Universität Münster

dbMISS Final Project Report:

Frequency-dependent attenuation in western Germany

Nasim Karamzadeh, Christine Thomas, Rafael Abreu

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Die Landesregierung Nordrhein-Westfalen

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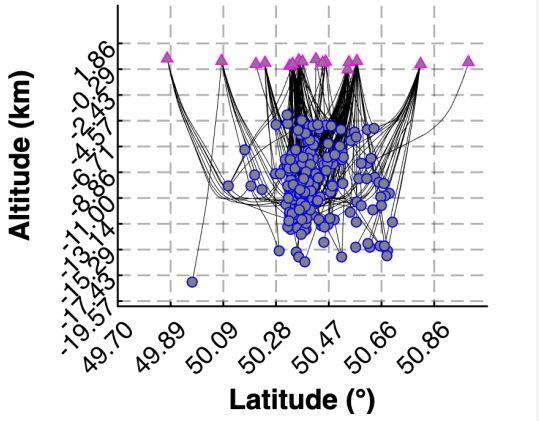
Core questions?

What are the characteristics of seismic attenuation in NRW and adjacent areas?

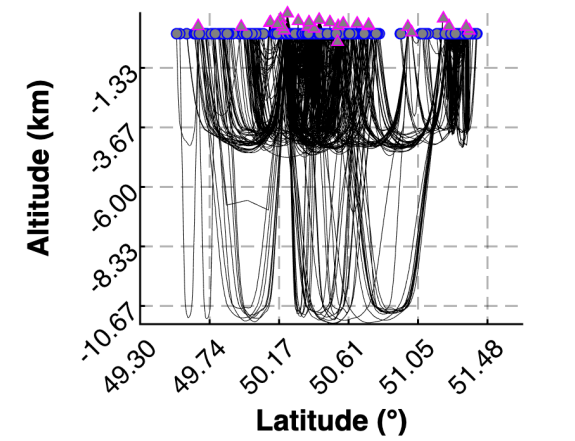
How does attenuation in the shallow crust differ from that along deeper crustal paths?

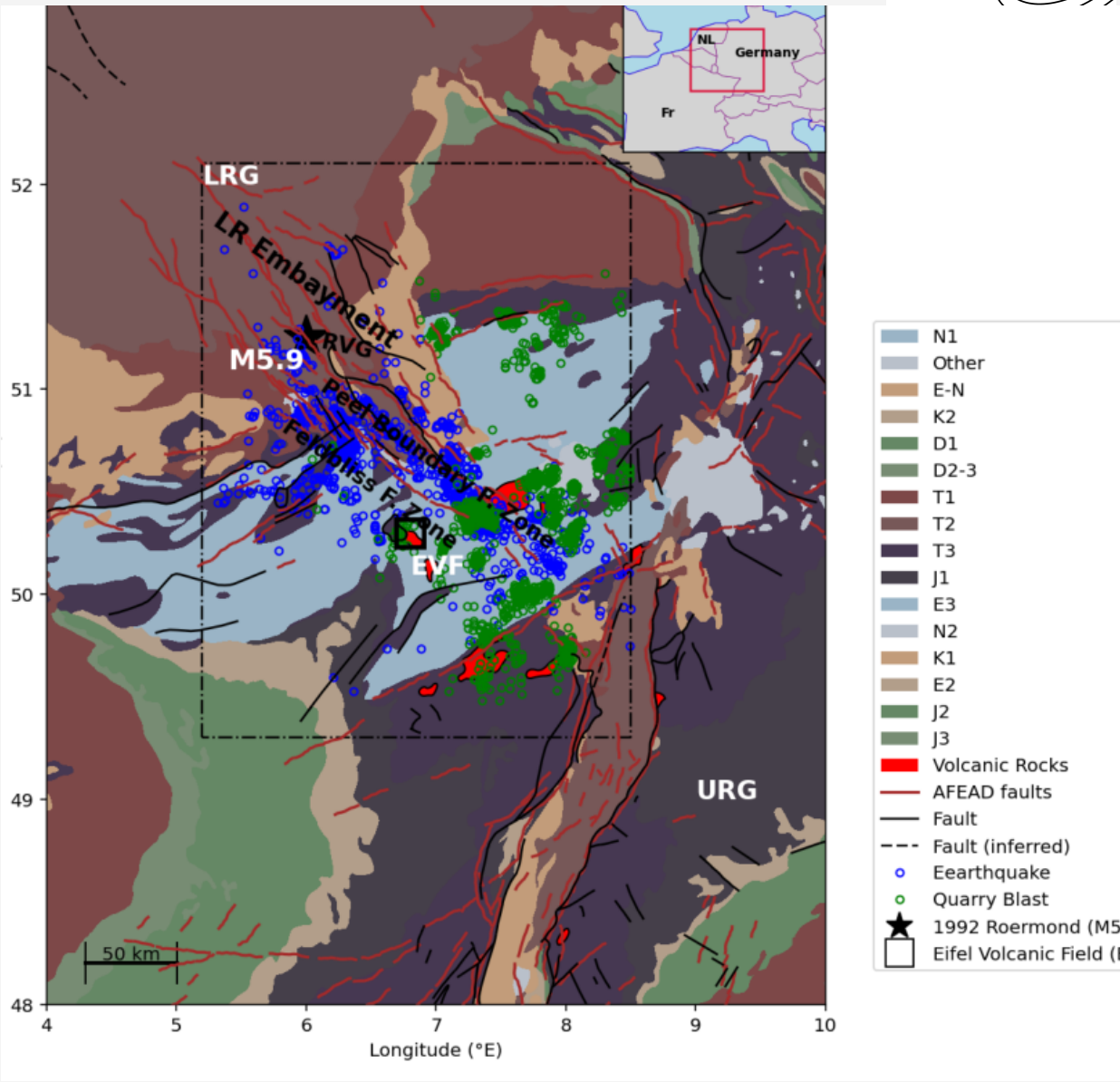
Natural depth contrast between two source classes

