

dbMISS project progress report:

Attenuation tomography in NRW

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Die Landesregierung
Nordrhein-Westfalen



Summary of the results for Q_c and $Q\text{-CN}$ (coda normalization method)

Coda-wave attenuation Q_c

Late coda waves exponential decay

scattering-dominated attenuation

Path-averaged attenuation $Q\text{-CN}$

direct S-wave amplitudes are normalized by coda-wave amplitudes measured at a fixed lapse time.

$$\ln \left[\frac{A_S(f, r) r^\alpha}{A_c(f, t_c)} \right]_{r \pm \Delta r} = -\frac{\pi f}{Q_S(f) V_S} r + \text{const}(f),$$

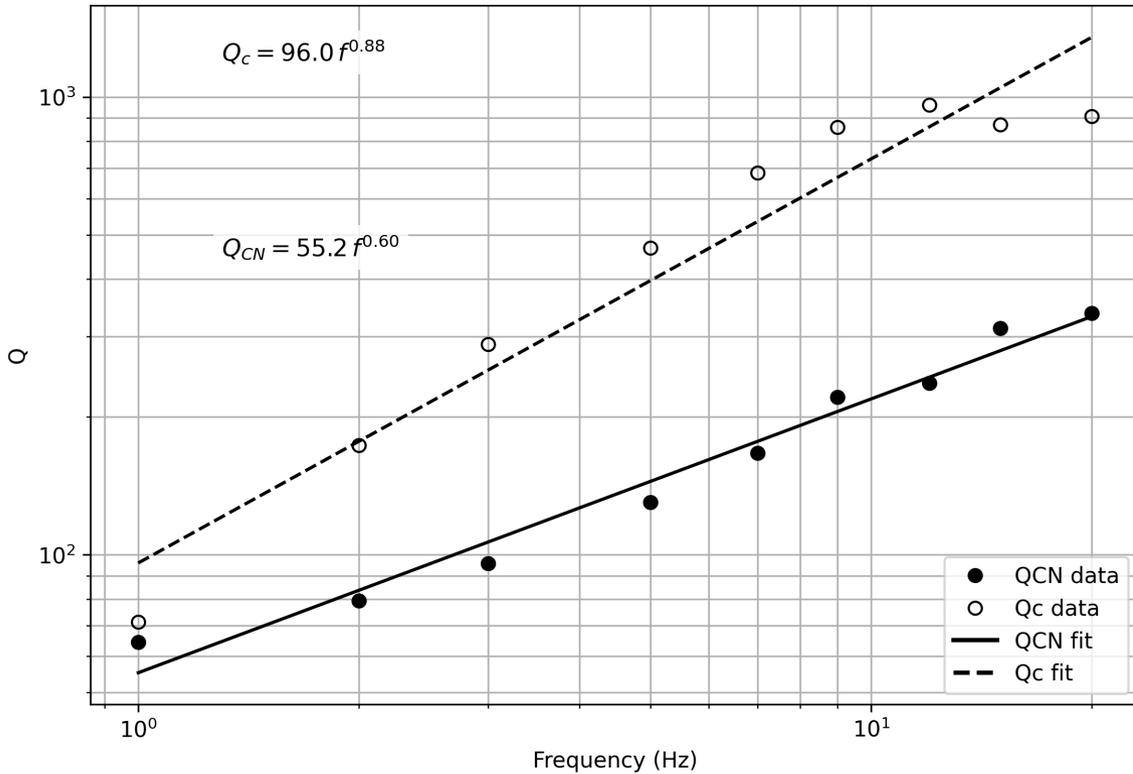
path-averaged, shallow-sensitive attenuation

Frequency-dependent optimal coda windows is selected to ensure stable and physically meaningful estimates

