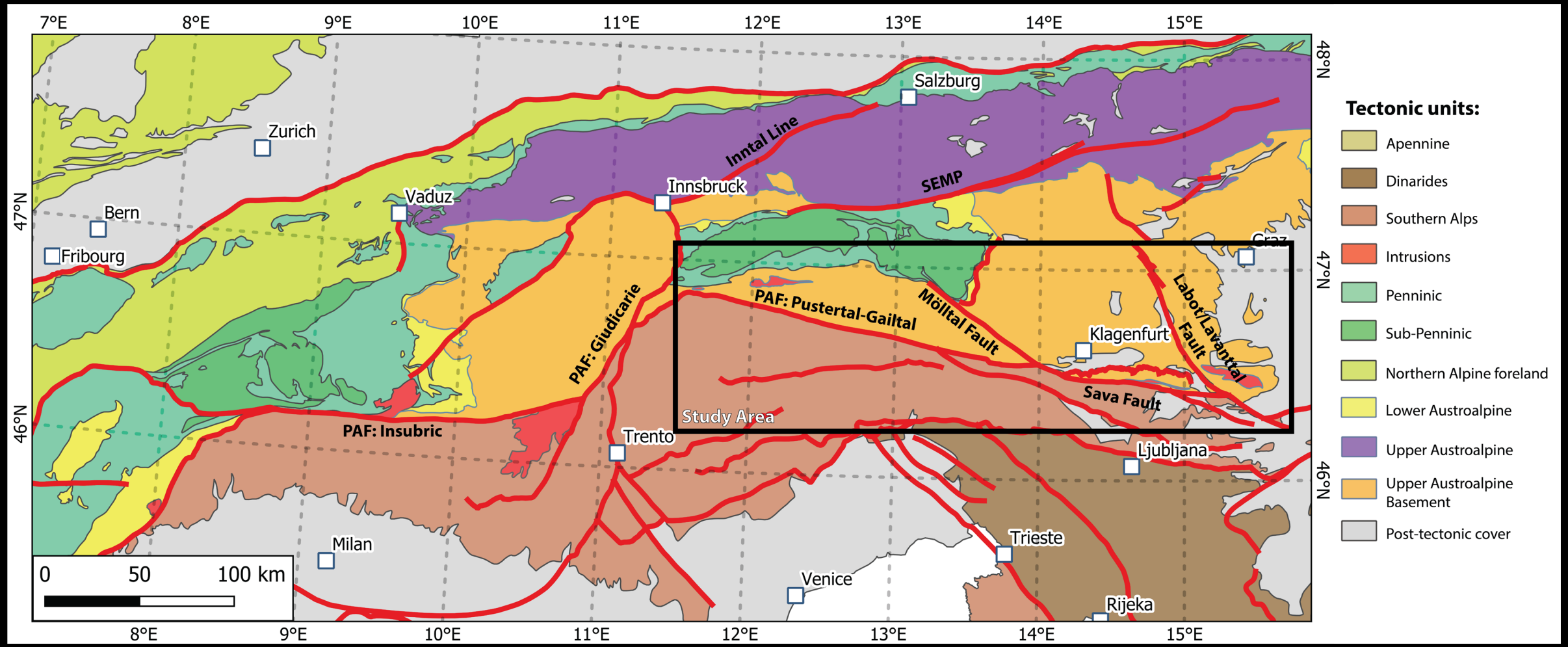
Finding Quaternary Seismogenic Activity Along the Eastern Periadriatic Fault System: Dating of Fault Gouges via Electron Spin Resonance

Erick Prince[1], Sumiko Tsukamoto[2], Christoph Grützner[1], Marco Vrabec[3], Kamil Ustaszewski[1]

[1]Friedrich-Schiller-Universität Jena, Institut für Geowissenschaften, Germany | [2]Leibniz-Institut für Angewandte Geophysik - LIAG Hannover, Germany | [3]University of Ljubljana, Slovenia