Earthquakes: deeper paths

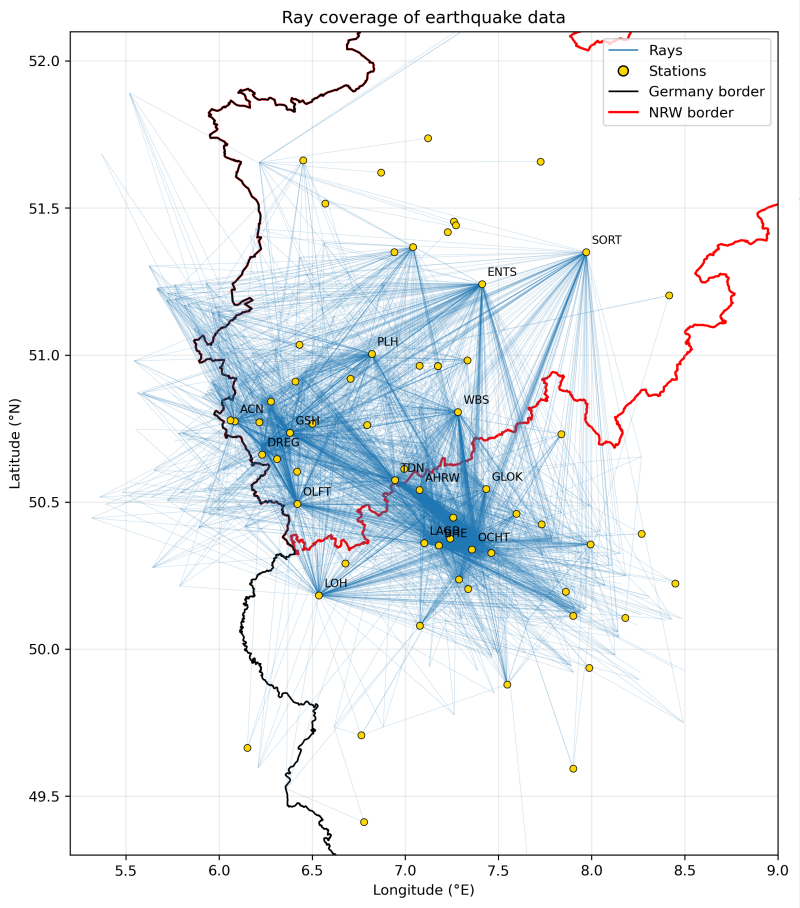


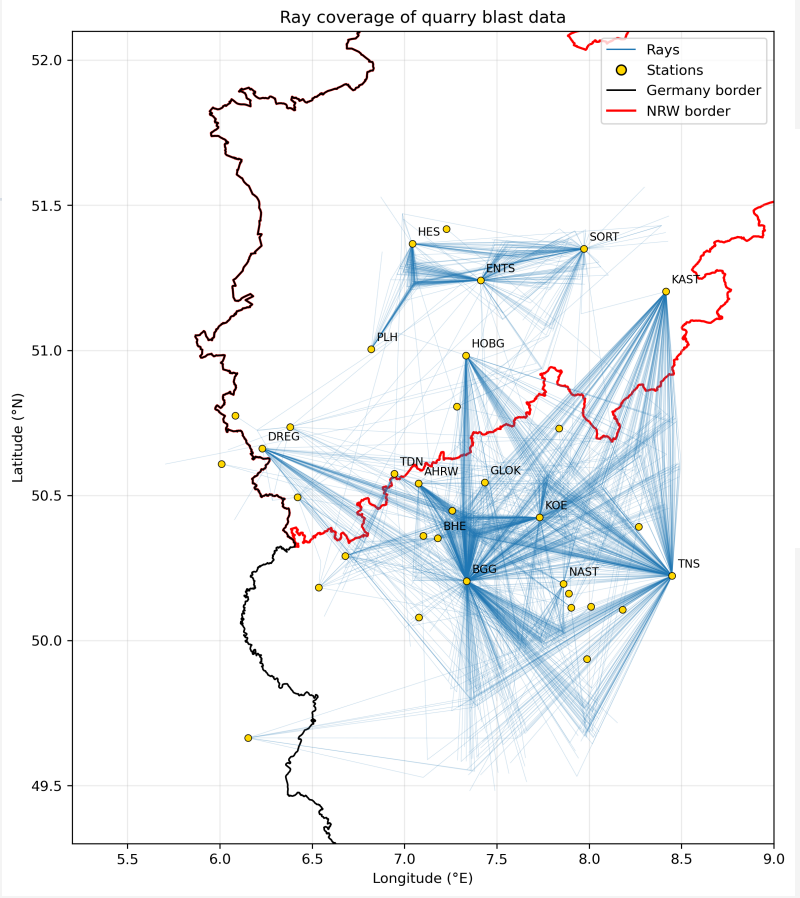
Quarry blasts: shallow crust

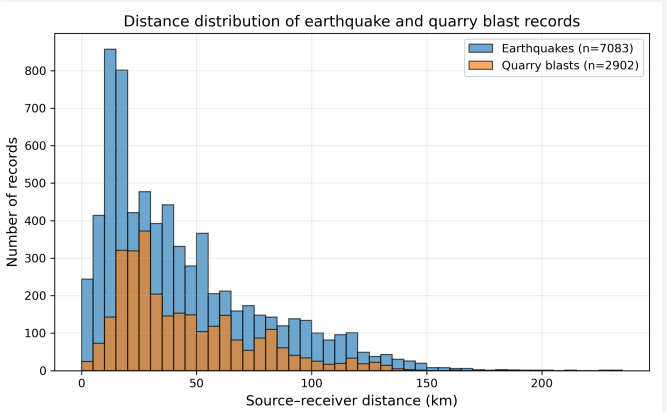


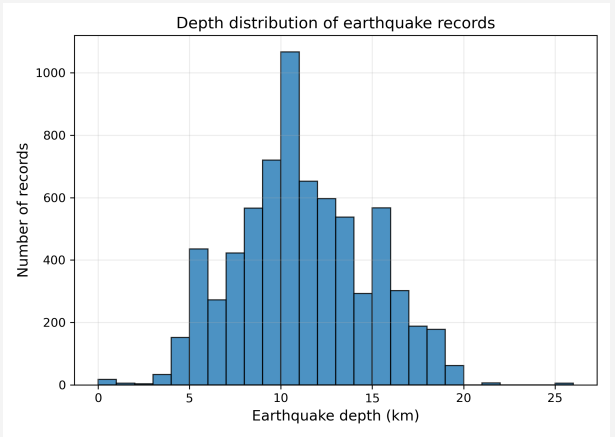


Data: Ray coverage and statistics









Final input after QC

Quality control: P/S picks, SNR, stable envelope and coda measurements

1,562 local earthquakes: 14,166 horizontal-component traces
1,627 quarry blasts: 5,804 horizontal-component traces
Networks: GD, RN, FloodRisk and Bensberg blast catalog

