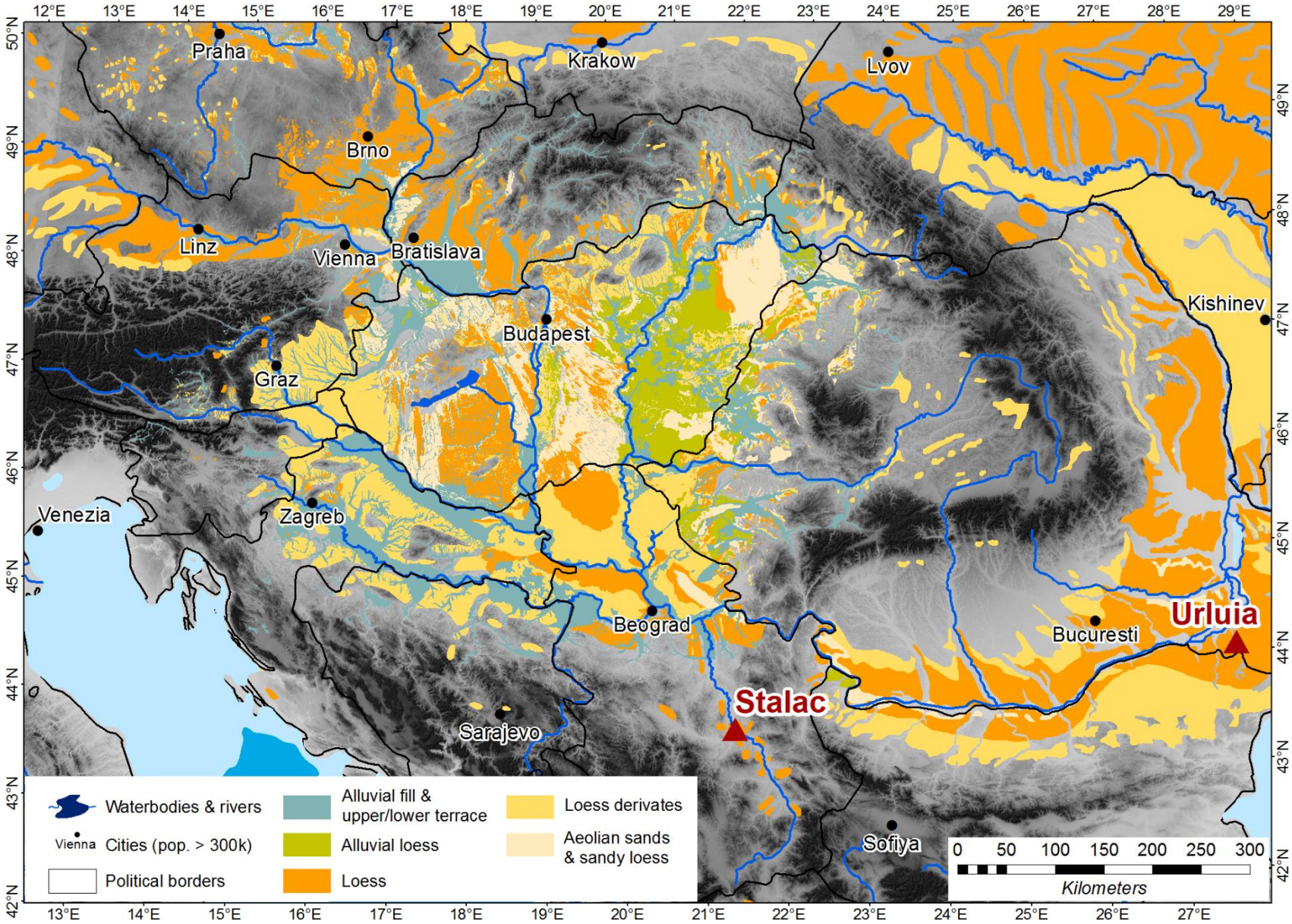
$$z_{tot} = \alpha z_{\alpha} + z_{\beta} + z_{\gamma} + z_{cosmic}$$