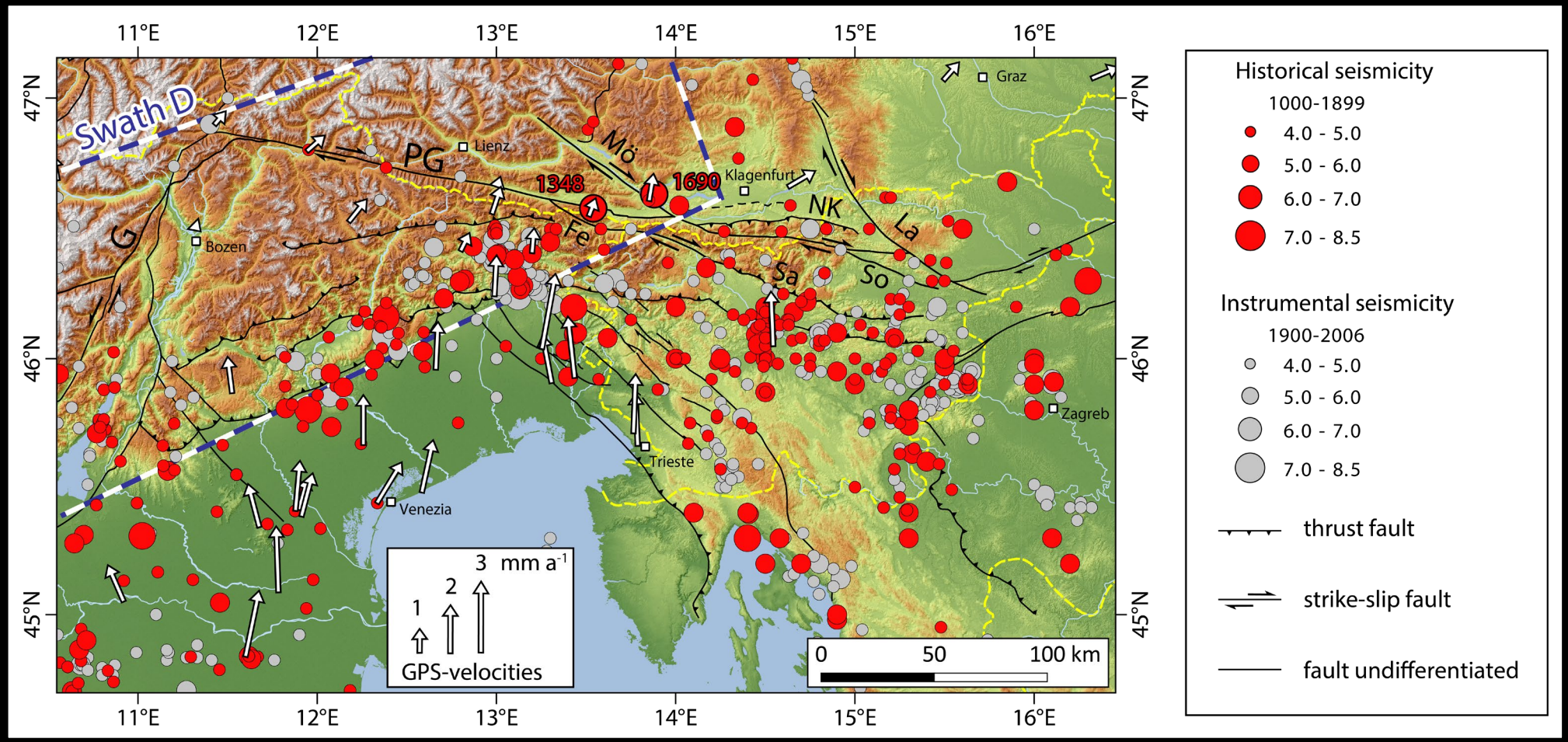
Geological Background



Modified after Schmid 2004

erick.prince@uni-jena.de

Seismicity along the Eastern PAF

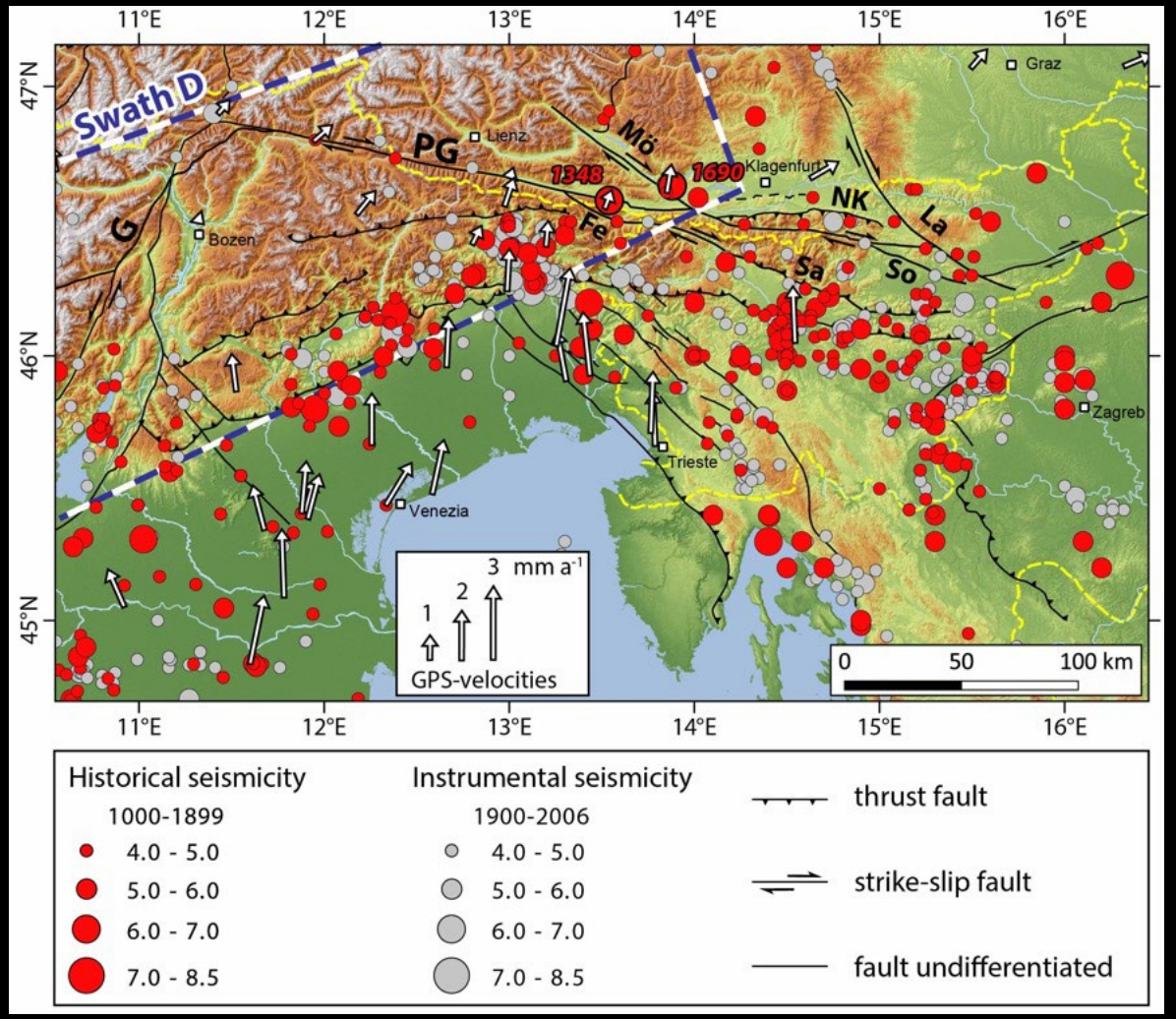


Historical seismicity (Grunthal & Wahlstrom 2012), instrumental seismicity (Stucci et al., 2013), GPS velocities (D'Agostino et al., 2008; Metois et al., 2015; Serpelloni et al., 2016)

Seismicity along the Eastern PAF

Which segments of the eastern PAF system accommodated seismotectonic deformation throughout the Quaternary?

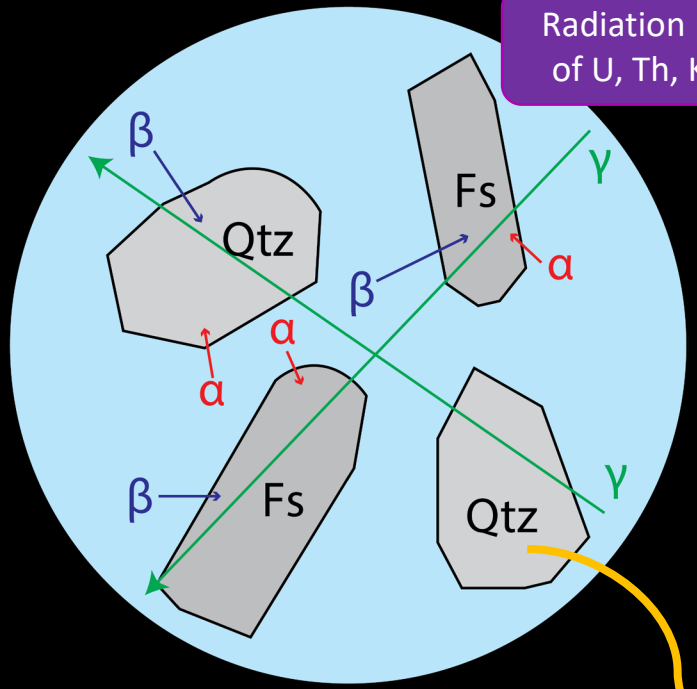
Dating of fault gouge via Electron Spin Resonance (ESR)



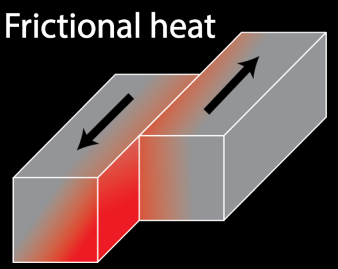
Historical seismicity (Grunthal & Wahlstrom 2012), instrumental seismicity (Stucci et al., 2013), GPS velocities (D'Agostino et al., 2008; Metois et al., 2015; Serpelloni et al., 2016)