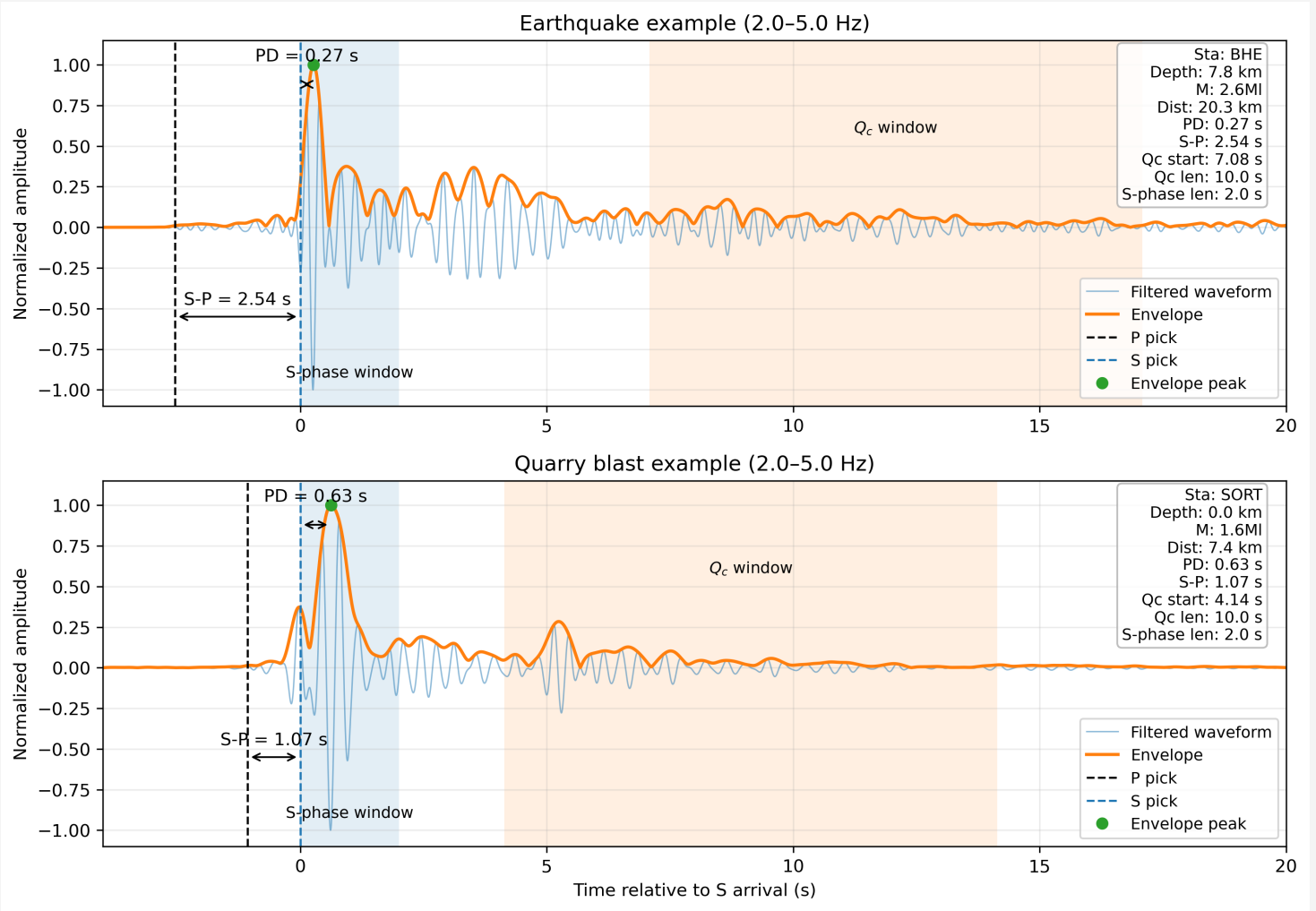
Method

MuRAT(De Siena et al. 2014) processing for both source classes

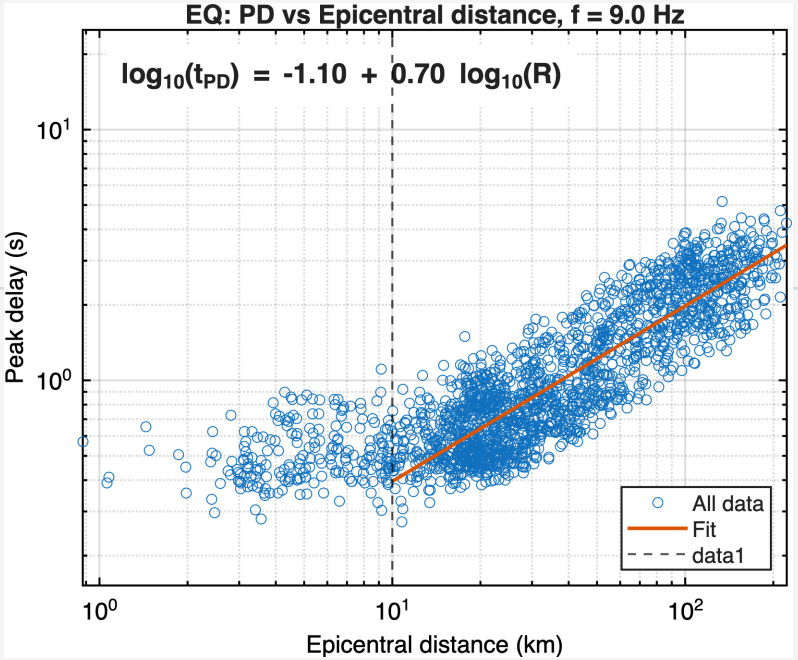
Three complementary observables

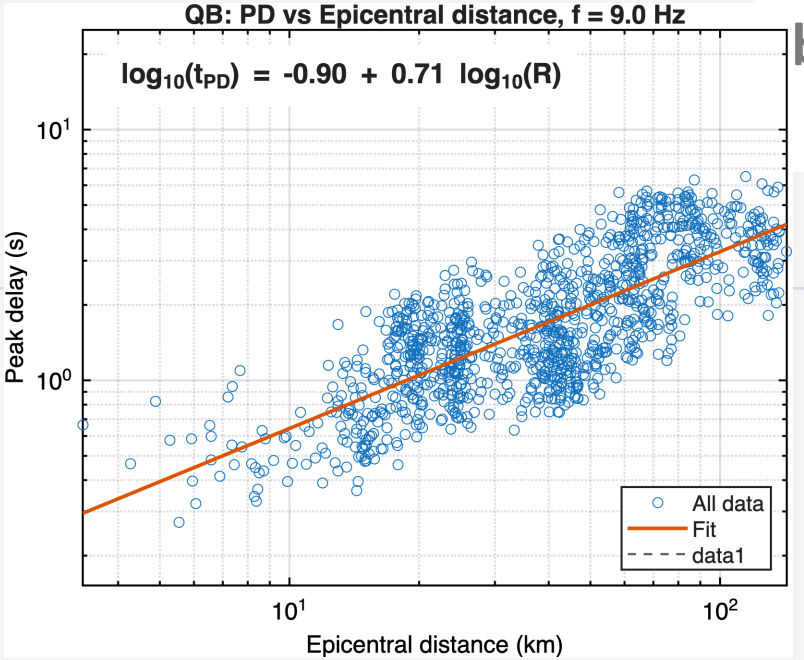