Calculated in R:
Dependent on geographical position on earth and sample depth

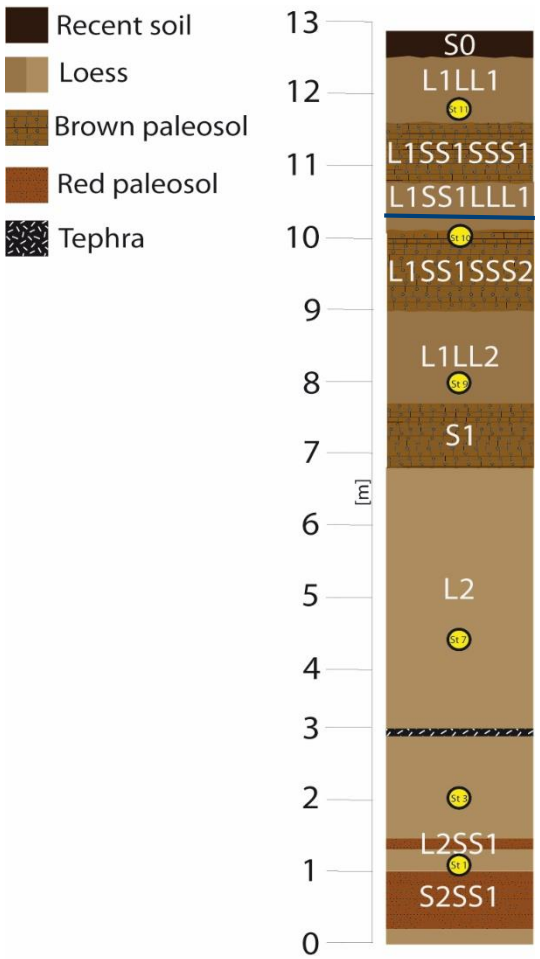
Radionuclide concentrations measured with high-resolution gamma-ray spectrometry and converted into dose rates



