Ambient noise attenuation and velocity tomography of Love & Rayleigh waves applied to the Ramona reservation linear array across the San Jacinto Fault Zone

Xin Liu[1], Gregory Beroza[1], and Yehuda Ben-Zion[2]

[1]Stanford University
[2]USC

November 22, 2022

Abstract

Our attenuation inversion method is based on Liu et al. (2015) using linear triplet of stations Application to the dense 3C linear array crossing the San Jacinto Fault in Ramona, CA Clear fundamental mode Rayleigh and Love wave phases are extracted Attenuation tomography maps reveal new information in addition to velocity tomography Shear velocity radial anisotropy and possible shear attenuation anisotropy

Ambient noise attenuation tomography of Love & Rayleigh waves applied to the Ramona reservation linear array across the San Jacinto Fault Zone

Xin Liu[1], Gregory C. Beroza[1] and Yehuda Ben-Zion[2]

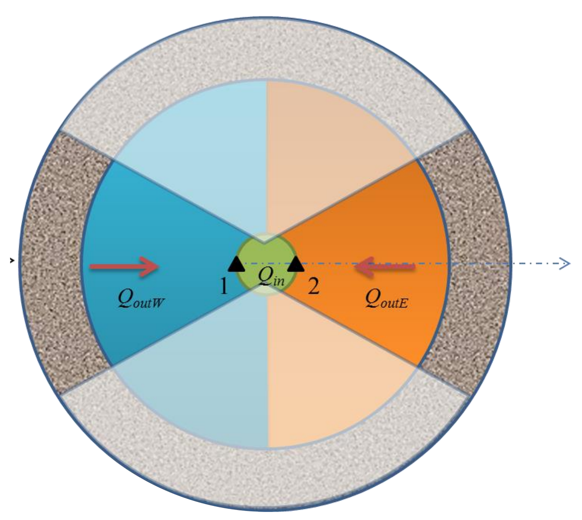
1. Stanford University ; 2. University of Southern California

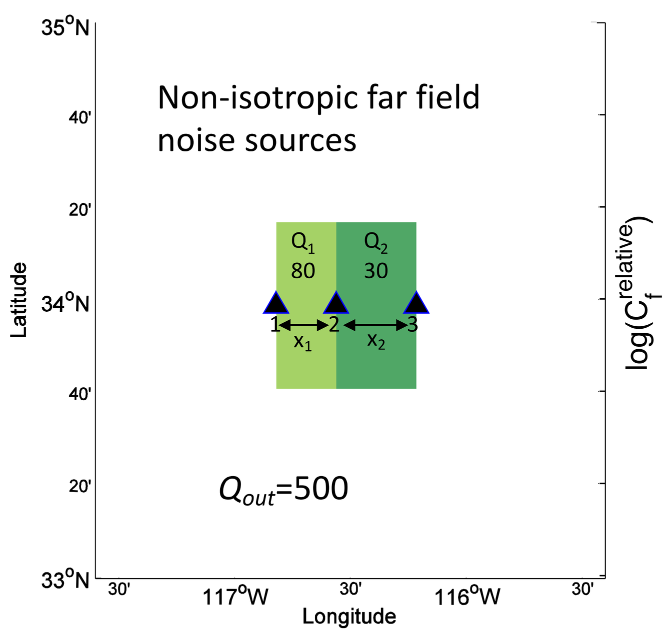
liuxin@stanford.edu
web.stanford.edu/~liuxin