- **PD: waveform broadening / scattering**
- **QCN: direct S-wave attenuation**
- **Qc: coda-wave attenuation**

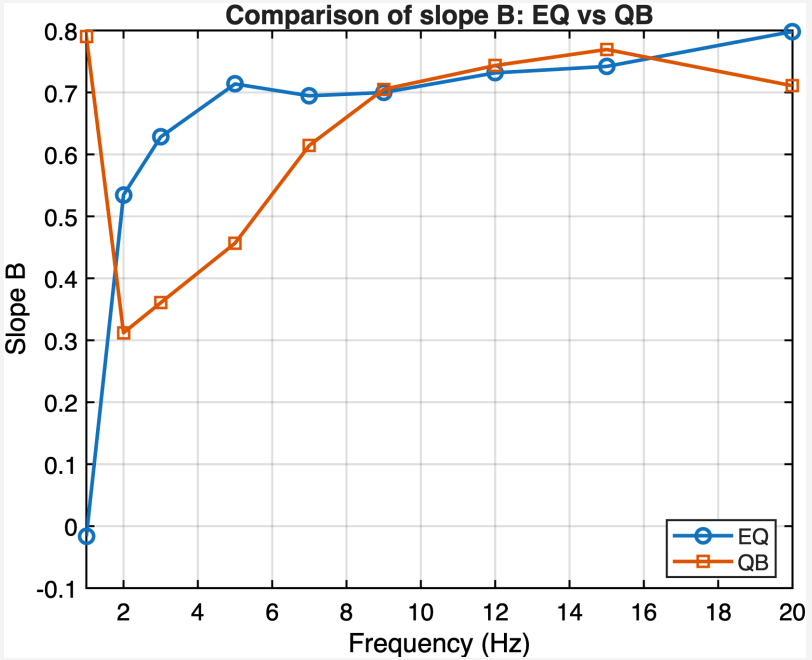
Common frequency bands:
1, 2, 3, 5, 7, 9, 12, 15, 20 Hz