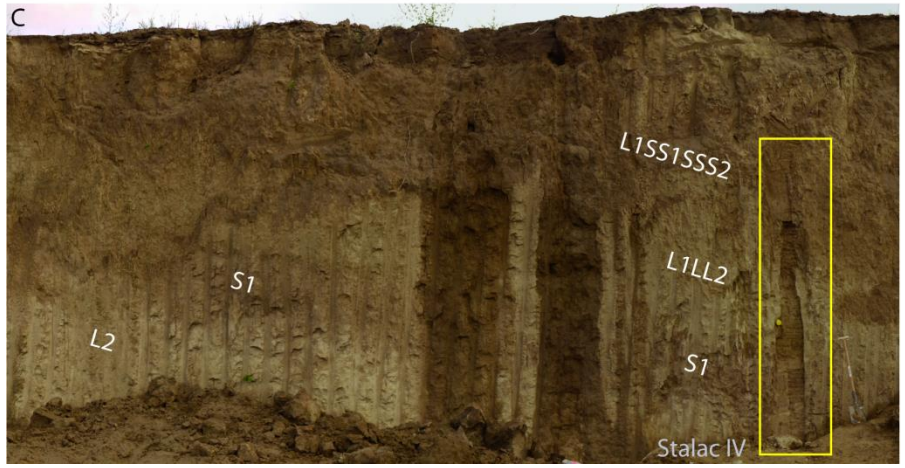
# Research Area

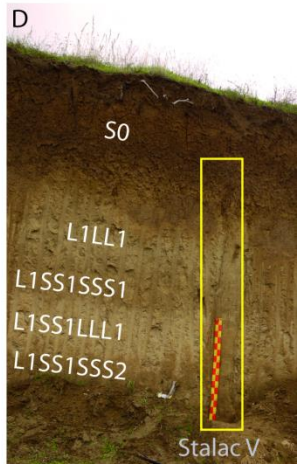


# Example 1:
# Stalać, Serbia



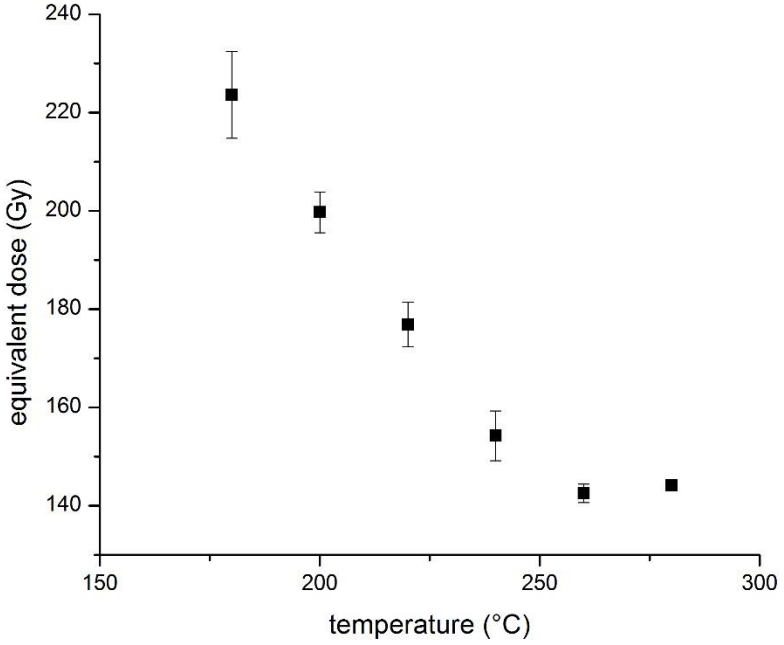


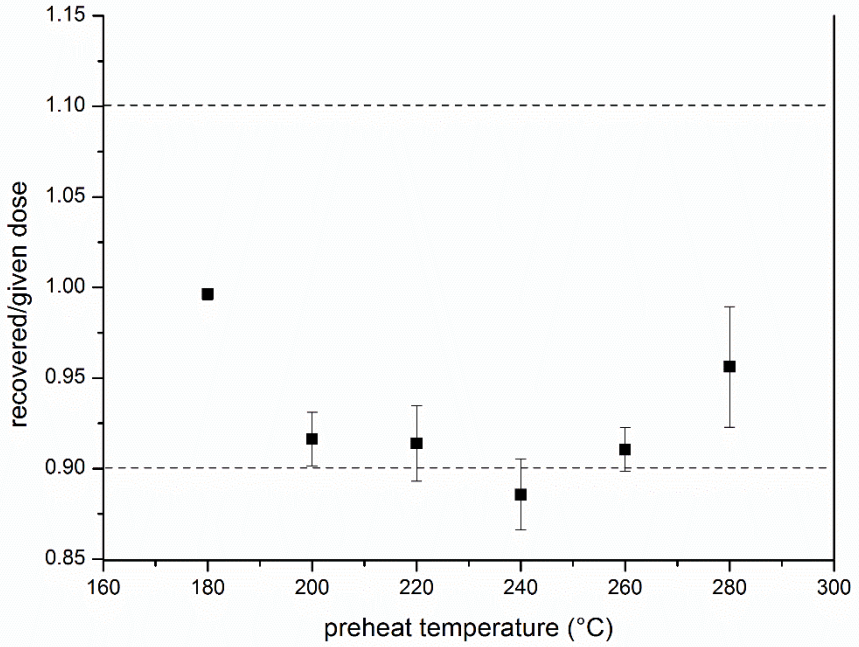
# Quartz 4-11µm - SAR protocol (Murray and Wintle, 2000, 2003)