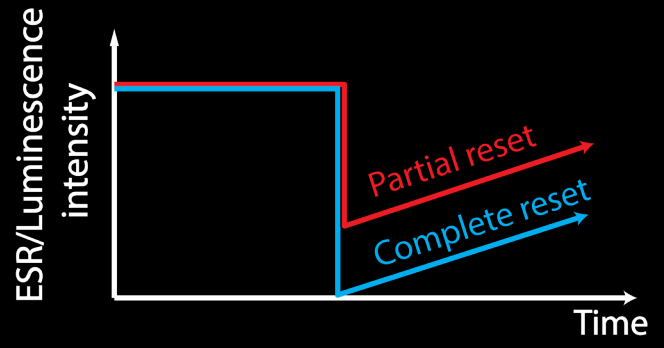
Electron Spin Resonance

Radiation product of U, Th, K decay



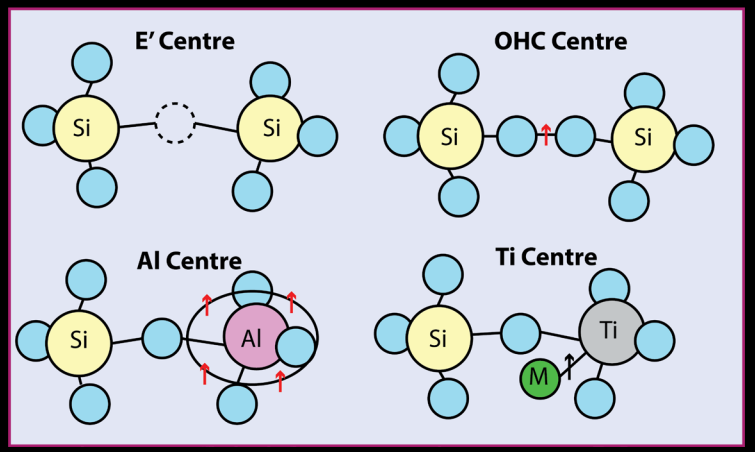
Earthquake

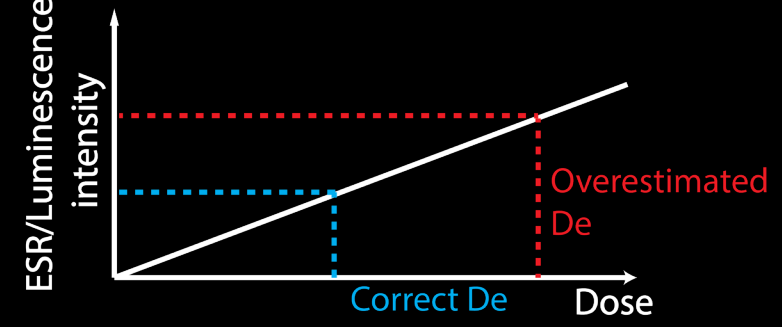




Electrons are released from the traps

Production and accumulation of unpaired electrons

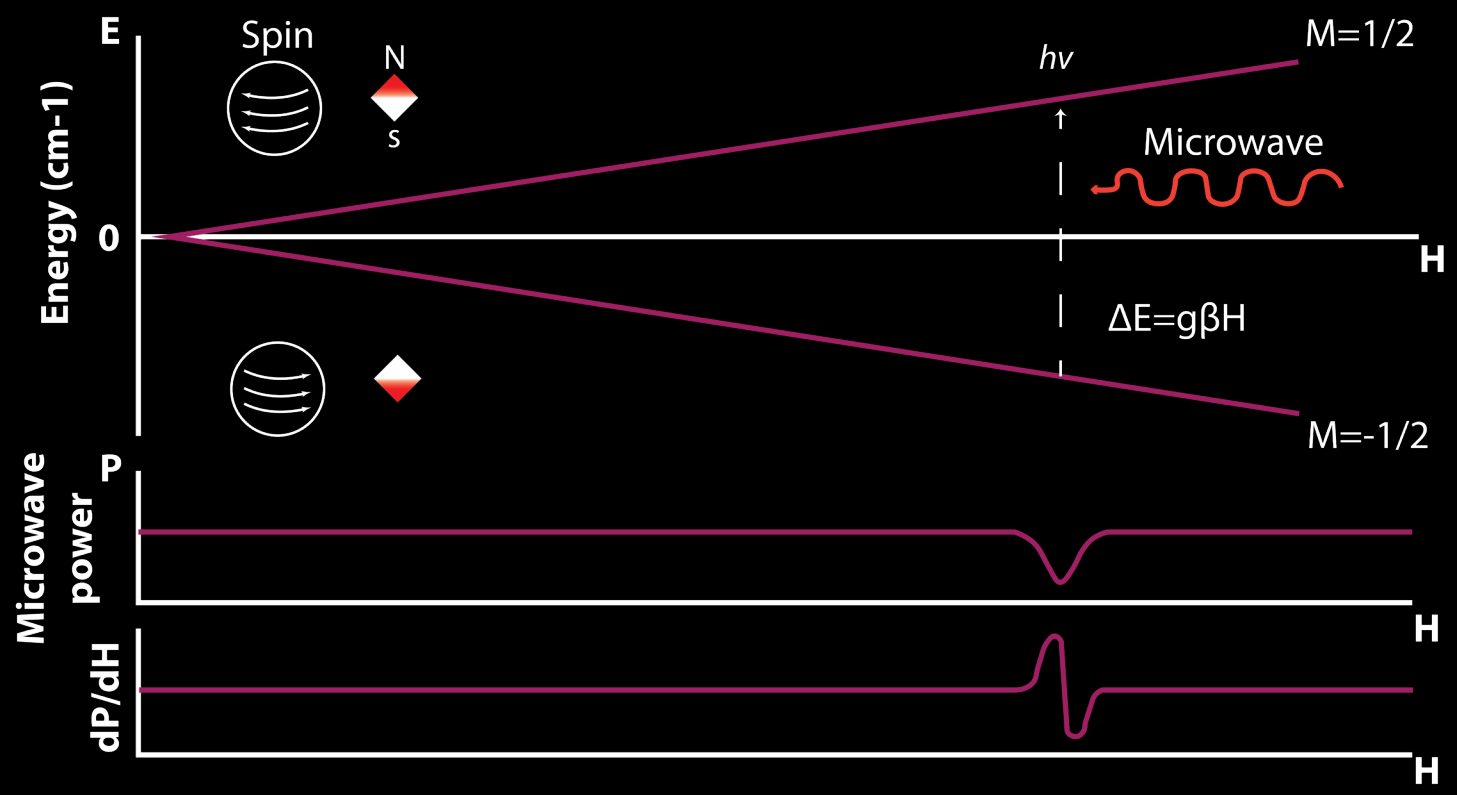




Modified after Tsukamoto, Tagami & Zwingmann, 2020

erick.prince@uni-jena.de

ESR Measurements



Modified after Tsukamoto, Tagami & Zwingmann, 2020

- Unpaired electrons align under a magnetic field according to their spin
- Microwaves are absorbed accordingly to the difference in energy
- ESR signal: First derivative of microwave power under the magnetic field