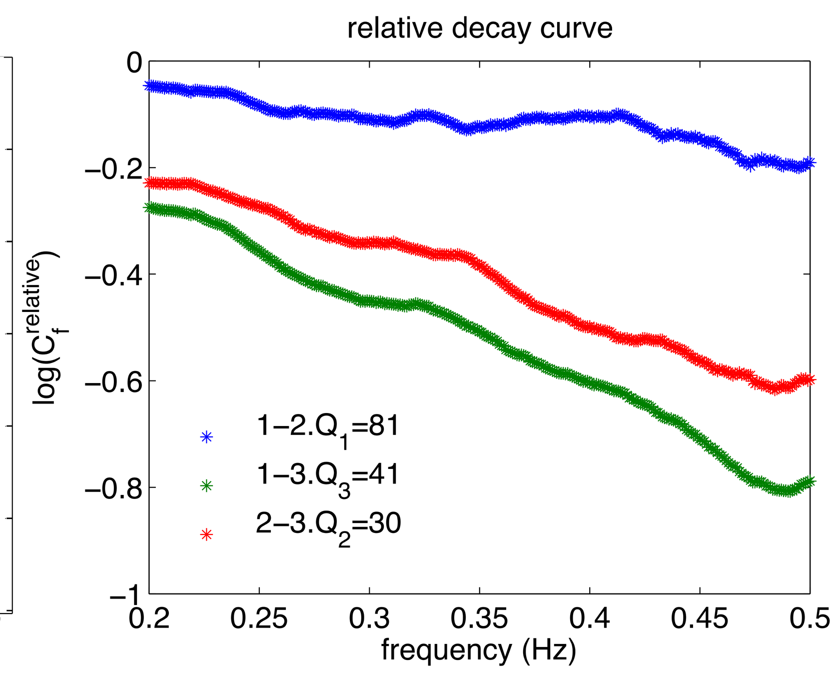
Summary

- Our attenuation inversion method is based on Liu et al. (2015) using linear triplet of stations
- Application to the dense 3C linear array crossing the San Jacinto Fault in Ramona, CA
  - Fundamental mode Rayleigh and Love wave phases
  - Attenuation tomography maps reveal new information in addition to velocity tomography
  - Shear velocity radial anisotropy and possible shear attenuation anisotropy