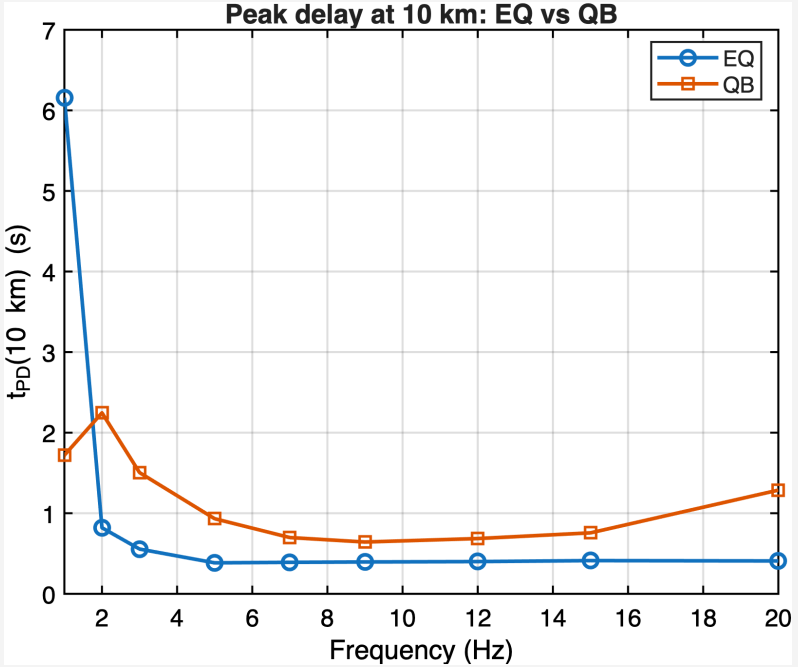


Results
Peak-delay behavior





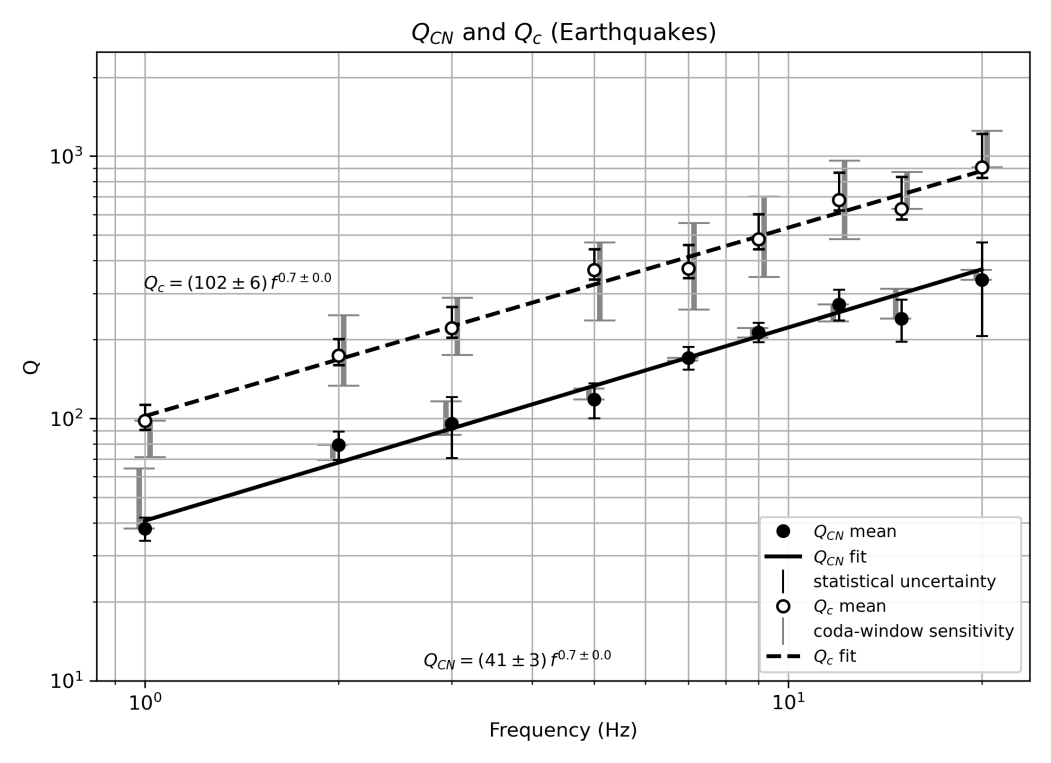


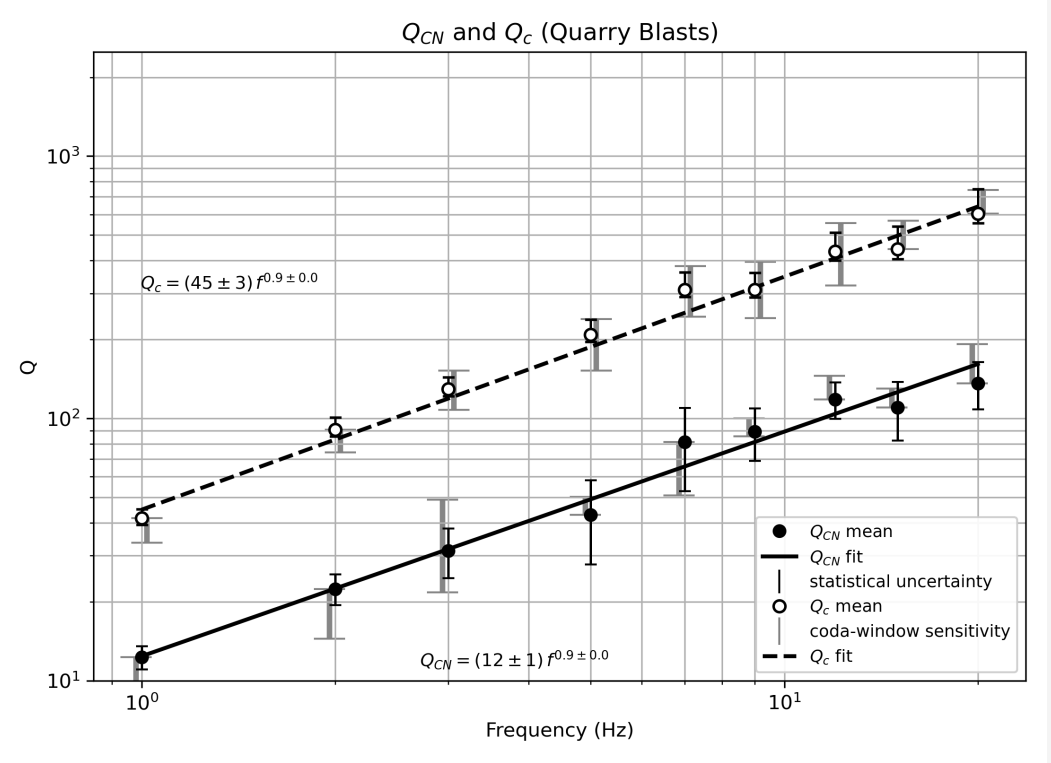


Quarry blasts generally show larger peak delays, indicating stronger shallow-crustal waveform broadening

Results: Frequency-dependent attenuation

Both source classes show frequency-dependent attenuation, but quarry blasts are systematically more attenuated