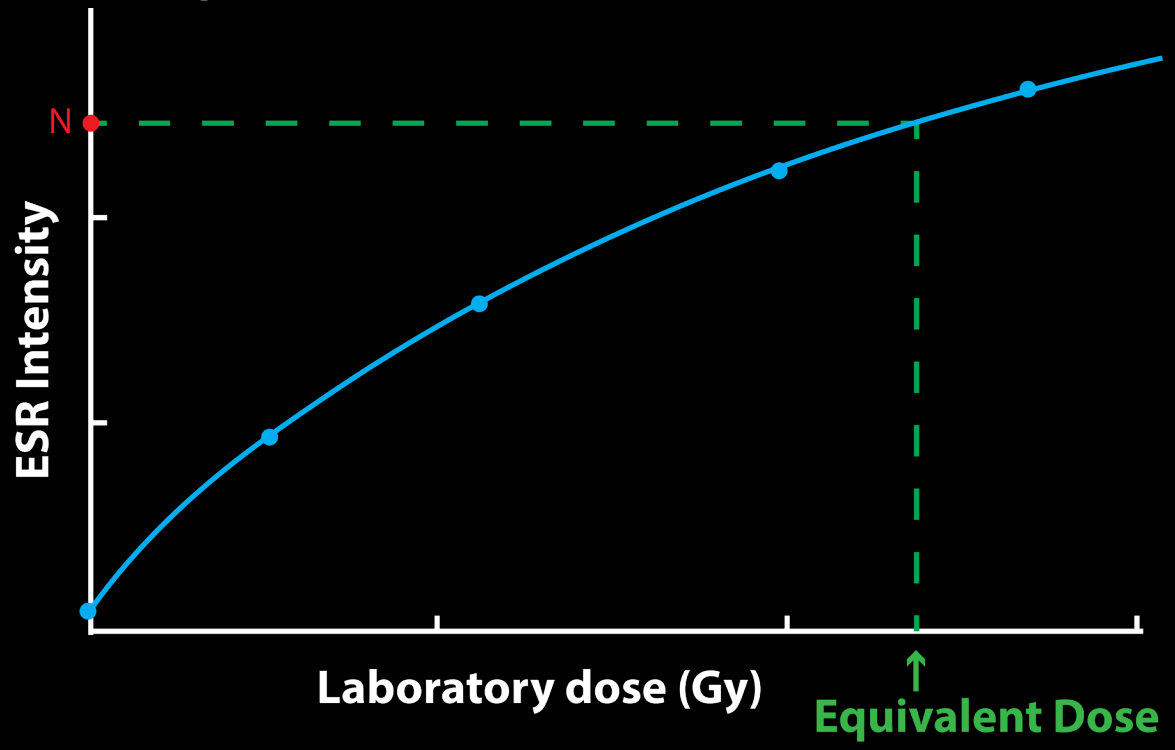
ESR Age calculation

$$Age = \frac{D_e}{\dot{D}}$$

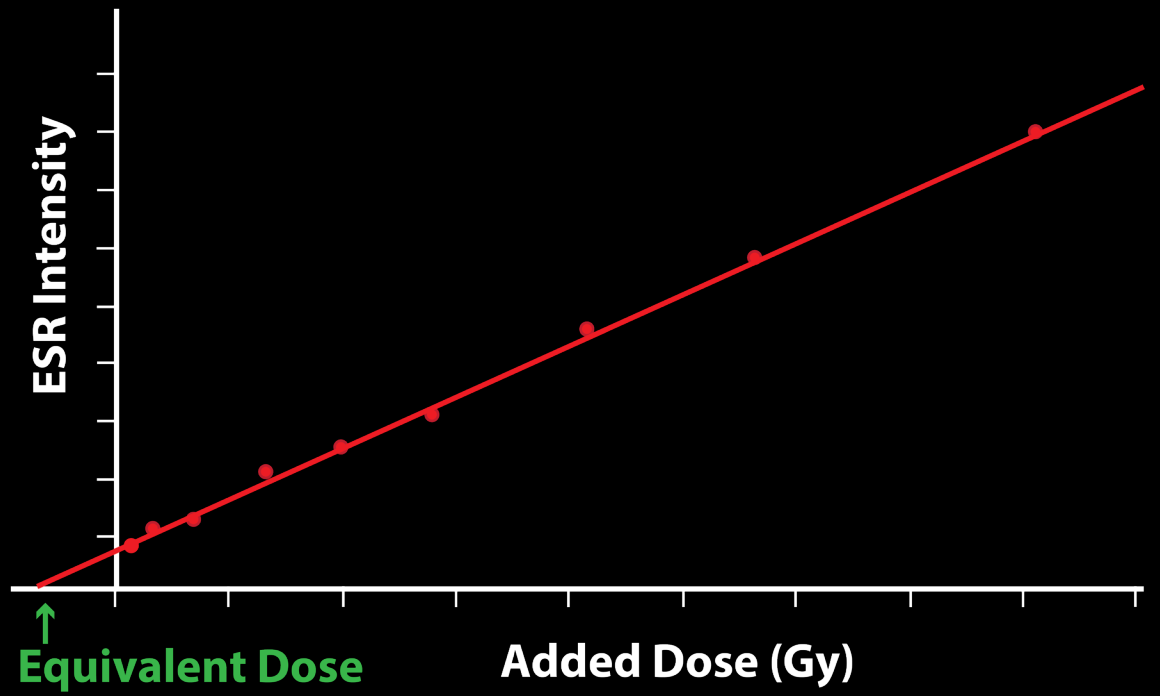
D_e Equivalent dose

$\dot{D}$ Dose rate

1. Regenerative



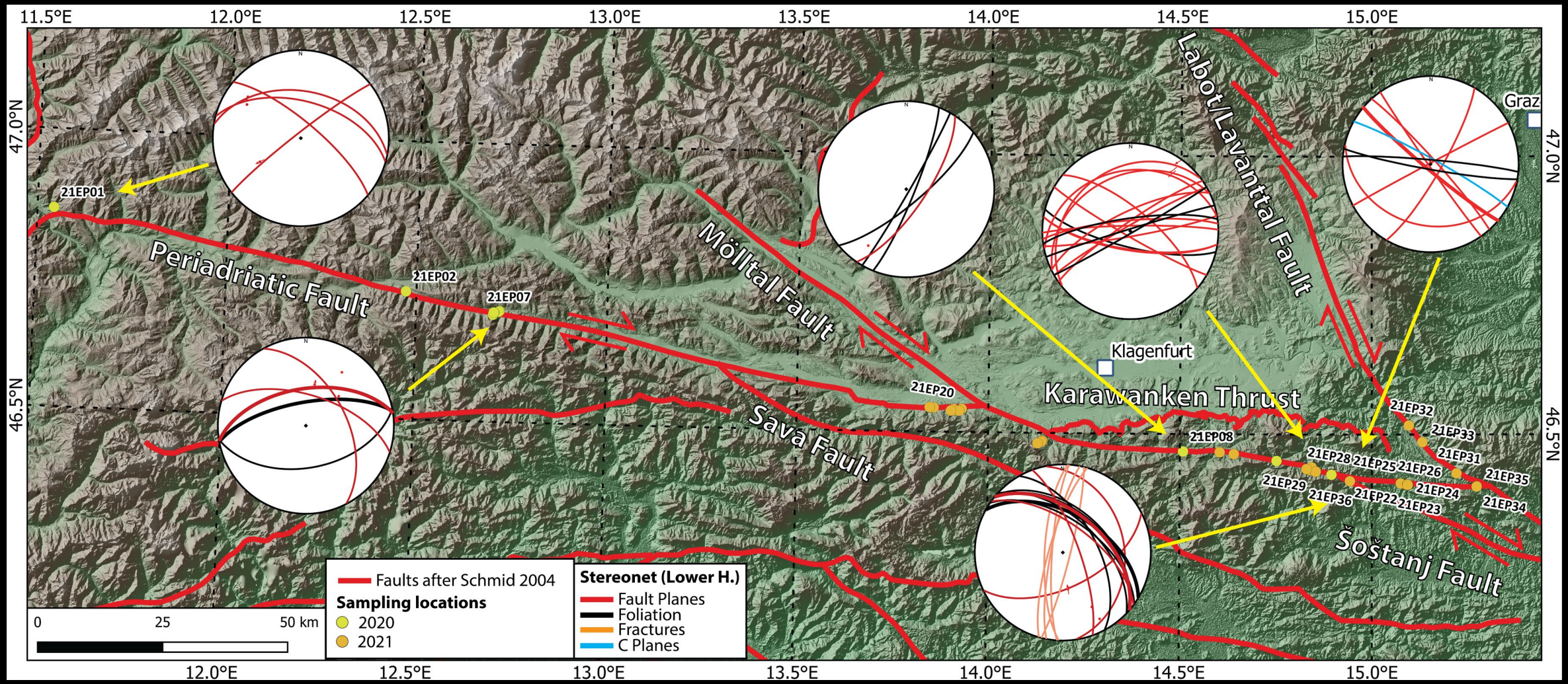
2. Additive



Modified after Tsukamoto, Tagami & Zwingmann, 2020

erick.prince@uni-jena.de

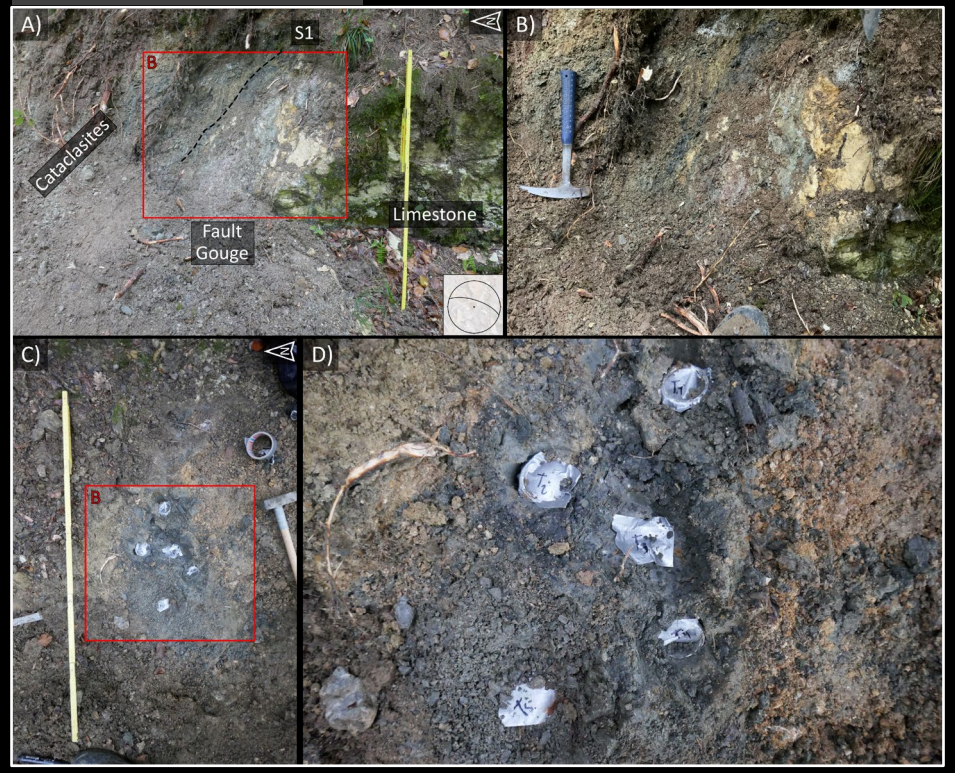
Fieldwork

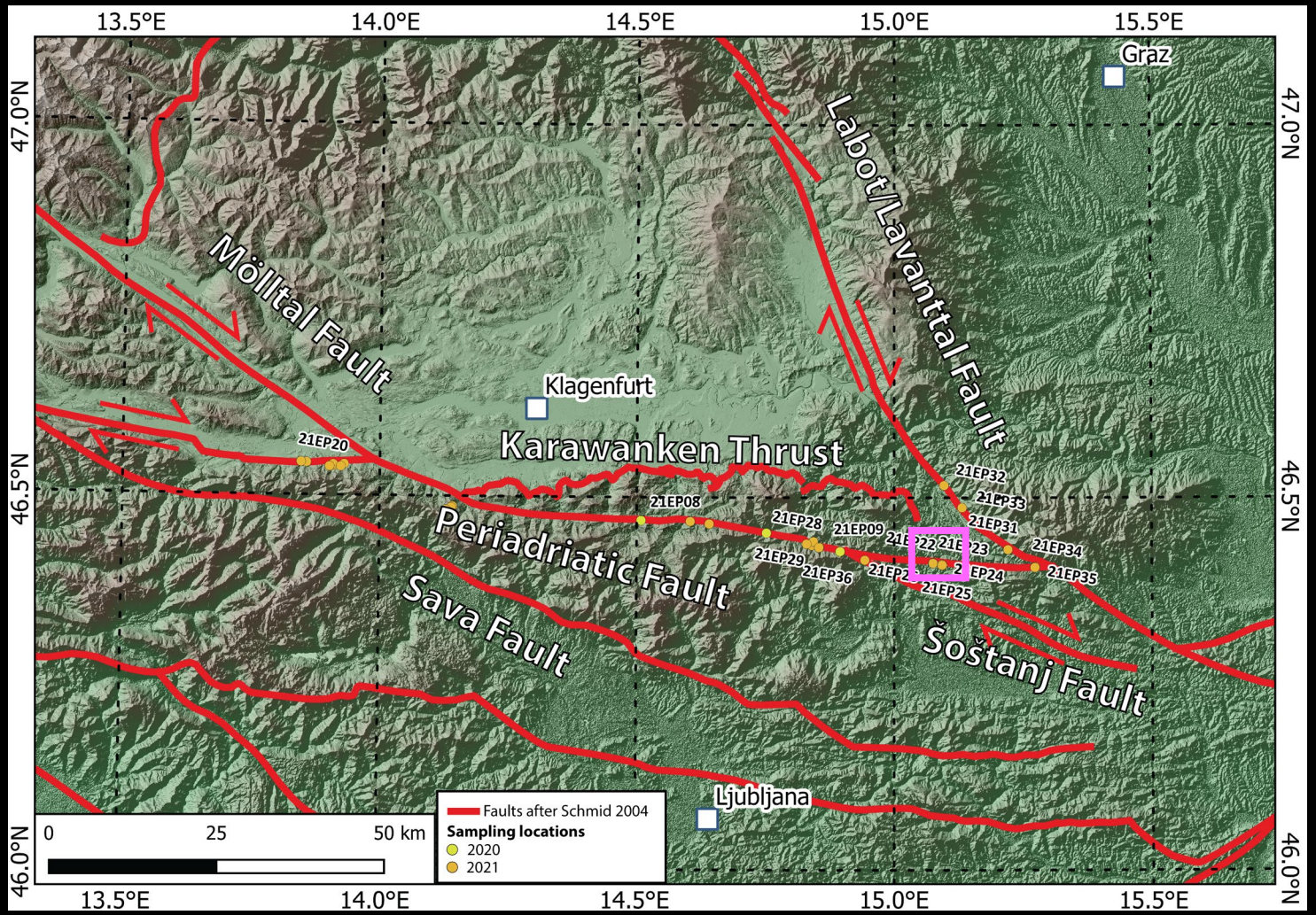

11.5°E
12.0°E
12.5°E
13.0°E
13.5°E
14.0°E
14.5°E
15.0°E
47.0°N
46.5°N
21EP01
21EP02
21EP07
21EP20
21EP08
21EP32
21EP33
21EP31
21EP28
21EP25
21EP26
21EP35
21EP29
21EP36
21EP22
21EP24
21EP23
21EP34
Periadriatic Fault
Möll tal Fault
Sava Fault
Labot/Lavanttal Fault
Karawanken Thrust
Šoštanj Fault
Graz
Klagenfurt
Faults after Schmid 2004
Sampling locations
2020
2021
Stereonet (Lower H.)
Fault Planes
Foliation
Fractures
C Planes
0
25
50 km