Theory: linear triplet of stations & amplitude ratios

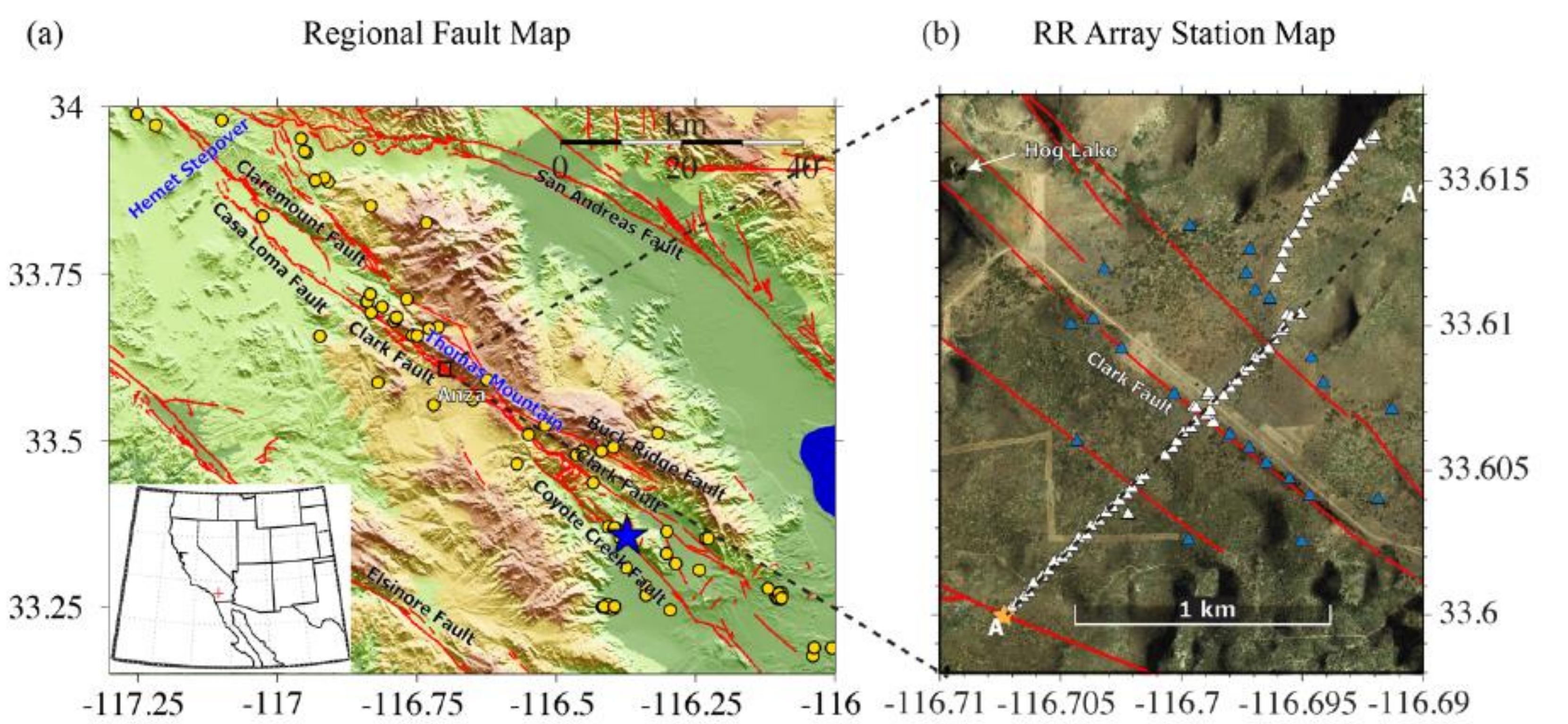






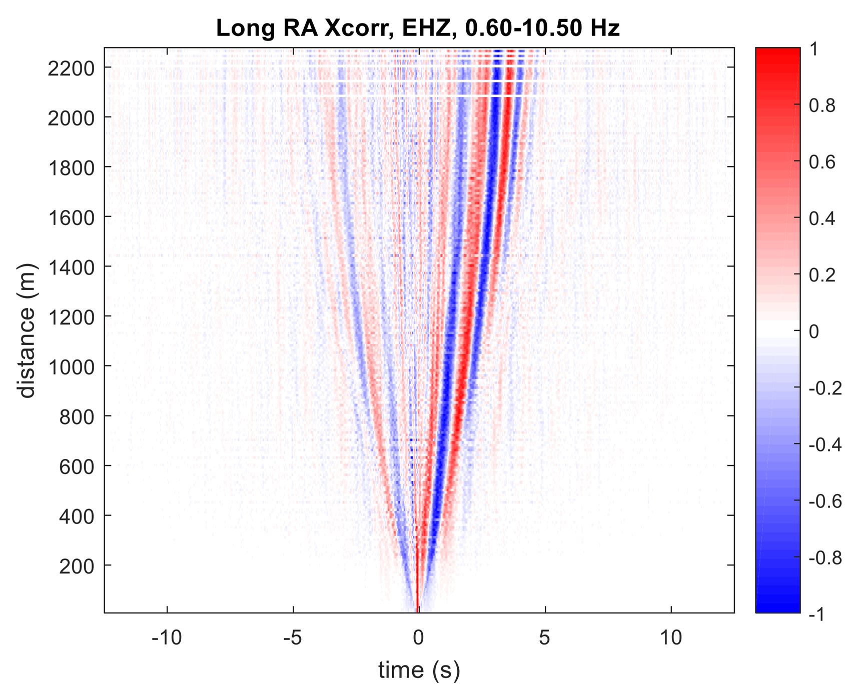
- Stationary phase zone
- Forward model: linear triplet of stations and different Q values
- Inversion: take log of amplitude ratios and apply linear regression for Q

Linear Ramona array and San Jacinto Fault (Clark Fault)