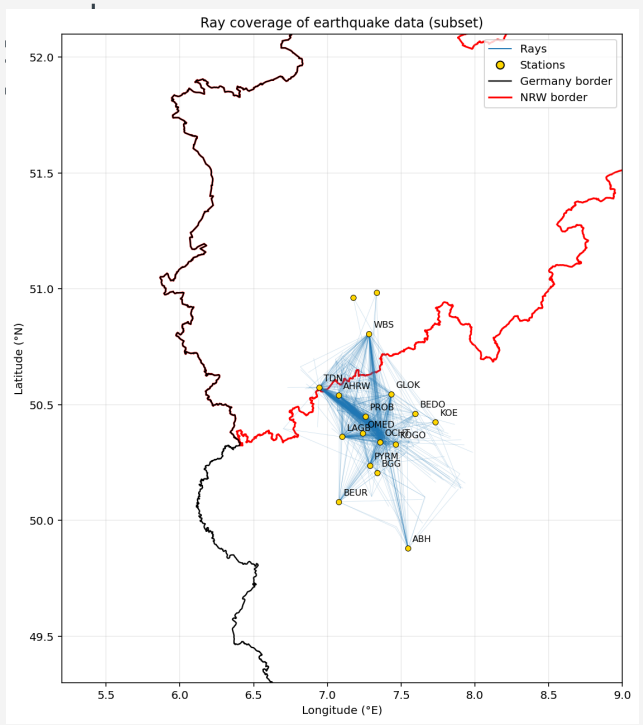
Power-law fits

Earthquakes

QCN(f) = (41+/-3) f^0.7
Qc(f) = (102 +/- 6) f^ 0.7

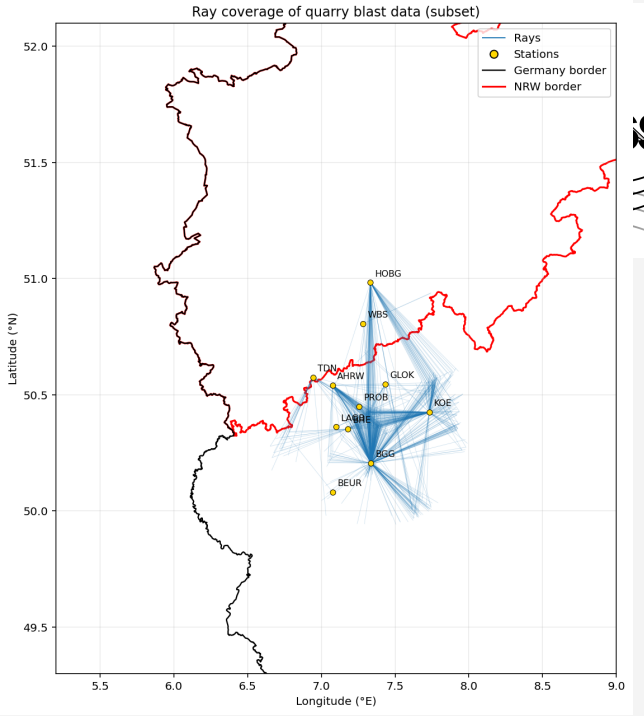
Quarry blasts

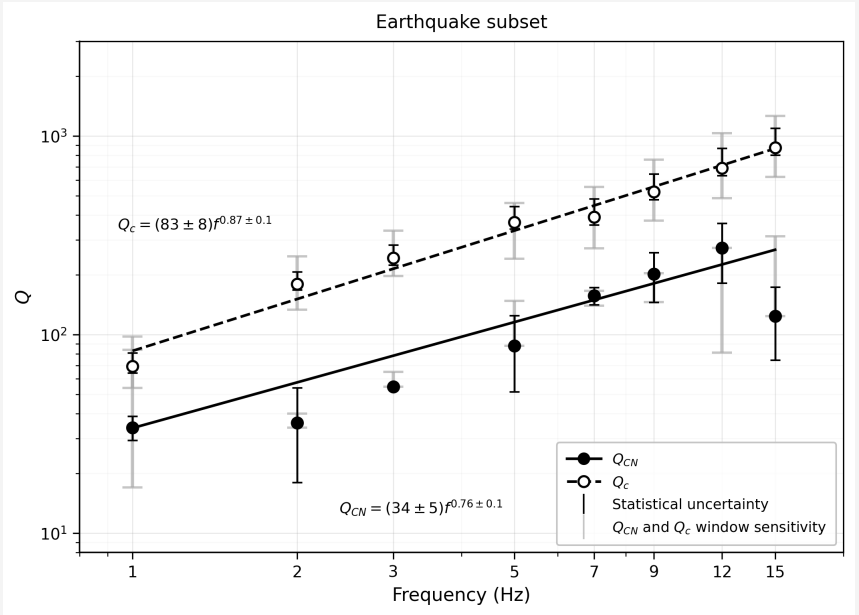
QCN(f) = (12 +/- 1) f^0.9
Qc(f) = (45+/-3) f^0.9

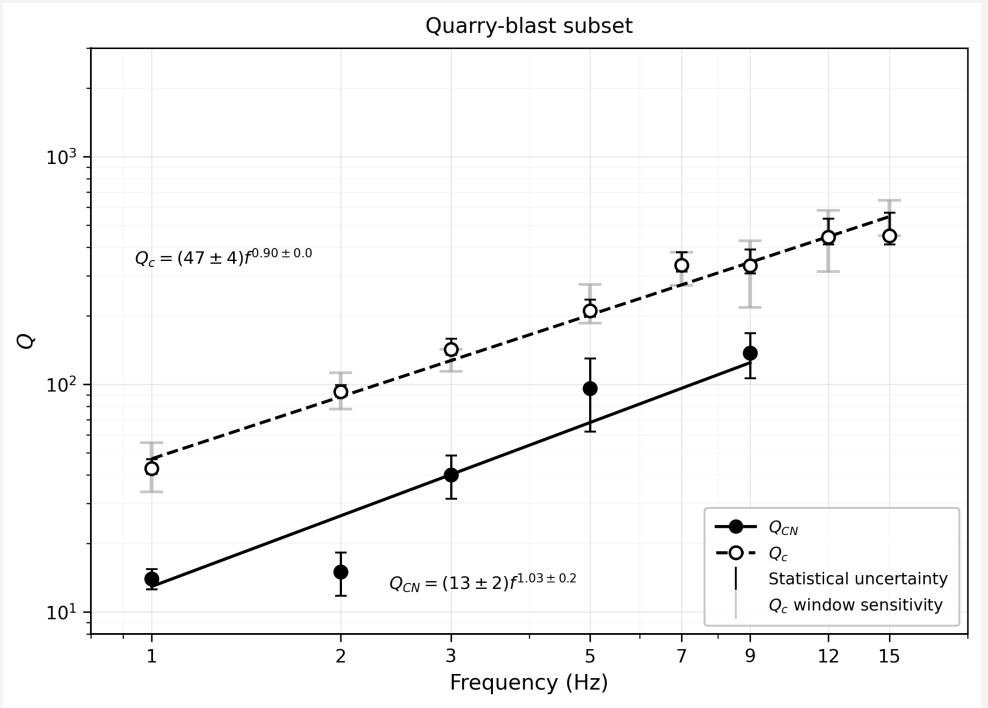


Does lateral ray coverage explain the EQ–QB contrast?

The EQ–QB attenuation contrast persists after reducing differences in lateral ray coverage







Summary of results

* Different crustal depths sampled
* Consistent EQ–QB contrast
  Quarry blasts show larger peak delays and lower QCN and QC than earthquakes.
* Clear frequency dependence
  Both QCN and Qc increase with frequency for both sources

* Strong depth dependence of attenuation
  The shallow crust is more heterogeneous and attenuating than the deeper crust, making quarry blasts a better proxy for shallow anthropogenic sources.