## Preheat plateau test (PHT)



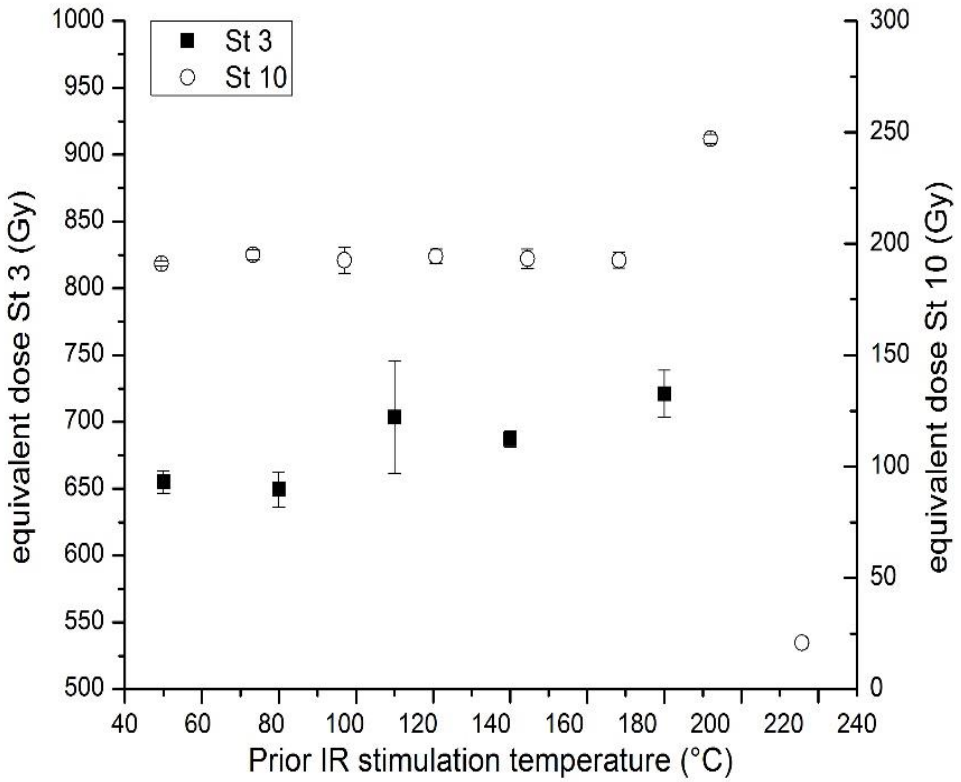

- Recycling ratios: 0.94-1.13
- Recuperation < 1.14%
- IR depletion: 1.06±0.05

## Dose recovery test (DRT)

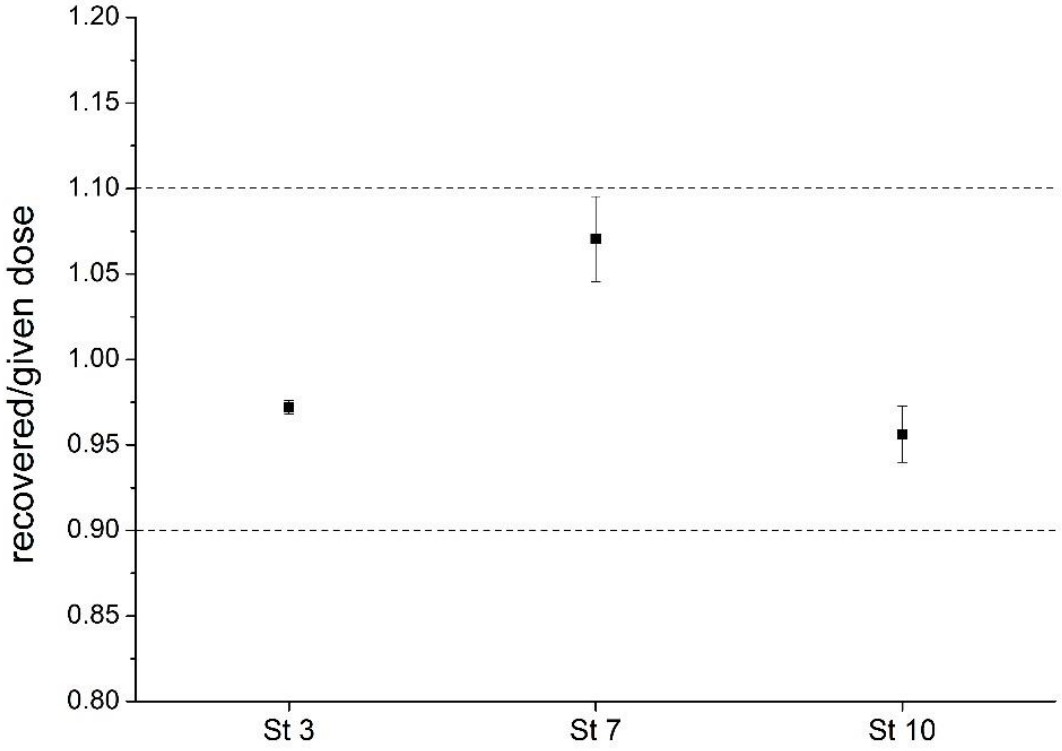



- Recycling ratios: 0.93-1.08
- Recuperation < 1.38%

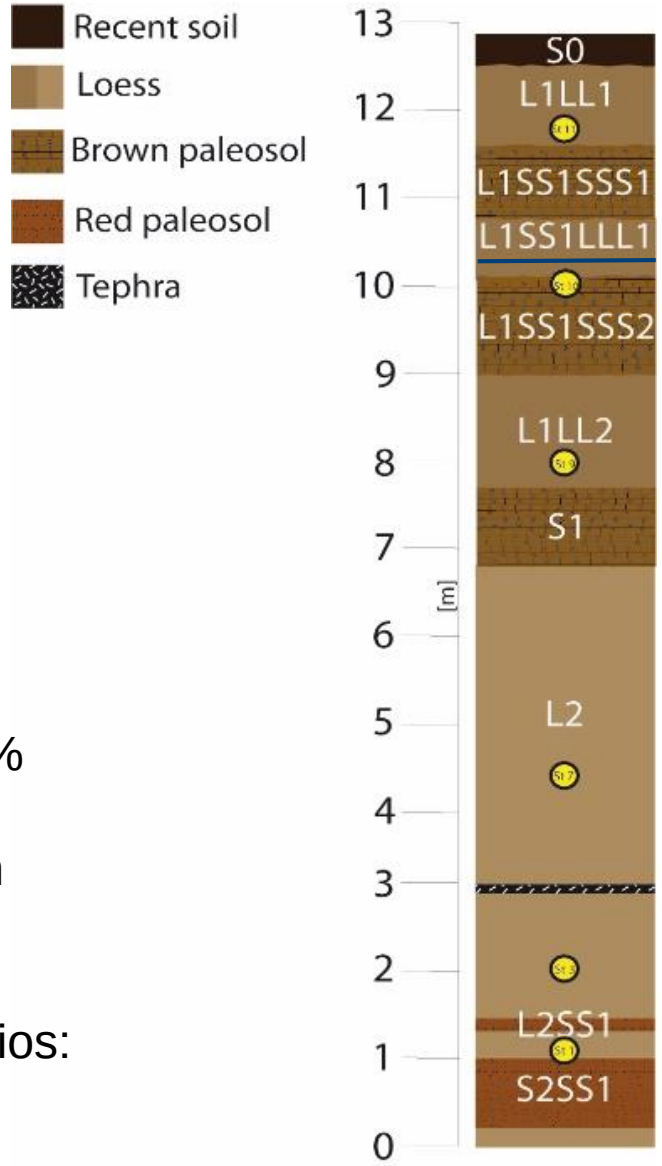
# Polyminerals 4-11µm Post-$IR_{50}$-$IRSL_{290}$ (Thiel et al., 2011)




First IR stimulation temperature test




Dose recovery test




| | Age | | De (Gy) |
|---|---|---|---|
| | | | 149 ± 8 |
| MIS 3 | 28.5± 2.3 | | |
| | 43.0± 3.6 | | 191 ± 10 |
| MIS 4 | | | 245 ± 12 |
| MIS 5 | 59.9± 4.0 | | |
| MIS 6 | 123 ± 8 | | 622 ± 32 |
| | 136 ± 10 | | 650 ± 36 |
| MIS 7 | 139 ± 11 | | 630 ± 32 |

Giaccio et al. (2017)

CI: **39.85** ±0.14ka

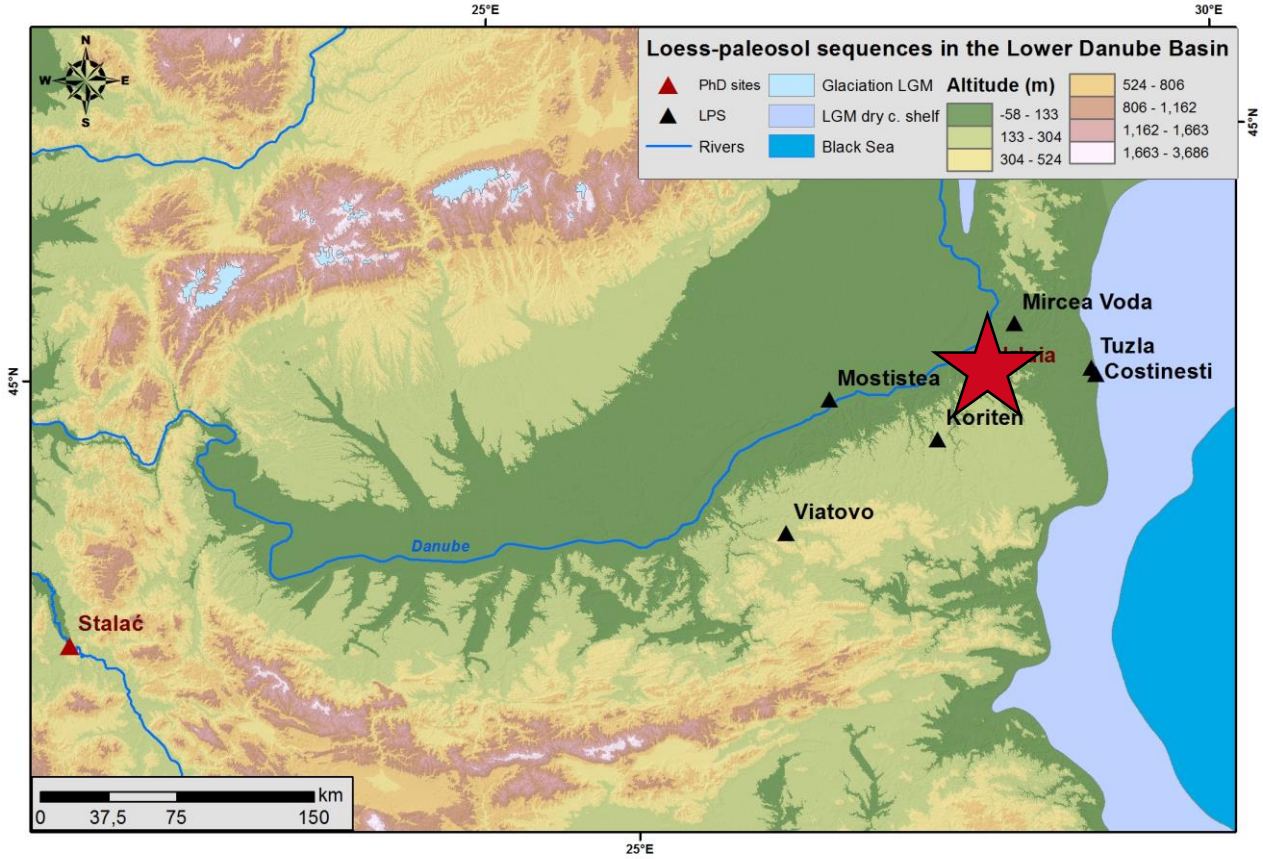
Residuals:
4-7 Gy, <2.5%

Recuperation
<1.6%

Recycling ratios:
0.96-1.06

Bösken et al. 2017, Geochronometria 44

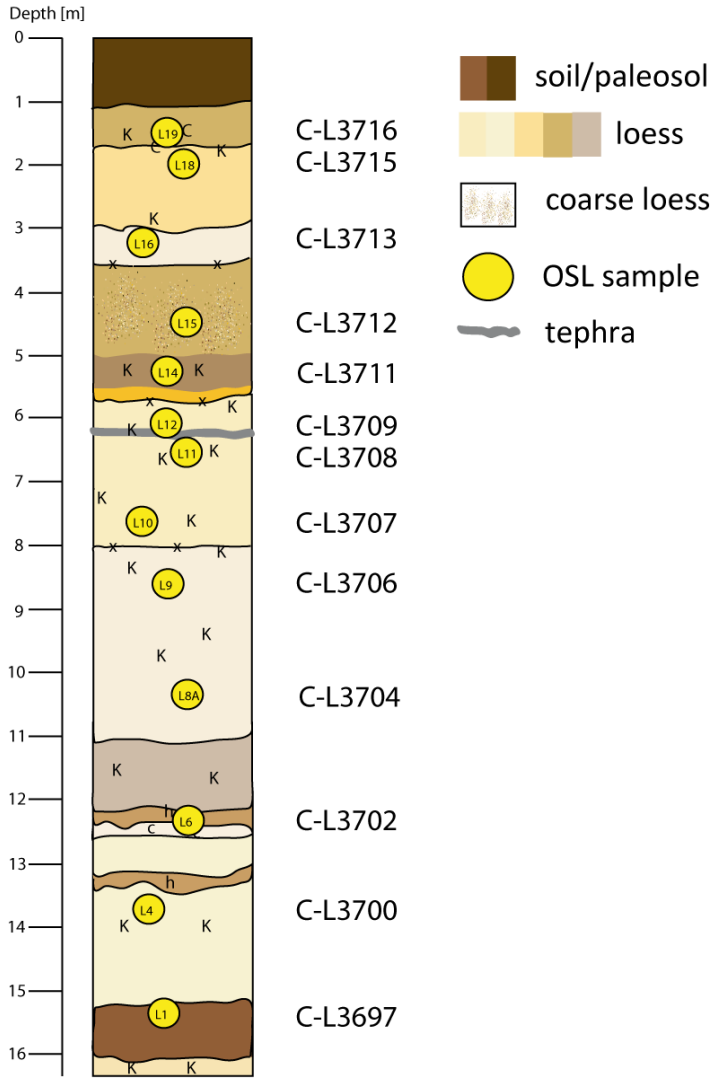
# Example 2: The Urluia loess-paleosol sequence




Cf. previous studies:

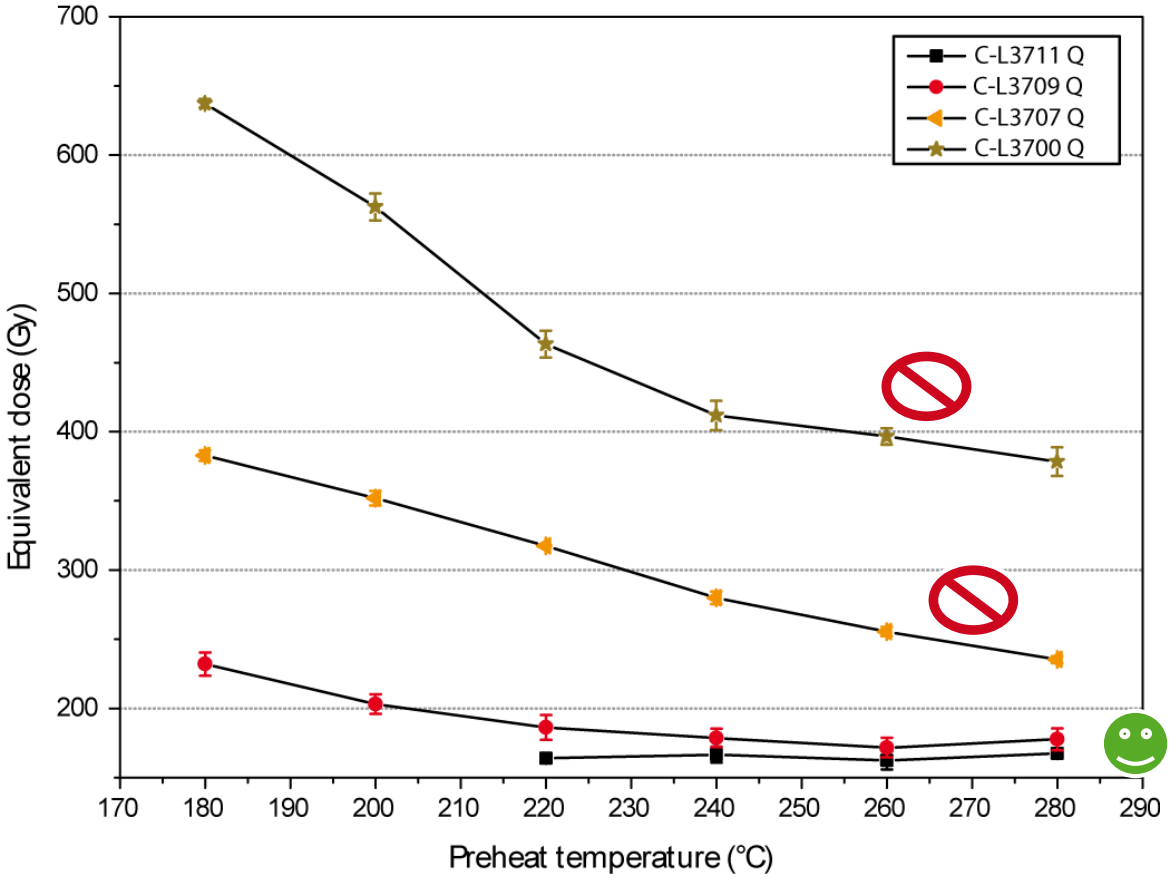
Fitzsimmons & Hambach (2014)
Fitzsimmons et al. (2013)
Obreht et al. (2017)
Fitzsimmons (2017)