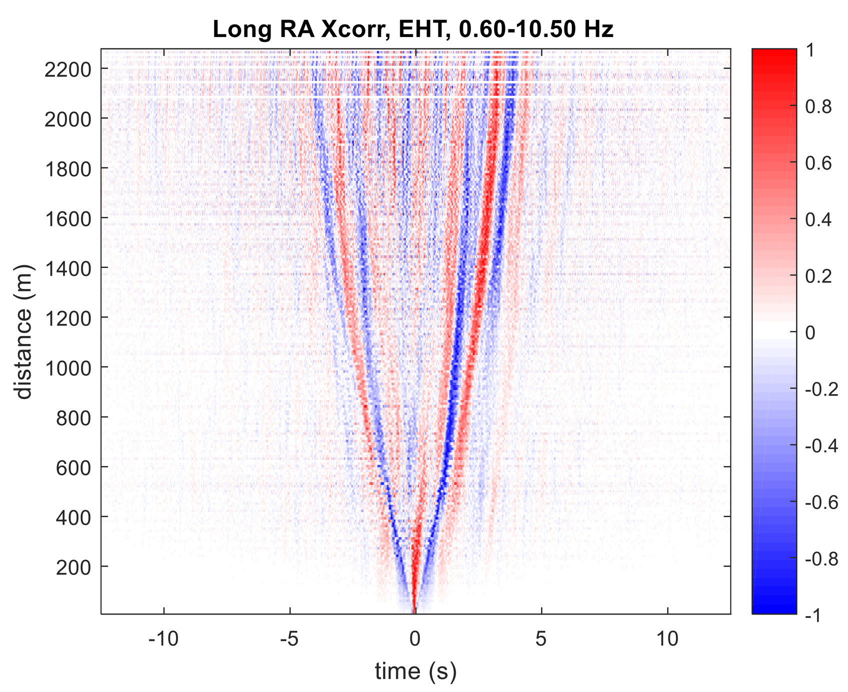


Map from Wang et al., 2020

ZZ component: Rayleigh wave

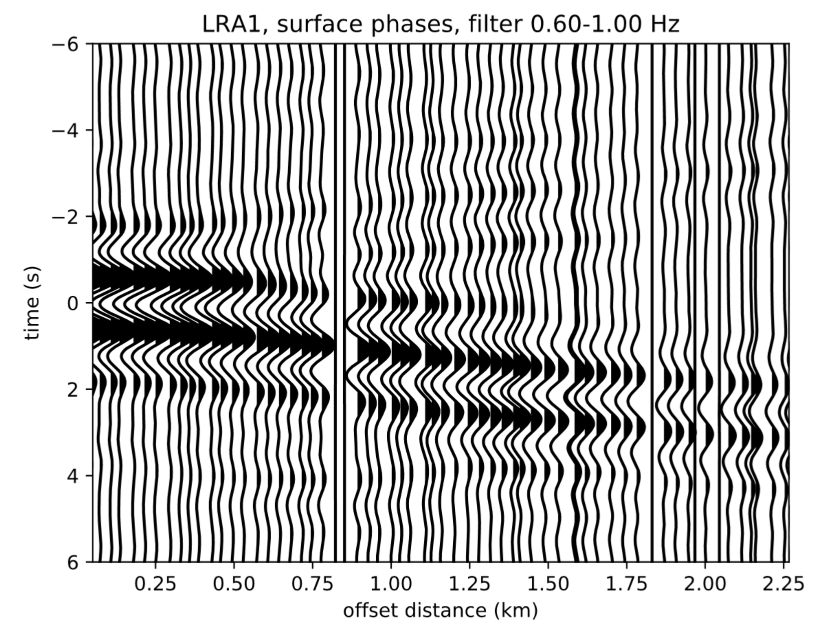


TT component: Love wave

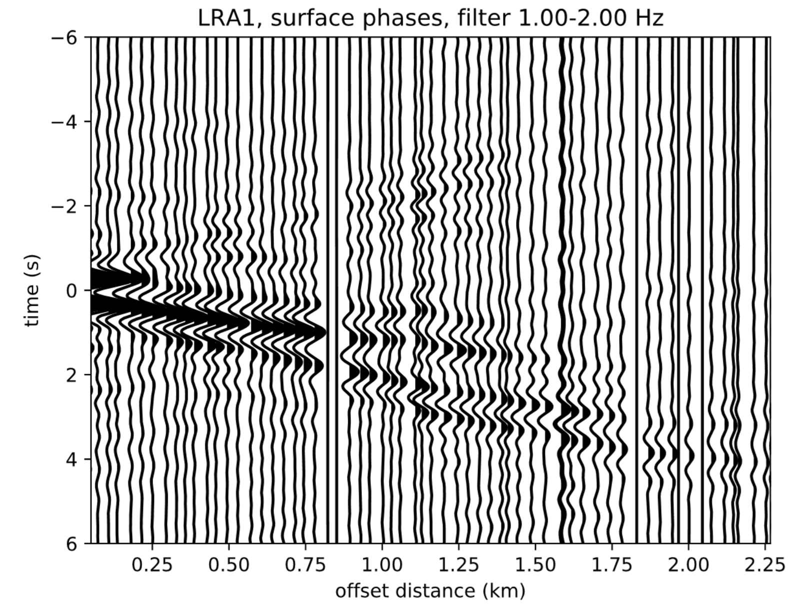


Extracting amplitude information from ZZ (vertical) & TT (transverse) components

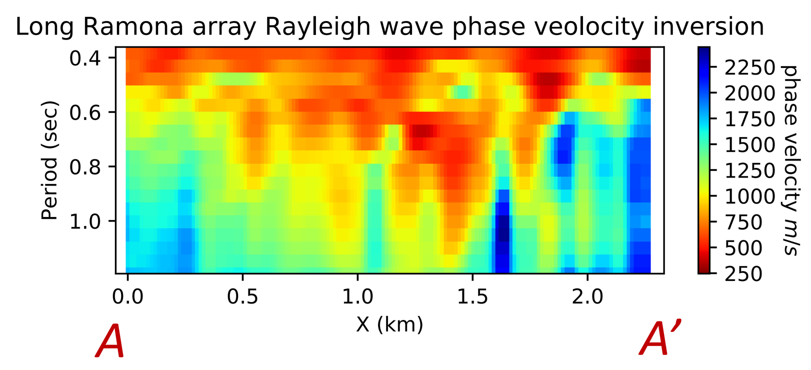
(ZZ) Leftmost virtual source: 0.6-1.0 Hz

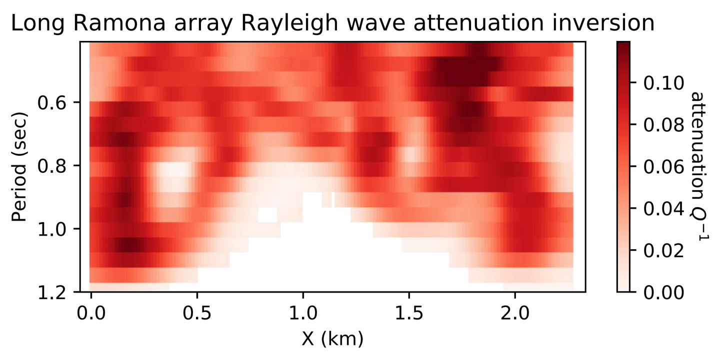


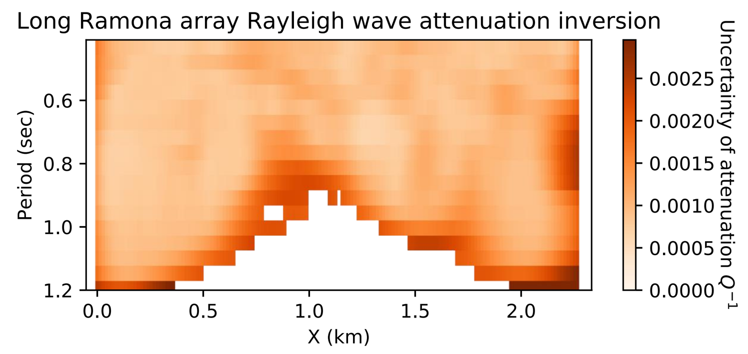
(ZZ) Leftmost virtual source: 1.0-2.0 Hz