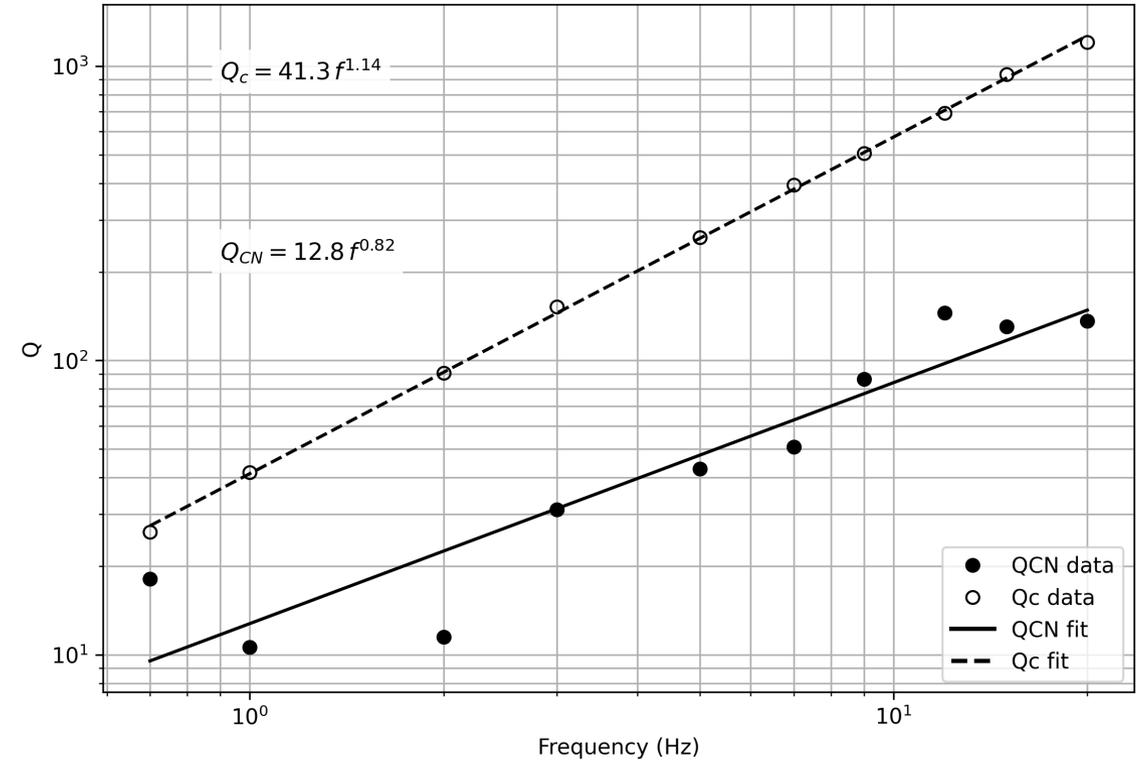
Coda wave time window: 5, 7, 10, 12, 15 second!

Summary of the results for Qc and Q-CN (coda normalization method)

Earthquakes: QCN and Qc (optimal windows)



Quarry Blasts: QCN and Qc (optimal windows)



- Frequency dependence attenuation
- All four curves follow a power-law form:

$$Q(f) = Q_0 f^n$$

- Q_c shows steeper slopes ($n = 0.9-1.0$)
 - Q_{CN} shows smaller slopes ($n = 0.6-0.8$)
- $Q_c > Q_{CN}$ at all frequencies and for both sources, (Q_c represents a more “diffusive” regime and therefore yields larger apparent Q than Q_{CN})
 - Earthquakes show higher Q than quarry blasts
 - 1- EQ: deeper source depths, longer propagation paths in consolidated crust, reduced influence of highly attenuative near-surface sediments.
 - 2- QB: Very shallow sources, strong interaction with unconsolidated sediments, enhanced intrinsic attenuation and scattering near the surface.
 - Quarry-blast attenuation provides the most realistic constraints for wind-turbine studies.

The combined behavior reflects the known geology of NRW:

- Thick sedimentary cover → strong shallow attenuation
- Faulted basin structure → strong scattering at low frequencies
- Crystalline basement → higher Q at depth

Implications:

- Q-CN is dominated by sedimentary and near-surface effects
- Qc samples deeper crustal volumes
- Quarry blasts emphasize sedimentary attenuation
- Earthquakes provide access to deeper attenuation structure

This supports a depth-dependent attenuation model for the region.