# Stratigraphy & sampling

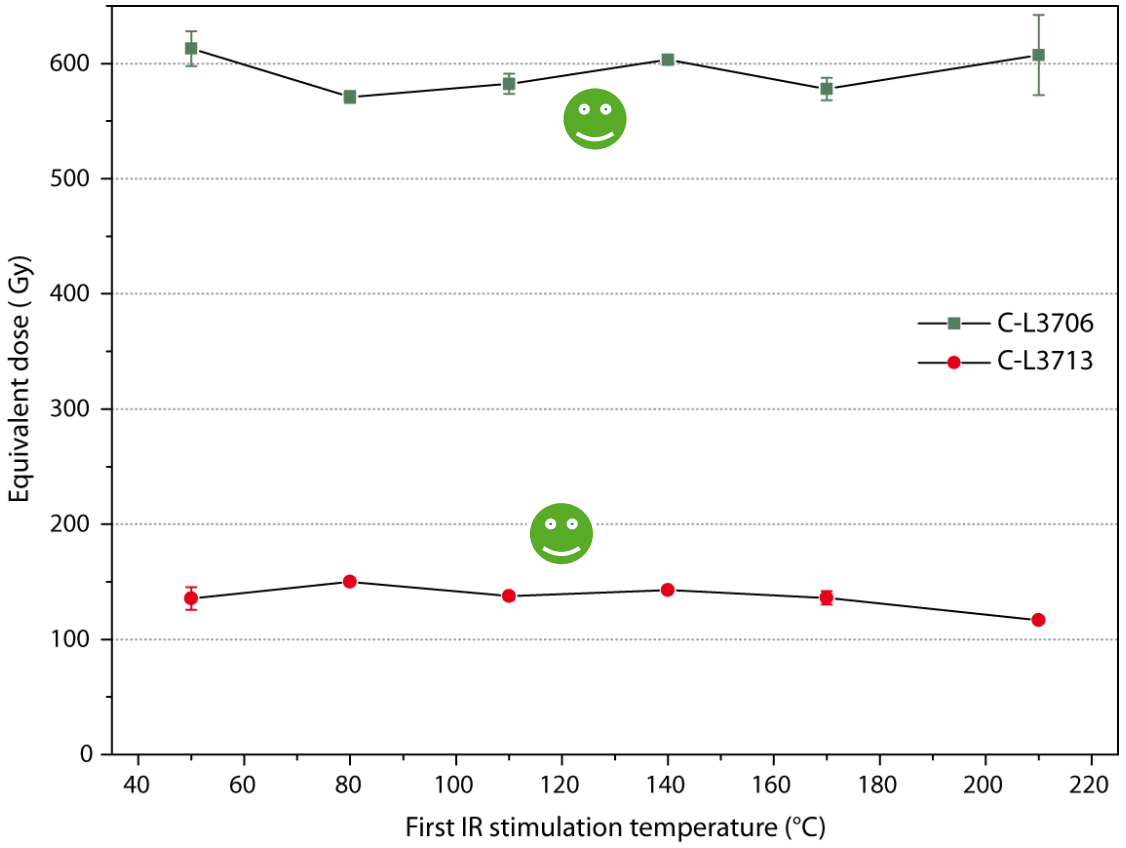



# Luminescence measurements of fine grains (4-11µm)

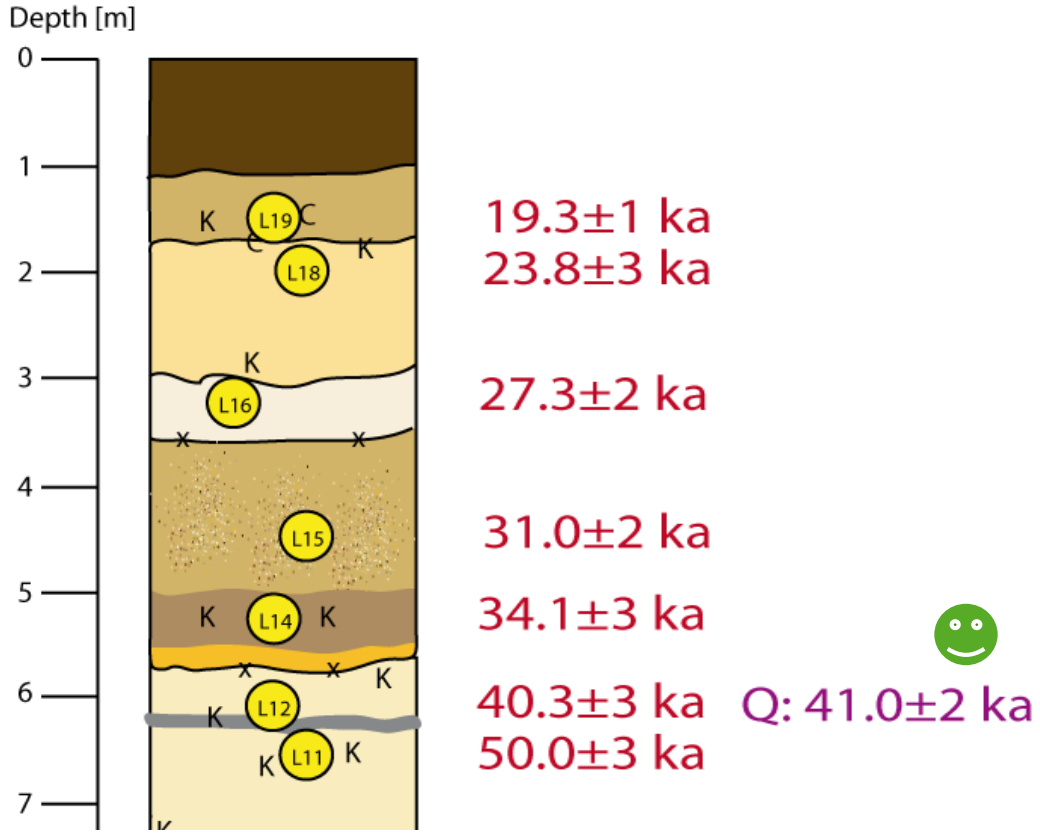
## Preheat plateau test
## Quartz SAR

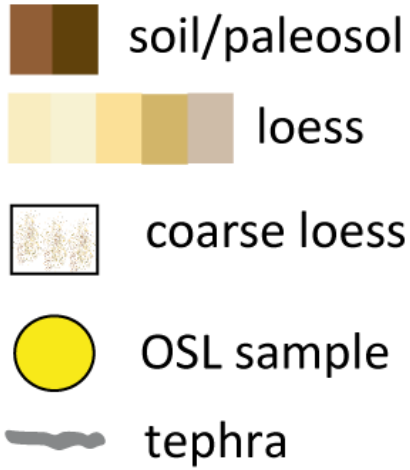



## 1st IR stimulation temperature test
## polymineral pIRIR290



# Luminescence geochronology




Giaccio et al. (2017)

CI: **39.85** ±0.14ka

Obreht et al., 2017, Scientific Reports 7:5848
Bösken et al., in prep

# Summary and conclusion

- Tephra layers serve as marker horizons to validate luminescence dating results
- Dating of tephra layers works well in last glacial loess deposits
- But big uncertainties and possible age underestimation are problematic for dating tephra layers in penultimate loess deposits
- Other methodological approaches might help solve these issues
  → next talk by C. Schmidt

Ulrich Hambach

Environmental Magnetism

Dan Veres

Quaternary Geology
Paleoclimatology
Tephrachronology

Eileen Eckmeier

Pedology

Pál Sümegi

Malacology

Philipp Schulte

Slobodan Marković

Geomorphology,
Sedimentoloy,
Geochemistry

Frank Lehmkuhl

Christian Zeeden


Igor Obreht

Stephan Pötter

Stefan Vlaminck

Archeology

Thomas Hauck

Wei Chu

Jürgen Richter

Dirk Leder

Luminescence

A. Timar-Gabor

Dominik Brill

Nicole Klasen

Anja Zander

Chr. Burow

Chr. Schmidt