Rayleigh wave phase velocity and attenuation





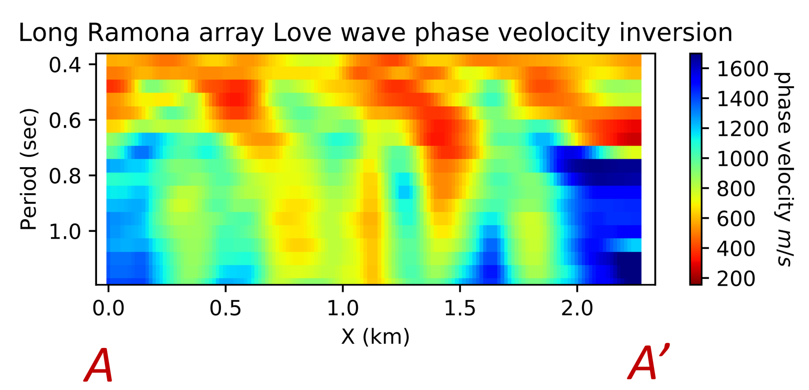


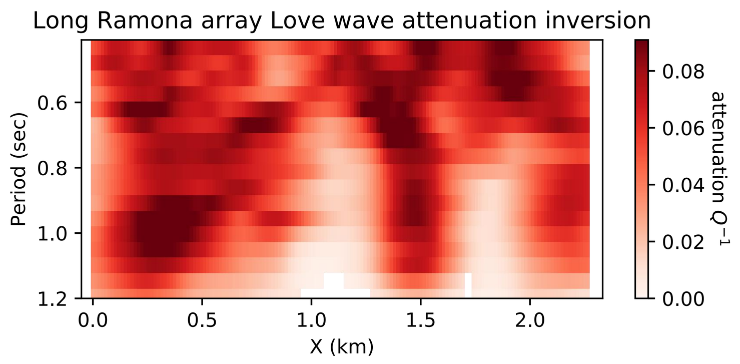
- Phase velocity inversion
- Linear least-square with neighboring smoothing

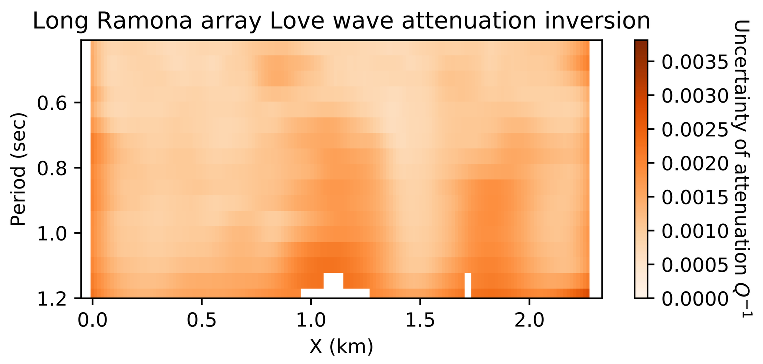
- Attenuation Q^{-1} inversion
- Linear least-square with neighboring smoothing

- Attenuation Q^{-1} uncertainty
- Derived from noise cross-correlation amplitude uncertainty