Fieldwork: Gouges along the PAF

10 Localities

Ravne, Slovenia



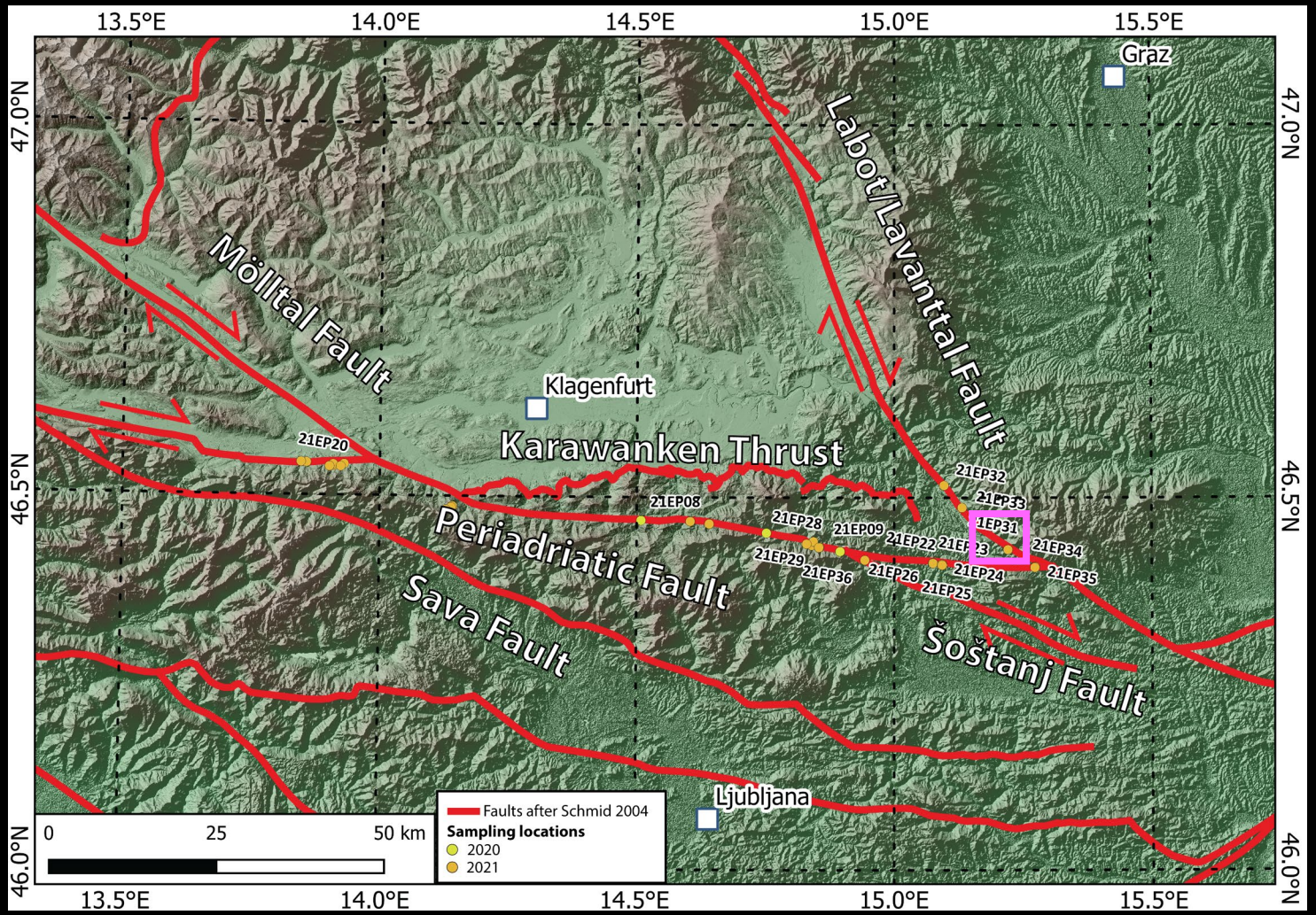


erick.prince@uni-jena.de

Fieldwork: Lavanttal Fault

4 Localities

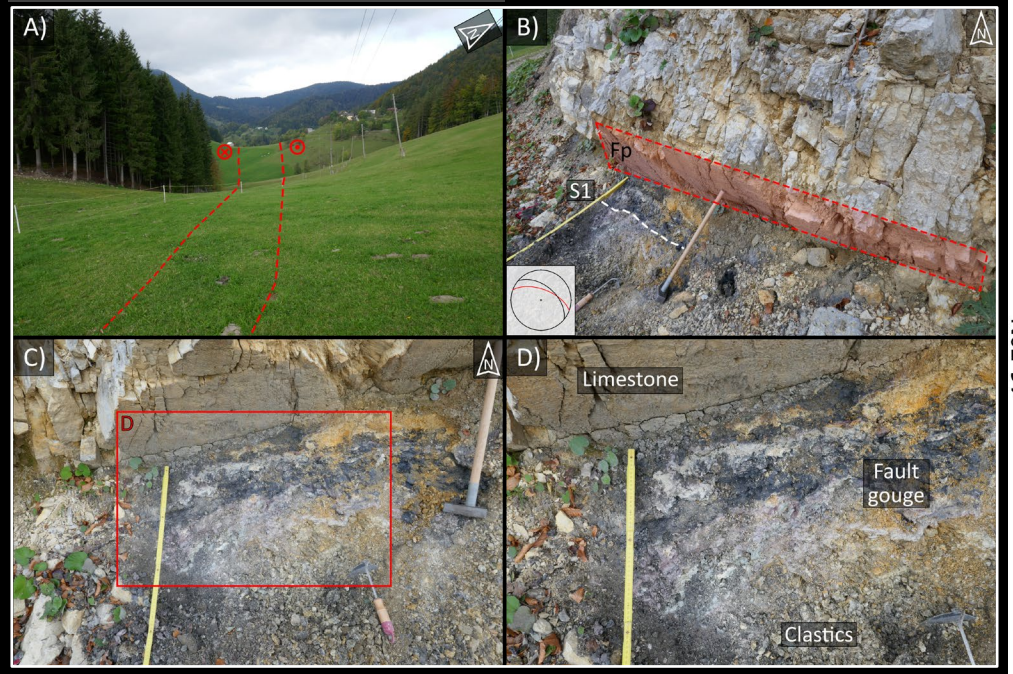
SE Mislinja, Slovenia

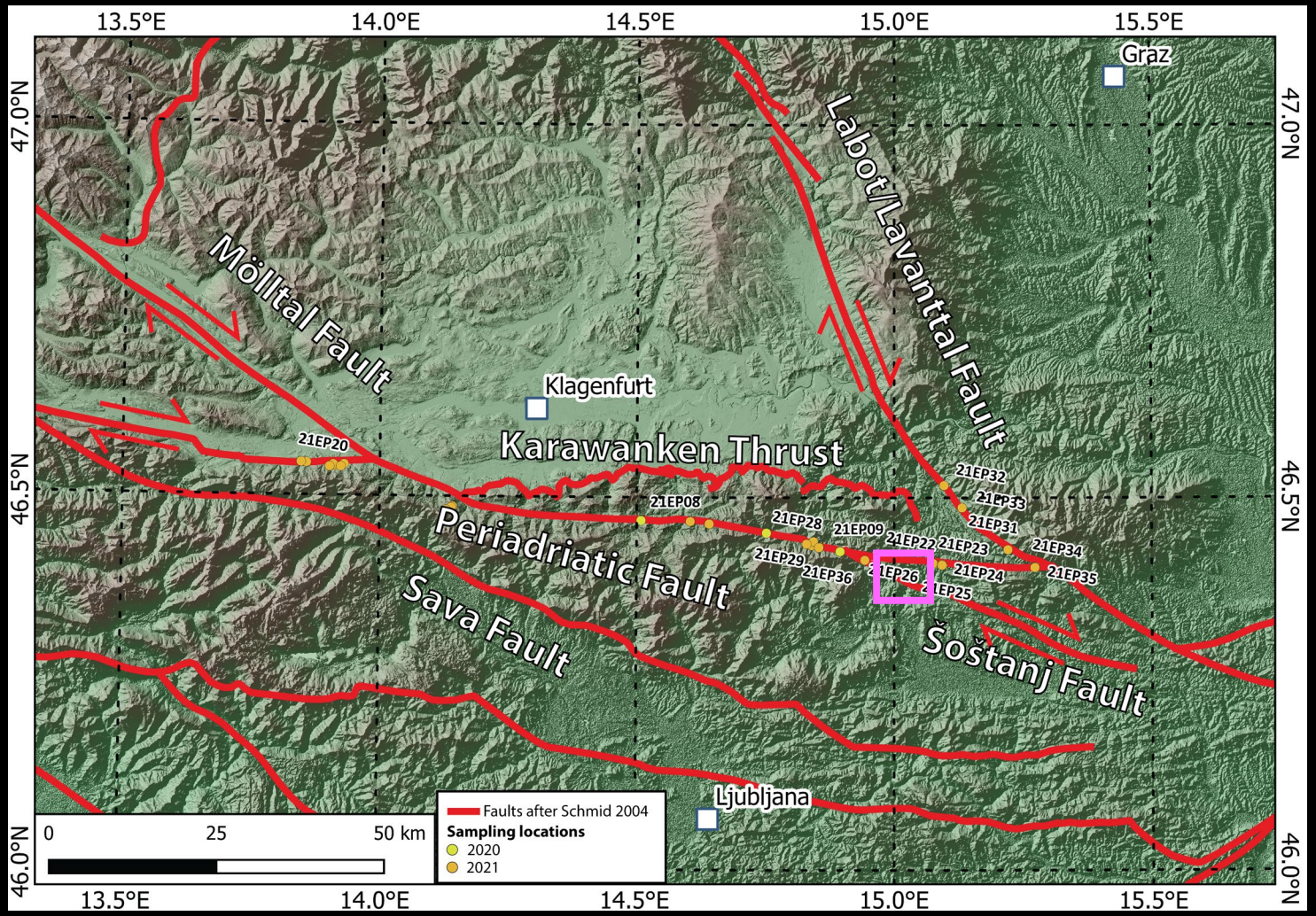


Fieldwork: Šoštanj Fault

1 Locality

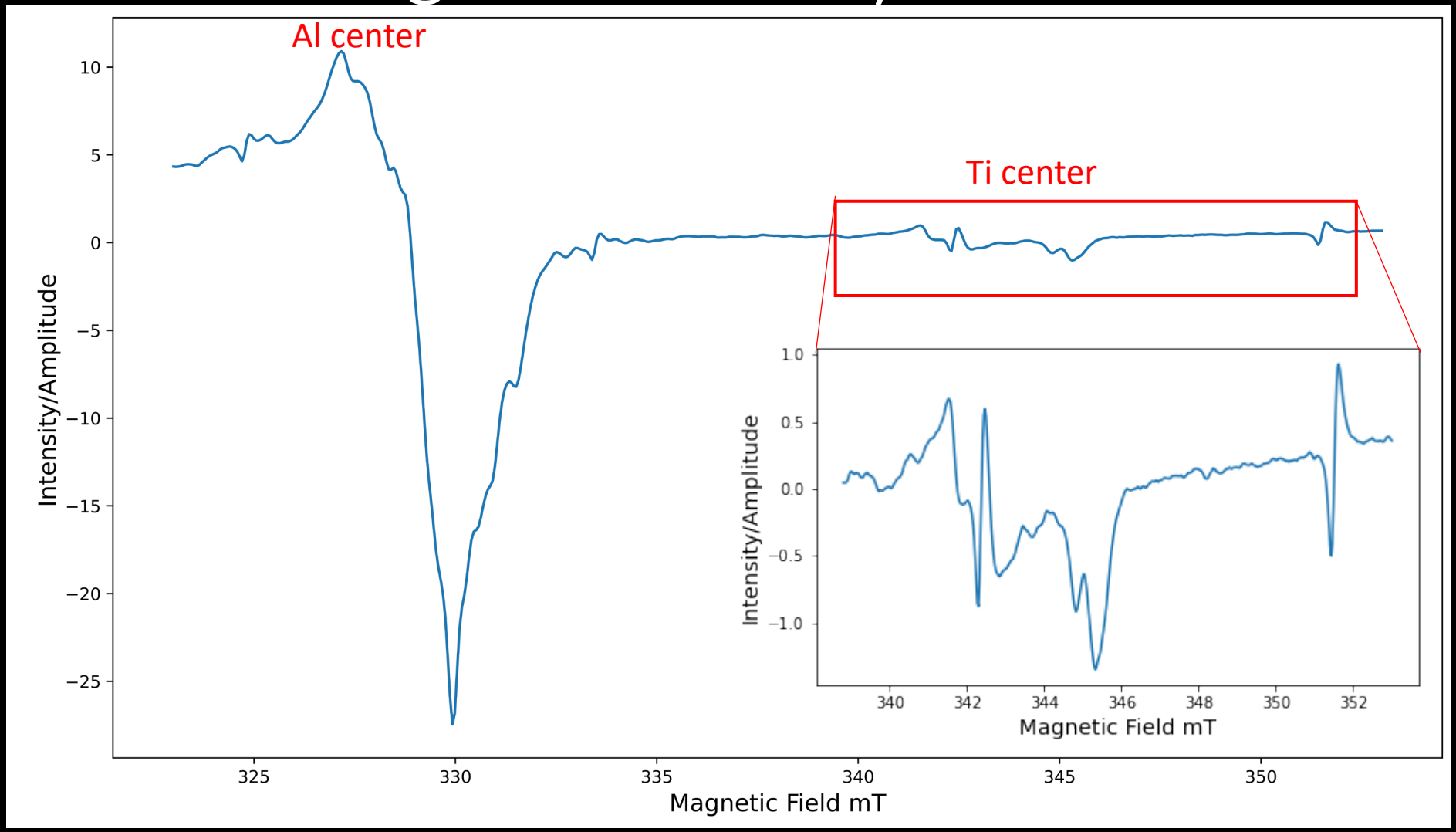
Bele Vode, Slovenia





erick.prince@uni-jena.de

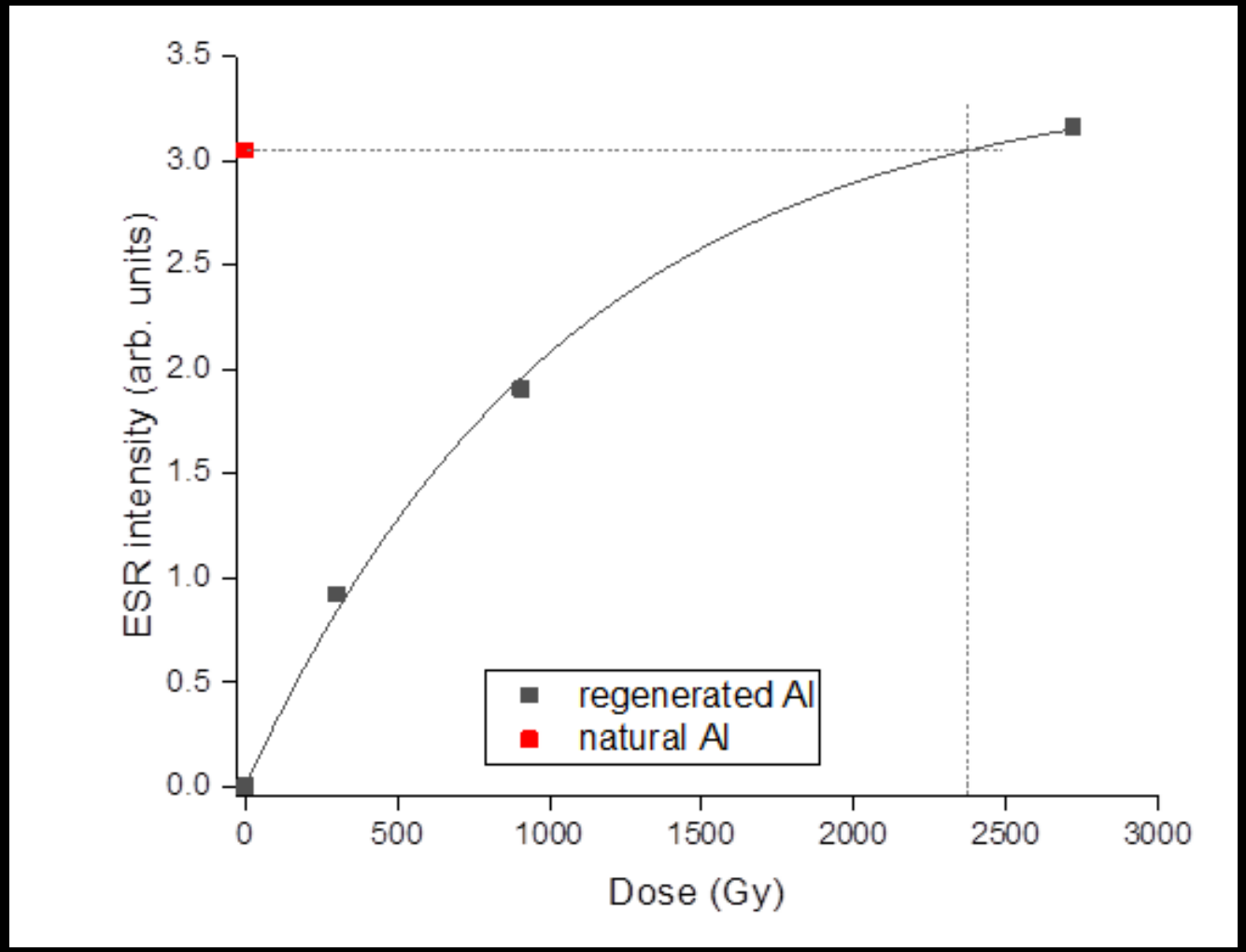