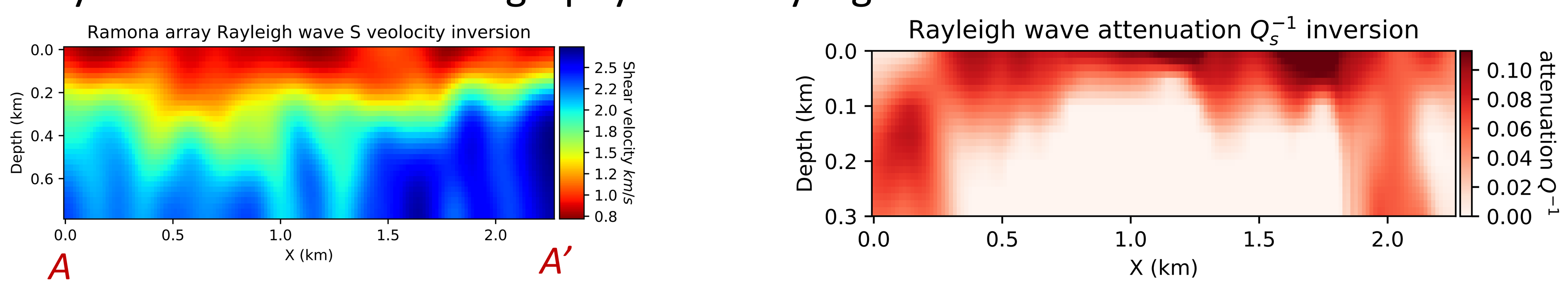
Love wave phase velocity and attenuation







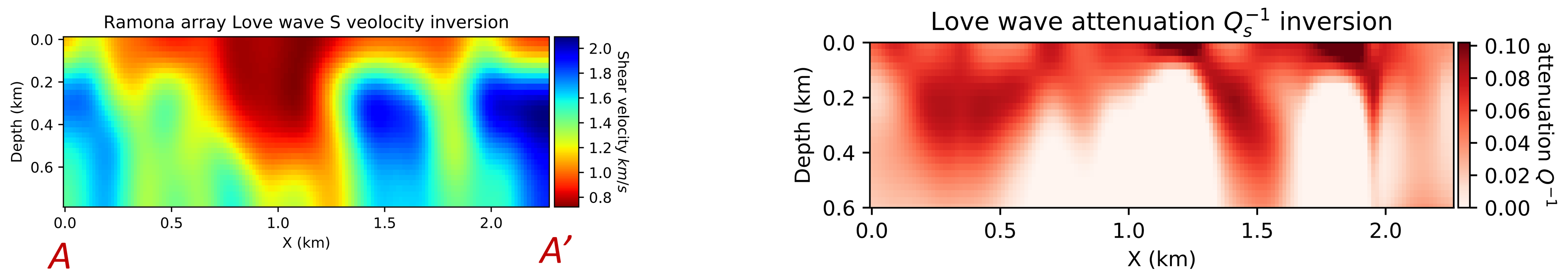
Shear velocity and attenuation tomography from Rayleigh wave



- Shear velocity inversion using MCMC
- Gaussian smoothing filter

- Shear attenuation depth conversion based on inverted shear velocity

Shear velocity and attenuation tomography from Love wave



Conclusion

- We derive reliable amplitude information with uncertainty and improve the linear triplet attenuation inversion approach
- Shear attenuation tomography results are preliminary and they complement the shear velocity tomography results
- Our attenuation tomography results for the Ramona array generally agree with the geological map of regional fault traces for Clark Fault

References

Liu, X., Ben-Zion, Y., & Zigone, D. (2015). Extracting seismic attenuation coefficients from cross-correlations of ambient noise at linear triplets of stations, *Geophys. J. Int.*, 203, 1149–1163, https://doi.org/10.1093/gji/ggv357

Liu, X., Nakata, N., Beroza, G., & Spica, Z. J. (2020). Characterizing the shallow subsurface structure with Rayleigh wave attenuation derived from ambient seismic field Correlations. (submitted)

Allmark, C., Curtis, A., Galetti, E., & de Ridder, S. (2018). Seismic Attenuation From Ambient Noise Across the North Sea Ekofisk Permanent Array. Journal of Geophysical Research: Solid Earth, 123(10), 8691–8710. https://doi.org/10.1029/2017JB015419