ESR Dating: Preliminary Results



Natural ESR spectra from Finkenstein locality

erick.prince@uni-jena.de

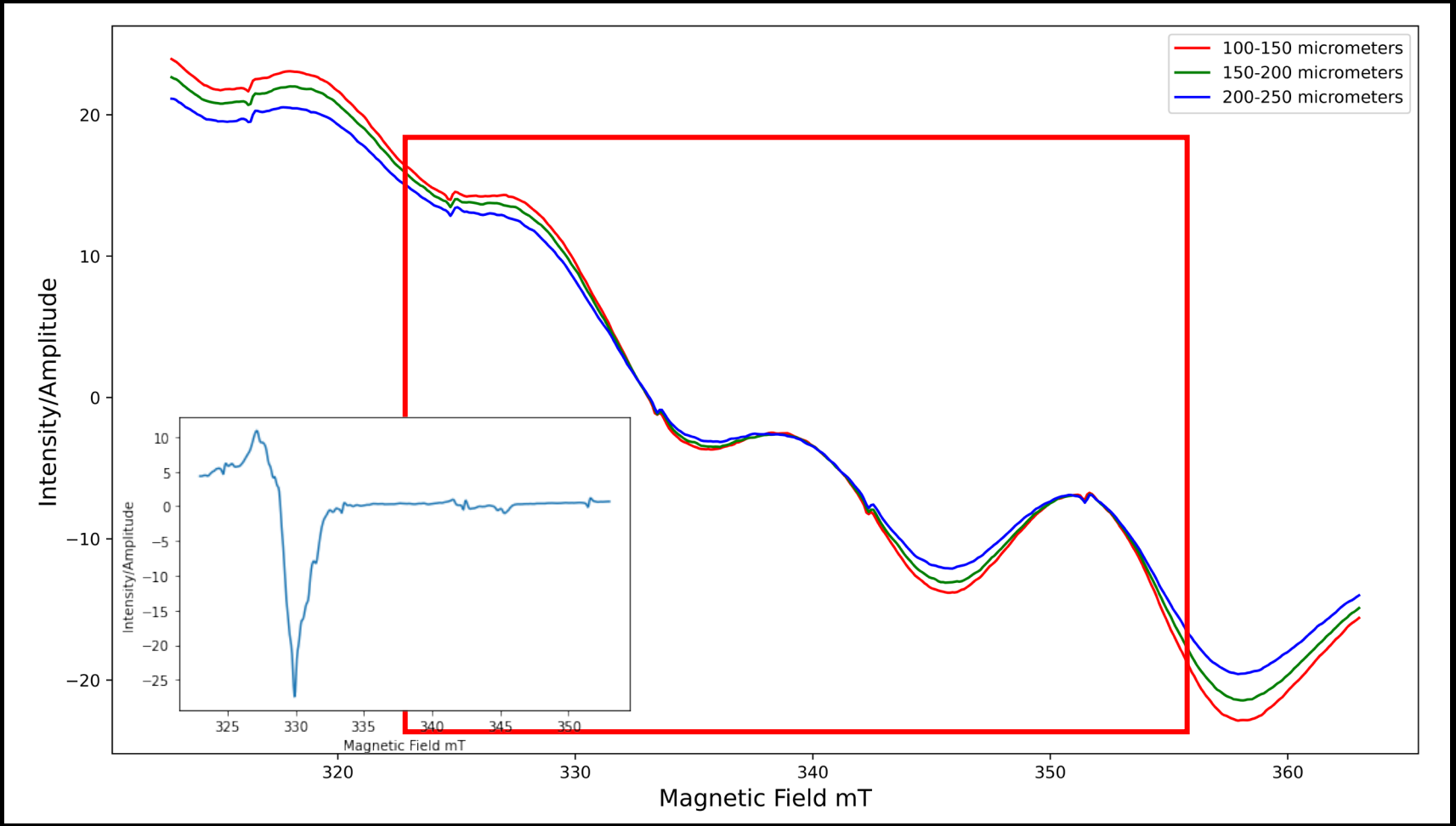
ESR Dating: Preliminary Results



Equivalent dose for Al Center using regenerative method: ~2400Gy

*Dose rate is needed to calculate age

ESR Dating: Preliminary Results



Natural ESR spectra from Kartitsch locality

Strong Fe contamination overprints Al and Ti centers

erick.prince@uni-jena.de

Summary

- Seismic activity during the Quaternary is likely along the eastern PAF
  - Analysis of the rest of the samples is needed
  - Ages can be obtained after calculating the dose rates via gamma ray spectroscopy
- Fe contamination could be present in more samples
  - Find a way to lessen effects of Fe in ESR spectra
- More sampling localities, especially along the Šoštanj fault, are still considered as future targets